A Radical Proposal for Teaching, Learning, Assessment and Curriculum Development in Higher Education Computer System Development Courses for the 21st Century

Roy Irvine Morien

Naresuan University Graduate School, Naresuan University, Phitsanulok, 65000, Thailand
Corresponding author. E-mail address: roym@nu.ac.th
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Abstract

The intervention of the Internet has opened up enormous possibilities in Higher Education Institutions (HEIs), as well as offering significant challenges.

This paper outlines a new regime for Teaching, Learning, Assessment and Curriculum development in computer systems development education considered more appropriate to the 21st Century. The role of teaching academics is seen as being radically changed as implied by a new title, that of Learning Leaders, with a new set of responsibilities based around the development of on-line teaching materials, and the curating of MOOCs and other courses offered online. Students will need to shoulder significantly greater personal responsibility for their learning, but well-supported by the plethora of on-line teaching materials, allowing Anytime/Anywhere/Anydevice access to that and to the enormous universe of knowledge available on the Internet. Quality of students learning will be assured by a regime of Continuous Assessment with computer-invigilated assessment, peer-assessment, and longitudinal assessment being undertaken for formative purposes in parallel with continuous face-to-face meetings or teleconferencing with Learning Leaders acting as mentors and learning guides. Curriculum delivery will be based on a Super Project of industry-strength to take advantage of the significant benefits inherent in project-based learning plus other teaching and learning activities as appropriate with Blended Learning. Overall, the course will be conducted in an agile, iterative, collaborative manner, with inline QA.

Keywords: 21st Century Education, Agile Education, Project-Based Learning, Continuous Assessment, Leagility in Education

Introduction

As we come to the end of the first two decades of the 21st Century, it seems somewhat unnecessary to be making proposals "for the 21st Century". However, experience in and observations of teaching, learning, assessment and curriculum development at this time indicates that in many Higher Education Institutions very little that might be described as being a radical change from pre-21st Century practices has occurred. The classroom is still the primary learning space, albeit with lab connections to the Internet, teaching processes are still fundamentally the same, with a usual weekly 2-hour lecture, perhaps another 2-hour lab session using computer terminals, assessment is still fundamentally the same, with some 'continuous assessment' during the term, in some subjects a project sufficiently small to be finished in 12 weeks, and a final exam that may very well decide the student's fate which may be to return to repeat the entire semester or the full academic year. Curriculum is still subject to perhaps a 5-year review cycle, and students sit in classrooms listening to lectures as the main learning environment.

The Internet has been described as a 'disruptive' technology, which indeed it is, having the potential to completely overthrow the conventional teaching, learning, assessment and curriculum development processes that are gathered together under the heading of the Pedagogical System in the HEI, one of three major systems within any HEI. Rather than being considered 'disruptive', which is a pejorative term with negative and unsettling

implications, the Internet must be seen as offering enormous opportunities in education as have never previously been experienced. As well, the Internet introduces a vast extension to the curriculum required in computer system development courses.

To meet the educational challenges of the 21st Century, this paper proffers a radical proposal for teaching, learning, assessment and curriculum development in Higher Education computer system development courses for the 21st Century. The discussion in this paper is substantially derived from a Proposal that I presented to a Faculty at my University in March 2016 based on the foundation principle or philosophy of *Skills, know-how, knowledge and deep understanding*.

Why Computer System Development Courses

Primarily, because this is the area of expertise and experience of the author who, between 1986 and 2012 lectured on programming, database system development, systems analysis and design, and software project management. The primary theme of his teaching over the entirety of that period was "agility and efficiency in development", starting with his interest in Software Prototyping (Naumann & Jenkins, 1982), (Doke, 1990), (Gronbaek, 1990) using what were then termed 4th Generation Languages and application generators, with understandings of Rapid Application Development (Martin & James, 1991) and Rapid Development (McConnell, 1996) leading to the adoption of Agile Software Development (Manifesto for Agile Software Development, 2001), (Schwaber & Beedle, 2001), (Poppendieck & Tom, 2003) and currently Low-Code Development products (Outsystems, 2020; Caspio, 2020; Software Testing Help, 2020).

Secondly, consider the characteristics of computer system development courses. Most subjects require significant hands-on learning of both development processes, such as programming, and/or hands-on learning of development packages. This implies that most subjects are very practical and have little or no 'theory' that needs to be learned before the practical work begins. Indeed, it is considered to be a much more meaningful and educationally valid situation where, following the hands-on subjects, with all their trials and tribulations and difficulties for students, can be retrospectively reviewed with theories, principles, practices and methods derived. This is a much more rewarding, and indeed 'thinking' approach than requiring students to sit through interminable lectures of development theory and process that are then applied (and often not applied) in subsequent practical subjects. This view can be substantiated by the advice that I and many other lecturers have given to students, that the best way to learn a programming language is to have a problem that needs to be solved using that programming language. Similarly, and perhaps this is only my experience, when an ex-student returned to the university and boldly told me, possibly a little retributively, they had 'learned more in their first 6 months at work than they had learned in the whole 3 years of the course'. Well, there are several ways of interpreting this, including perhaps his failure to learn during the course. My reply to that student, however, was "That's not surprising given that you have spent 6-7 hours a day engaged in hands-on practical learning activity using a narrow scope of development tools and languages."

Learning Spaces, not Classrooms

Traditionally, and still, the vast majority of teaching and learning time is spent in the classroom, an enclosed physical space. Under my proposal, the classroom would become effectively obsolete, and the terminology of the 'learning space' substituted. First of all, the Internet is in itself an enormous learning space offering Anytime/Anywhere/Anydevice learning opportunities. with access to a volume of knowledge never before accumulated "in one space". The Internet allows us to define a 'learning space' as any location wherever that

has an Internet connection. As has already been demonstrated in many schools, colleges and HEIs, learning spaces can be open areas with coffee-shop style furnishings, complete with an internet connection for student-owned computers, a large tv monitor, a printer and a computer connected to the Internet, with a significant set of software installed for student use (and for students to learn, of course). We could use the term Virtual Classrooms to describe non-traditional physical spaces used to access content on the Internet. For example, from a very practical viewpoint, the hospital bed of a hospitalized students can be a learning space, or the hotel room of a student who is travelling away from home can be a learning space. However, it is practical and reasonable to consider the Blended Classroom where groups of students receive instruction from the Internet with a teaching academic present to monitor student learning and aid in understanding where necessary.

It is interesting to see the juxtaposition of the terminology of "21st-century learning strategies: creativity, collaboration, innovation and communication." With descriptions of Learning Spaces such as "Modern art and light fixtures, brightly colored walls and portable furniture create a vibrant, energetic learning space." (Charlestone Day School, 2020). The University of NSW in Australia describes its approach to 21st Century Learning spaces in these terms: "Flipped classrooms at the University of NSW place the class leader in the middle of working groups. The groups sit at desks and interact with shared screens. This style of learning develops career-strengthening skills in leadership and teamwork. Here, you are supported to lead discussions, share your insights, and collaborate with others.", and the Deputy Vice-Chancellor of UNSW described their new business building in this way: "the new building's interior was designed to meet students' needs ... it was hoped that the innovative architecture would foster creative thinking. The building's unconventional design reflected the university's move away from the most conventional form of teaching. "(There are) no more lecture theatres in our buildings because we think they can be done just as well online," she said. Instead, the building comprises smaller classrooms and meeting areas for hands-on learning after students watch lectures on the internet. (Griffiths, Andrew and Adrian Raschella, 2014). There are, in fact, a host of websites of educational institutions describing their "innovative classrooms" or "21st Century Learning Spaces" and so on.

Envisaging the Future

It is easy to envisage a situation where small groups of students, perhaps working as a formalized Learning Team, fill the Learning Spaces with chatter on the topic being studied, viewing and reviewing the videos, helping each other to understand and learn, encouraging each other. I would also envisage the situation where the students may decide to search the Internet for more information on particular points raised in the video being watched. This ability to link to other sources of information creates an active, extended, learning environment. Ideas are exchanged, explanations are given, curiosity is aroused, discussion can be wide-ranging, all creating a wide-ranging gathering together of knowledge. A rich, engrossing learning activity from the comfort of the beanbag or comfortable sofas.

Internet and Cloud-Based Course Administration

There is no doubt that the Internet provides the problems, the challenges and the solutions. In much of the discussion below, computer-controlled online attendance, computer-invigilated tests and quizzes, computer-based communications and so forth are either stated or implied.

I contend that the 21st Century education environment as envisaged here cannot be achieved without sophisticated Learning Management Systems that encompass all of those academic administration functions. In (Roland, 2017), the top instructional technology priorities are listed as:

- Personalized Learning,
- Digital content and curriculum,
- Professional development,
- Online Testing,
- Common Core state standards

And cites the technology necessary to achieve this:

- Communication and Collaboration tools
- Student computing devices such as Chromebook, or Tablet computer
- Classroom collaboration tools,
- Software apps such as Google Apps for Education
- A sophisticated Learning Management System (LMS)
- Mobile printing facilities.

Radical Change for Teaching Academics

- Teaching academics must become highly proficient at using the facilities offered by the Internet in their teaching activities.
- The terminology of 'teacher' or 'lecturer' should be abandoned and replaced by 'Learning Leader'. The role of the Learning Leader would include:
- Creation of professionally produced learning materials as interactive videos to be available to students on the Internet. There should be an on-going program of updating this video material, adding to it, retiring videos with obsolete content, monitoring students FAQ's to change or redo content that appears to be problematic, and so forth.
- Curate available online videos and learning materials from providers such as Udemy®, Youtube®, Pirple® and MOOC course providers and recommend to students for their learning and interest.
- Act as mentors, study guides, helpful assistants to students.
- Monitor the continuous assessment activities to identify at the earliest time students who are having difficulties.
- Learning Leaders will be readily available at specified times to have face-to-face meetings, or internet teleconferences, with students to ensure on-going student understanding and advancing in their learning task.
- Make continuous assessments of the learning efforts and progress of the student Learning Teams and individual students by observations and questions at the face-to-face meetings.
- The role of Learning Leaders as a stand-up lecturer presenting lectures to a group of students will be abandoned.

Radical Change in Assessment Practices

First, mid-term tests and end-of-term tests will be abolished. It is unreasonable to force students into the situation of having a single-attempt test at the very end of the semester or the academic year that will determine whether a student will be required to repeat the entire 16-week semester or even a full year. The psychological, economic and (especially in the case of Asian students), the familial and social consequences can be devastating. How much better would it be to be continually guided, mentored and assisted on a regular, frequent, continuous basis. The Internet offers a highly effective, efficient and cost-effective way to conduct assessment activity without requiring intervention or effort by Learning Leaders. This allows the concept of Continuous Assessment

as the primary assessment approach. This is derived from the Agile Software Development concept of Continuous Testing, Iterative Development, short periods of development with an expected 100% correct outcome.

Blended Assessment comprising a mix of computer-invigilated on-line tests done frequently, together with peer assessment, longitudinal assessment by a responsible Learning Leader, and self-assessment by the student. Assessment, while being summative, will primarily be used as formative assessment (Wabisabi Learning Blog, 2019). The recommendations of the NSW Education Department in Australia: New South Wales (NSW) (Department of Education and Training, 2008b) in Australia states in its publication *Principles of Assessment and Reporting in NSW Public School*s (NSW Department of Education and Training, 2008):

Assessment should be integrated into the teaching and learning cycle.

- Assessment needs to be an ongoing, integral part of the teaching and learning cycle. It must allow teachers and students themselves to monitor learning.
- From the teacher perspective, it provides the evidence to guide the next steps in teaching and learning.
- From the student perspective, it provides the opportunity to reflect on and review progress and can provide the motivation and direction or further learning.

and also NSW Government Assessment Standards Authority (2020),

- provides opportunities for teachers to gather evidence about student achievement in relation to syllabus outcomes
- enables students to demonstrate what they know and can do
- clarifies student understanding of concepts and promotes deeper understanding
- provides evidence that current understanding and skills are a suitable basis for future learning.

Certain less than appropriate assessment practices that are rarely acknowledged can be overcome by having a significant element of computer-invigilated assessment. With an appropriate Learning Management System that records student on-line attendance, presents quizzes and tests that the student does online, with the computer recording the result, no interference with results is possible.

I would suggest that any student doing these online tests or quizzes be able to repeat the activity as many times as necessary to achieve a 100% score. We need to stop considering scores of 50% as being indicators of learning achieved and see the corollary as being indicators of learning failure.

Radical Change in Student Learning Practices

- Students will form Learning Teams comprising 6 students to a team. At regular intervals, members of the team will be exchanged with other Learning Teams.
- Learning Teams will have the joint responsibility to assist and encourage other team members in their learning activity, behaving where appropriate as mentors, and sharing knowledge.
- Learning Teams will be self-managed and should provide students with insights into matters regarding teamwork, team leadership, intra-team conflict, collaboration and cooperation.
- Team members will be responsible for peer assessment of other team members on a regular basis.
- Learning Teams will regularly meet a Learning Leader in face-to-face meetings or internet teleconferences to report progress, present peer assessments of team members, and report on the progress of learning and progress of the Super Project.

Radical Change in Curriculum Delivery Practices

Keeping in mind that the suggestions in this proposal are specifically intended to be for computer systems development courses, it is suggested that the overall course be based on what I term a Super Project.

The Super Project

The Super Project will be an industry-strength project that is commenced at the start of the course, continues as the primary curriculum-deciding activity, until the end of the course. I do not stipulate 'the end of the project' because there is no requirement to finish the project. The value of the project is found in the learning opportunities inherent in such a development project.

I would envisage a variety of projects be devised for an incoming cohort of students and undertaken with each Learning Team undertaking one project. Requirements are added at frequent intervals over the term of the project activity and these requirements are carefully curated by Learning Leaders to be both appropriate to the level of learning accomplished by the students so far, and ensure that the required curriculum in the Course is adequately covered.

By being involved in a hands-on project, confronting the problems inherent in team activities, being required to develop their own development standards, learning by hands-on experience the programming languages, database software, development assistance packages, and necessary documentation and progress reports, the students will develop problem-solving skills of considerable benefit in their later careers.

By having a course-long project, students gain a significantly better understanding of software development problems and become much more involved in the project. The benefits of project-based learning are well-documented in a myriad of learned and academic articles. This is acknowledged by system development lecturers now, with the requirement for students to complete a small, semester-limited project appropriate to their particular subject. This practice is almost useless in that students have no opportunity to confront changing requirements, it is usually an individual effort and where it is a team effort, this offers poor students the opportunity to hide behind other group members' efforts.

Continuous Assessment of the students' learning will occur, with appropriate diaries, worksheets, regular meetings with a Learning Leader allowing observation of student effort and progress, peer assessment and so forth.

The Course as a Project: An Agile Approach

If we define a project as "A project is a purposeful activity being undertaken by, or intended to be undertaken by, one person, or a group of people acting together as a team, with the intention to achieve a useful outcome" then an education course is a project in itself. Students and (now) Learning Leaders are a group of people undertaking a purposeful activity with the intention to achieve a useful result. In (Morien, 2015) I discussed treating a course as an Agile Development Project, applying Agile Software Development principles to that project.

By way of this thinking, a computer software system development course can be run as an Agile project, with short iterations where each iteration, of 2 weeks, can be an intensive learning activity with an end of iteration computer-invigilated quiz or test. Agile concepts of iterative learning, continuous assessment, in-line QA with a high level of collaboration between participating parties. Student progress can be planned and reported in accordance with the artefacts and requirements of the Scrum Agile Method (Manifesto for Agile Software Development, 2001). For example, each student Learning Group would be required to keep several documents

to report their activities and provide an audit trail of activity.

- The Project Backlog: a continuously updated list of matters to be dealt with.
- Student Personal Backlog: a list, taken from the Project Backlog, of the matters that the student undertakes to deal with.
- Student Activities Diary: a diary of students' effort in dealing with the matters in the Student Personal Backlog, including problems, solutions found, personal commentary of progress and success, and so forth.
- Student Outcomes: the student should be able to demonstrate the actual outcomes achieved for each of the items in the Student Personal Backlog, that can also be checked against the Student Activities Diary.

By this means a responsible Learning Leader has available a longitudinal record of the student's effort and achievement that will enable the Learning Leader to contribute to the student's assessment outcomes.

Student Retrospection on Hands-On Learning

It is the opinion of the author that there are too many subjects that are theory-based where there is essentially a promise that the theories will be seen to be relevant in some forthcoming subjects. For example, to teach a particular software development method intending that to be adopted and elaborated in a future subject is a problem for various reasons. As well, given the large number of system development methods published since the 1980s when SDLC or the Waterfall Approach was first mooted, it is futile to teach a particular one. Graduates who subsequently enter the workforce will almost inevitably find that their carefully learned, now favorite development method has no place in their new place of work.

In the course development approach suggested here, it is inevitable that students will, by their own experience in the Super Project, come to realize many things about project development. This will include the need for an organized approach with agreed standards and common practices, useful documentation, and so on. Late in the course, possibly as a final year project, the students would be required to write a retrospective analysis of these matters, with a comparative assessment of several published methodologies. In my view, the students would benefit far more from making their own mistakes, arriving at personal realizations and then subsequently writing what is essentially a mini-thesis on the subject, rather than being forced to learn a particular lecturer's particular favorite method.

Curriculum Coverage – Adequate and Appropriate?

Academic staff are, or certainly should be, able to state a nearly exhaustive list of important curriculum topics and components that the students need to learn to be sufficiently proficient to graduate with a Degree. In computer systems development courses, students will need to become proficient in programming (including proficiency in more than one language and ability to learn other languages), database management (ER Modelling, Relational Databases, NoSQL databases), Analysis and design methods (and supporting tools), and so on. Careful consideration of what, and when, to include new requirements in the Super Project will ensure that all of the main and major curriculum topics are covered. Students should be encouraged to strike out on their own to discover other interesting facts and packages and languages and learn them for no other reason than it is interesting. This self-guided learning may well garner assessment.

Considering the nature and extent of the Super Project, and the student effort required, it is certain that students will not only graduate with a high level of proficient and hands-on skill in the practical aspects of systems development but also in the soft skills of problem-solving ability, teamwork, team leadership, independence of thinking, creative thinking and so on. There is no doubt that the Curriculum Coverage enabled

by the Super Project concept will certainly be adequate and appropriate.

Batch Processing versus Fast Tracking

In the manufacturing world, there are, inter alia, two basic approaches to production. One, the time-honored batch processing where the production line is geared up to produce a large volume of one item before being realigned to produce a large volume of another item. This is quite opposite to the idea of adaptive processing that may be traced back to the Toyota Motor Company and discussed in (Morien, 2005a). This approach to production allows short production runs, with almost individual item changes, without costly changes to production facilities.

This approach can be applied in a course. If some students wish to accelerate their course progress, to fast-track through the course, then having the required learning matter available online for Anywhere/Anytime/Anydevice access, with substantially computer-invigilated and marked tests and quizzes, removes impediments to that fast track progress. Most HEIs have an often long Semester Break, usually with Christmas and New Year holidays, and students leave the university and go home. Again, should a student Learning Team wish to remain at the university and carry on learning, a 4-year course can effectively be completed in 3 years.

The Prime Minister of Australia, supporting a major report into reforming education in Australia, was talking about essentially this. One of the key-points of the PM's support for reform was "The report says that too many Australian children fail to reach their potential at school because of the restrictive nature of year-level progression". In other words, he was saying that the current batch processing of cohorts of students with little opportunity to Fast Track and progress ahead of the batch, is educationally unadvised. The headline to the article being references include the phrase *"... the (educational report) calls for a move from mass learning to tailored education."* (Robinson & Natasha, 2018),

We can learn a lot about this area of activity from the literature on Agile Supply Chain and Logistics, which the author has adapted to the HE industry (Morien & Limthamrong, 2018; Morien, 2019).

Lean Practices in Teaching and Learning

Lean management and lean practices have the purpose of ensuring efficiency in processes, and the eradication of practices that either do not contribute to the process outcome, and are thus waste, or modification of current processes to achieve cost-efficient outcomes.

There are three major processing systems in HEIs: (Morien & Limthamrong, 2018; Morien, 2019)

1. The HEI General Administration System, which includes all of the general administrative functions necessary for the HEI to continue operations. These functions include HR Management, Payroll, Purchasing, Accounting, Budgeting, and so on. These are candidates for 'lean analysis', and are the typical systems considered when discussing the application of lean thinking in an enterprise.

2. The Education Support System, which we define as including all of the administrative functions necessary for the university to accept students, enrol students, organize teaching timetables, control student enrolments in subjects, handling fee payments, recording examination results and grades, appeals against assessment, controlling graduate research and dissertation submission, and can also be seen to include the decision making processes for offering new courses and subjects and deciding on curriculum. As essentially administrative, the Education Administration System is also clearly a candidate for 'lean analysis'.

3. The Pedagogical System, which we see as including all of the processes and activities involved in designing curriculum, sourcing, developing and presenting the curriculum to the students, making learning materials available to students, 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. So anything to do with Teaching, Learning and Assessment is included in the Pedagogical System.

It is this latter system and all its components and activities that we see as being of particular relevance when considering 'agile education' or, also terms used in the literature, 'agile classrooms' and 'pedagogical agility'.

In computer courses, lean practices can be introduced to streamline curriculum delivery. In the conventional course structure, separate subjects are essentially silos of information which, when analyzed can be seen to be closely associated, so closely that they can be effectively combined. For example, systems analysis methods are usually taught in a subject silo, and that system analysis method may be directly applicable and appropriate to a database systems development subject where a system is being developed. The database systems development subject will usually require a small, semester-limited development project that will require programming activity and development tools usage, both of which may be taught in other subject silos. In (Morien, 2014), (Morien, 2016), it was suggested that, in these conventional style course structures, these subjects could, and should, be amalgamated. After all, programming code specific to database systems is required, a database system development project can be undertaken using a development methodology, and an ER Model, data modelling approach is recommended. In the Super Product based course, at each step, or iteration, of the project development, database concepts can evolve as needed, and programming requirements can also evolve, and the development methodology is elaborated as required, over the course of the project.

Proof of Concept – is the Super Project Proposal Viable?

For two years, in 2001 and 2002, the author was the Lecturer-in-Charge of the students' Capstone Industry Experience Project Units at his university in Australia. Students had a year-long project to satisfactorily complete to finish their course and be entitled to graduate.

For the first time in that Faculty, the projects were undertaken according to principles and practices of Agile Software Development and Agile Project Management. Prior to this, the projects had always been undertaken in the traditional manner: the first semester was dedicated to the development of the Requirements Specification Document, and the second semester was dedicated to the development of the system in accordance with the Requirements Specification. Indeed, the students had never been introduced to Agile Development Methods in any meaningful way. Where they were previously mentioned in, perhaps, a Systems Analysis subject, they were deprecated and taught as second-tier methods of little real value.

The author initiated the use of Agile Methods with a single lecture that described the concept of Iterative Development, short development cycles, continuous assessment of outcomes and the highly collaborative nature of this method. The students were given permission to develop in this way, indeed exhorted to do so. Following that first and only lecture, the students were told to begin development immediately, as soon as a coherent and defined requirement was elicited from the client. As most of the projects were typical database processing systems, the students were also given information about the ER Modeling methodology developed by the author, termed Focal Entity Prototyping first published by the author in 1992 (Morien, 1992) and subsequently (Morien, 2005c), (Morien, 2017). The outcomes of these projects were highly satisfactory. The students thoroughly enjoyed the freedom and lack of tedium in the development of voluminous documentation, they

thrived on the hands-on practical work, they developed a well-grounded respect for the need for project standards and appropriate documentation, and the systems developed were in almost every case lauded and applauded by the client. This was the case in as reported in (Morien, 2004a, 2004b) and (Morien, 2005b, 2006), (Morien, 2008).

The author has absolutely no doubt that the Super Project concept will prove just as valuable in giving the students hands-on practical enjoyment of developing the system, and be an excellent platform for curriculum presentation.

Further Supporting Bibliography

This section lists several articles, videos, websites and blogs that support the proposals made in this paper. The three main areas of interest included here are Learning Spaces, Project-Based Learning and Assessment.

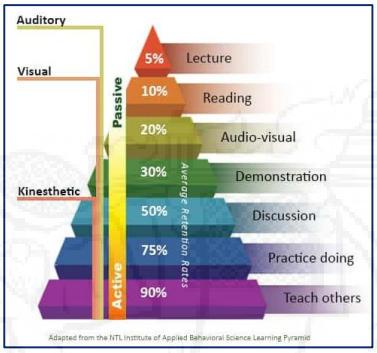

Figure 1 Source: https://www.educationcorner.com/the-learning-pyramid.html

21st Century Learning Spaces

Figure 1 is a rendition of the Learning Pyramid that represents the efficiency and effectiveness of different teaching and learning processes.

Broadly, it indicates that students attending lectures retain only about 5% of what is presented in the lecture, assuming that the lecture is 100% verbally presented. By having displayed lecture notes would add a further level of comprehension by reading those displayed notes.

What is startling about this pyramid is that it indicates that teaching others results in 90% information comprehension and retention, and 'Practice Doing' which implies hands-on, practical work, results in 75% information retention.

This Learning Pyramid has been criticized in a variety of ways, but any teacher or lecturer will agree with the general principles drawn from this Learning Pyramid. That is, to apply a phrase that I have often uttered "When we teach we learn", and also hands-on practice is the best teacher.

Clearly, a move away from classroom instruction towards other forms of information presentation will increase students' learning and information retention.

NIST International School. (2019). *Rethinking Learning Spaces for 21st Century Schools.* Retrieved from https://www.nist.ac.th/rethinking-learning-spaces-21st-century-schools/

... many schools continue to construct their facilities with traditional, and arguably outdated, classrooms and resources. NIST began shifting away from this several years ago as we incorporated current research, student and teacher feedback, and expert consultants into the design process. From the bright multi-purpose spaces in The Hub to the open, engaging Mechai Learning Commons, many of the areas in the school's buildings now resemble workspaces of cutting-edge companies rather than classrooms.

APO. (2010). *21st Century learning spaces.* Retrieved from https://apo.org.au/node/20236

A new environment of schooling has been emerging over several decades of the 20th Century, stimulated by a new economy, new technologies and new understanding about learning. In today's interconnected, technology-driven world, learning typically takes place in physical, virtual and remote places. It is an integrated, highly-technical environment in which learners learn. The new learning spaces incorporate technologies, engage the learner, creating new learning possibilities, enhancing achievements and extending interactions with local and global communities.

George Lucas Educational Foundation. (2018). *Getting rid of the lecture bottleneck.* Retrieved from https://www.edutopia.org/article/getting-rid-lecture-bottleneck.

"The lecture is a bottleneck for several reasons—one size does not fit all in learning; there's no replay, rewind, or fast-forward button in a lecture; and a large group of students are all dependent on one teacher to access learning."

Wawasan Open University. (2019). *Characteristics of a 21st Century Classroom.* Retrieved from http://woulibrary.wou.edu.my/weko/eed502/Characteristics_of_a_21st_Century_Classroom.pdf

The 21st Century classroom is student centered, not teacher centered. Teachers no longer function as lecturers but as facilitators of learning. The students are learning by doing, and the teacher acts as a coach, helping students as they work on projects. Students learn to use the inquiry method, and to collaborate with others--a microcosm of the real world they will experience once they leave the classroom.

Preference for Project-Based Learning

Harriss, H. E. (2014). *Architecture Live Projects acquiring and applying missing practice-ready skills, PhD, Oxford Brookes University.* Retrieved from https://radar.brookes.ac.uk/radar/items/7504258d-d3e9-4ee5-8350-ff0028035e3a/1/

Live Projects can enable students to acquire the three skillsets due to their ability to offer experiences that more closely align with professional practice.

Thomas, J. W. (2000). *A Review of Research on Project-Based Learning.* Retrieved from https://www.nido.cl/uploaded/pblresearch2.pdf

There is ample evidence that PBL is an effective method for teaching students complex processes and procedures such as planning, communicating, problem-solving and decision-making"

Zouganeli, E., Tyssø, V., Feng, B., Arnesen, K., & Kapetanovic, N. (2014). *Project-based learning in programming classes – the effect of open project scope on student motivation and learning outcome.* Retrieved from https://folk.ntnu.no/skoge/prost/proceedings/ifac2014/media/files/2412.pdf

The effect of project work on learning outcome cannot be emphasised enough. This is in accordance with other studies (Blumenfeld et al., 1991). Biggs and Tang (2007) underline also the importance of student motivation, expectations of success and alignment of teaching methods with intended learning outcomes.

Hanh, C. (2015). Project-Based Learning: 5 Key Features to Motivating Students. Retrieved from https://www.linkedin.com/pulse/project-based-learning-five-key-features-motivating-students-hahn/

Central to the concept of project-based learning is putting students in an active role, encouraging them to explore a real problem in an area of interest to them and without a predefined solution. This is effective when teaching STEM (science, technology, engineering and math) subjects as it brings theory to life and closely mirrors the problem-solving required in science, engineering and math careers. Project-based learning also teaches additional skills such as teamwork and critical thinking, vital for any future career.

Blumenfeld, P., Soloway, E., Marx, R. W., & Krajcik, J. S. (1991). Motivating Project-Based Learning: Sustaining the Doing, Supporting the Learning. *Educational Psychologist, 26(*3&4), 369-398.

We have argued in this article that there is considerable promise in the notion of project-based education to enhance motivation and thought ... Projects in which students pursue long-term investigations of a significant question and produce artefacts that represent answers to those questions have the potential to motivate students and help them better understand subject matter content.

Tse, W. L. (2003). Application of Problem-Based Learning in an Engineering Course. *International Journal of Engineering Education, 19*(5), 747-753.

In this paper, a new approach is proposed using the problem-based learning technique to convey such engineering knowledge. A creative group project was designed for the class whereby students were required to develop their own way of designing a calculator using MCU. Throughout the project, they acquired self-learning techniques to tackle new problems. Moreover, problem-based learning provided students with a cooperative learning environment to enhance their learning capabilities.

Preparation for a Career

While it is acknowledged that HEIs are not training schools, and the education provided at HEIs must incorporate a broader range of subject matter that might be found in a technical college, preparation for a career is still essential. Graduating students should be able to enter their first career position with a set of useable and useful skills that they have the ability to apply in a meaningful, practical and valuable manner without the need for close control and monitoring. Those skills should encompass a wide range of 'hard skills', including programming in 2 or more languages, database development for both Relational and NoSQL databases, knowledge of several packages and utility software including office products, communication products, search engines and so on, as well as the soft skills of teamwork, problem-solving, creative thinking and personal ingenuity and imagination. It is certain that after three years' practical hands-on development, teamwork, project management and so on, the new graduate will possess, and be able to apply, that set of skills. There is no doubt that potential employers will applaud these characteristics and skills and the graduate will enjoy full employment opportunities.

Conclusion

Higher Education in the 21st Century can be and must be, vastly different to even 10 or 20 years ago. The advent of the Internet has, as in many industries, been a hugely disruptive force, but, again as in many industries, has proffered great challenges and opportunities that must be grasped and pursued. This paper offers a radical re-think on all aspects of teaching, learning, assessment and curriculum made possible by the facilities of the Internet, together with the principles and practices of what is now being termed "agile education" or "agile pedagogy". The particular academic area targeted is that involving computer systems development education, which encompasses courses on information systems, computer science, business computing, among others. This does not mean that the ideas presented here are restricted to this academic area.

The radical changes to all aspects of computer systems development education proposed here are in fact well supported by the literature, and certainly by the author's personal experience as published in many papers.

To end on a friendly, encouraging note, we apply an old motto from way back "Try it, you'll Like It".

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