A System Strategy for Higher Education

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Abstract

The exponential growth of technology and artificial intelligence means that the world is rapidly changing. Education is not exempt from this trend. New ways of engaging and teaching are needed. This need has been exacerbated by the arrival of the Coronavirus which is stimulating higher education to re-evaluate its approach to teaching and learning. This is a conceptual paper which looks at several theories and philosophies that underpin all forms of "learning" especially those theories coming from the Systems paradigm which the authors consider is essential for future higher educators. Based on these theories, a new approach to higher education is proposed and an example given of how it could work in practice. The paper provides a platform for further discussion and debate to support the strategic vision and direction of travel for higher education.

Keywords: Higher Education, Cybernetics, Systems Thinking, Learning Theories, Active Learning.

1 Introduction

This conceptual paper is a discussion document on new ways of disseminating information at university level that is based on the work of three experienced practitioners in the field of higher education. It integrates current understanding of how the human brain works, what sort of knowledge will be need in the 21st century and how this can be combined with technological developments to provide an education in a more digitally enabled society. It also draws on the well documented differences between teaching mature (andragogy) and younger learners (pedagogy). Mature learners are normally more self-directed, independent and can draw on pervious learning experiences. This allows any curriculum designed for their needs to be more student centred, application based and focus on problem solving. Savicevic, (1999) (who coined the term andragogy), explicitly claims andragogy as a discipline, the subject of which is the study of education and learning of adults in all its forms of expression' (Savicevic, 1999, Henschke, 2003, Reischmann, 2003). New teaching methods will necessitate new evaluation techniques which, it is suggested, may involve much more self-criticism and reflection The hypothesis proposed is that higher education will need to consider new teaching and evaluation methods to better fulfil a meaningful future role in society. The methodology adopted to examine this hypothesis is to use the participant-observation experience of the authors who have spent their working lives in universities and supplement it with secondary data in the form of extensive research in the literature, publications and on-line information. This paper concludes with suggestions of a new approach to teaching and evaluation in higher education institutions.

2. Background

The standard ways of disseminating knowledge (such as books and lectures by experts to a group of learners) has been in existence for hundreds of years. Advances in technology and the different attitudes of today's society means that new dissemination methods are now both possible and needed. Although the future cannot be predicted with certainty, the lockdown due to the Coronavirus has led to a greater uptake in the use of certain digital tools within the education sector. These include webinars, podcasts, online collaborative tools such as Microsoft Teams and Zoom, open education provision such as

Massively Open Online Courses (MOOCs) and M-Learning (learning via mobile devices). These tools are useful but are not sufficient. They need to be integrated together to provide a new dimension of collaborative and social models of learning. The paper suggests that the solution is not simply to improve and increase on-line learning but to incorporate it into different methods of delivery which fully utilise the advances in modern technology and neuroscience research. The avenues that this paper explores are Concept Formation, Cybernetics, System Thinking and Learning Epistemologies.

2.1 Concept Formation

Over the last twenty years there has been a complete revision of how the brain functions in particular in how it forms concepts. The classical theory was based on various assumptions and was known as the Triune Brain, shown in Figure One. Some assumptions for the triune brain were that there are universal "fingerprints" for feelings that are common to all humans and specific parts of the brain are centres for specific feelings. The brain was also seen as an action-reaction machine and by changing reality (environment) one can change the reactions i.e. feelings. Sagan (1986) popularised this version in his best seller on the development of human intelligence (Dragons of Eden) and Goleman (1995) used it in his book on Emotional intelligence. The theory was backed by well documented psychological experiments and was regarded as rational, intuitively sound and satisfying good common sense.

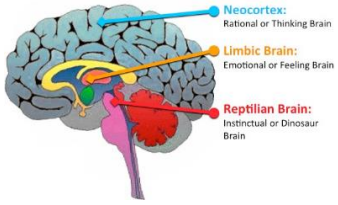

Figure One The Triune Brain (Source google)

However, when the previous experiments were repeated, many were found to be flawed and this model of the brain became discredited. There has thus been a movement away from the reactive brain (classical) to a constructivist one. (Barrett, 2017) All areas of the brain work together as a whole i.e. as a system. Some major discoveries are:

- Both beliefs and emotions are constructed by the brain by what is termed the "interoceptive network" This network has input from the senses AND the body and each input requires energy
- The sole purpose of the brain is to keep the energy budget of the brain in balance. The brain is working continuously and is bombarded with incessant, noisy, ambiguous and has to make sense of them. It does so by making educated guesses of what will happen next (predictions) which are based on past experience and feelings
- The brain continually compares these predictions with inputs and makes a correction if needed. The interoceptive network also takes energy into consideration and then initiates an action. This whole process takes milliseconds and is unnoticed by the person who believes the action is a reaction to a stimulus. It isn't. It is a reaction to what the brain perceives to be reality. Thus, reality is only what you believe it to be
- These mechanisms have evolved over the millennia and cannot be changed. The consequence is that to change behaviour, one has to work on the material that the mechanism accesses – past experiences. Current events become the past and so we must build up a set of pleasurable events which were effective (and therefore can reinforce belief).

It is now also believed that emotions play a large role in the learning process (Dimasio 2005). This has implications for education and means that approaches to education should enable the learner to connect to the sub-conscious levels of their brain.

2.2 Cybernetics and Systems Thinking

The science of Cybernetics arose from the conferences sponsored by the Joshua Macey Foundation and ran from 1941 – 1960. Their aim was to pursue meaningful communication across all scientific thinking and thus to provide an integrated framework that would unite Science. The first conference, which was entitled "Feedback Mechanisms and Circular Causal Systems in Biological and Social Systems", was attended by an unprecedented network of great minds at the time and included Norbert Weiner who coined the word "Cybernetics"(Weiner 1948) The word is taken from the Greek word "kubernētikós" meaning steersman. Cybernetics can be called the science of organisation or control. It posits that there exist general laws that govern effective control and these laws are applicable to all levels and all sizes of organisations. The original cyberneticians realised that to be effective, their new discipline must cover all knowledge. This led them to Systems Thinking and the two subject areas have developed together in similar ways.

The word "system" has several different meanings in English. It can mean "how to" - *We have a system for playing Roulette. We use the ACOL bidding system in Bridge.* This is not the meaning in this paper. It can also mean a set of rules and regulations – *they are always trying to beat the system*. Again, this is not the meaning in this paper. A final meaning connects it with computers or machines – *We have a systems problem. I am using word processing system*; *All conferences put in place a feedback system* This latter would be the design, distribution and analysis of a questionnaire and is not a system as we mean it. For this paper, the definition of system is taken from Ackoff. 1971)

> *"A system is a set of parts where no single part has an independent effect on the whole. The way that a part affects the system depends on what the other parts are doing at that time. Thus, a system is a whole that cannot be divided into independent parts."*

One important aspect of this definition is that the essence of a system comes from the interaction between its parts and not on their individual existence. Another is that there are properties of any system that only belong to the whole and not possessed by any of its parts. One can improve the performance of the parts taken separately but this will not guarantee that the performance of the whole would necessarily improve. (It could even get worse!) It's the way the parts fit together that determines the performance of a system. Other important features of a system are:

Boulding (1956) suggested different levels of systems which are becoming more complex. The first five covered static frameworks, clockworks, thermostats, life systems, plant and animal systems. Level six is the human level: *"... the individual human considered as a system… In addition to all, or nearly all, of the characteristics of animal systems, humans possess self-consciousness, which is something different from mere awareness*". Self-reflexivity is *"... bound up with the phenomenon of language and symbolism"*. Level seven is the level of social organizations. *"The unit of such systems is not perhaps the person- the individual human as such – but the "role"- that part of the person which is concerned with the organization or situation in question"*. Like any other classification, Boulding's one can be questioned. It is however to be noted that, after nearly 40 years, it has not been basically contradicted by any subsequent experimental or theoretical development. This paper deals with levels six and seven.

Several other features that characterise systems are:

Interdisciplinarity The Macy meetings included mathematicians, neuroscientists, anthropologists, social scientists, computer pioneers, information theorists and psychologists. As cyberneticians strongly believe that knowledge cannot be compartmentalised, it is important to approach problems from as many different perspectives as possible. In the present UK education system, it is almost impossible to do any interdisciplinary teaching. The reasons usually given are difficulties in getting funding, timetabling and performance measures but no-one denies the need! It is interesting that interdisciplinarity is being encouraged in research funding whilst

evaluation is still subject based. These cybernetic ideas mirror the current thinking in diversity leading to more innovation and creative thinking

Non-linear behaviour. Both Cybernetics and Systems thinking recognise that most behaviour (especially of humans) is non-linear (now called Chaotic behaviour). In a non-linear system, small changes in the input can cause large changes in the output. The usual example is that of the weather where small fluctuations of temperature, or rainfall in a far-away country can cause tornados in another locality. The learning pattern of learners is generally non-linear and thus non-predictable, so the approach must be flexible and adaptable to many circumstances. There is an advantage also that small changes in the teaching methodology can lead to large improvements in the results.

Feedback The notion of feedback has been with us from ancient times but the new thinking by Wiener (4) introduced circular causality where the output was fed back into the input. The simplest form of this is the thermostat, which is termed a self-regulatory system, but Wiener advanced the idea of a self-adaptive system where the targets of the system can be identified and when needed changed by the system itself. An example is "Assessment for Learning" where assessment will feed into future learning for the student. (Black et al, 2003)

To fully appreciate the power of Systems Thinking it is important to look at the other major paradigm which is Scientific Thinking. This rests on the shoulders of three giants: Descartes, Galileo and Newton. Descartes advocated the idea of Analysis i.e. the process of breaking down a complex problem into simpler parts. When the individual parts are solved, the individual solutions can be reassembled as a solution to the original, bigger, problem. As seen from Ackoff's definition of a system, this cannot be done with complex problems because every part depends on other parts. An alternative (used in System Thinking) is Synthesis which is putting things together rather than taking them apart. Analytic Thinking has been used for so long that it is difficult to accept that it doesn't work but if one looks at the major problems of the world today – climate change, destruction of the environment and nationalism, the deficiencies in the analytic method are clear. The ideas concerning analysis and synthesis have important repercussions in how we teach.

Galileo was the great experimenter. He initiated the concept of hypothesise- test – theorise. There has been much research by von Foerster (1960) on the relationship between the any measurer or experimenter and the measurement obtained and the results indicate that an experiment is not independent of the experimenter. Nevertheless, what has survived from Galileo's work is the Plan-Do-Check-Act (PCDA) method. This PDCA was adopted by the lean Philosophy and is often called "the Scientific Method".

Newton assimilated the ideas of Descartes and Galileo and combined them with newer areas of mathematics such as Calculus to produce a theory which was revolutionary and brilliant. It united many branches of science and could explain seemingly different phenomena such as the orbit of the moon, tides, comets and gravity. Space and time were absolute (as opposed to relative). A major plank in this theory is that of single cause and effect or "determinism" As with the analytical method of Descartes, the major problems of the world today such as climate warming and environmental change do not have single causes and need a multi-discipline approach..

2.3 Existing Learning Epistemologies.

Existing epistemologies that resonate with the theories discussed above can be seen in the work of the cybernetician, Gregory Bateson, and the psychologist Chris Argyris. There are also contributions from the work of two pioneering educationalists, Maria Montessori and Jean Piaget**.**

Gregory Bateson (1904 - 1980), an `eminent biologist and systems theorist' describes his work as an attempt to illuminate `the barriers of misunderstanding which divide the various species of behavioural scientists. He classified five levels of learning: (Bateson, 1972) Apropos this paper, level 2 allows corrective changes in the set of alternatives from which choice is made. For machines this would be self

-corrective systems. This is often called "learning to learn" Learning level 3 is change in the process of Learning 2, e.g. a corrective change in the system of sets of alternatives from which choice is made. This would correspond to what is called "a paradigm shift" Many current pedagogies are sited in level 1 which is a simple feedback loop but, in this paper, it is advocated that pedagogies should be sited in level "Learning level 2" i.e. their primary function should be to teach people how to learn. Bateson regarded learning as a systemic phenomenon which was inherently relational. The latter brings in the role of the observer- in this case the instigator and the seeker of the knowledge. Learning is seen as an emergent process. To quote Plutarch "*when the wood is ignited one cannot predict the type of fire*"
The work of Chris Argyris ("double loop learning.") relates closely to Bateson's levels one and three Level 1 is equivalent to a single feedback loop where learning: a situation is resolved by an action which then helps to clarify the situation. As humans, we have a basic need to develop a set of beliefs about why things are the way they are (our culture). But, knowing this desire to understand the world around us, we need be careful about the information and experiences we are using to create these "beliefs". Argyris (1991) found that there was a difference between what people actually believed and what they professed to believe. There are social pressures to "follow the herd. "Double loop learning tries to identify the real beliefs, and this creates a second feedback loop. This results in double loop learning which is shown diagrammatically in figure 2.

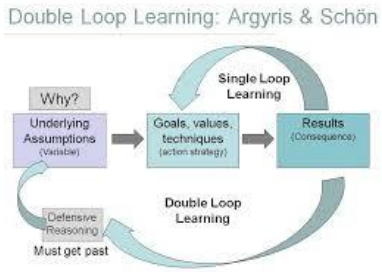

Figure 2

Double Loop learning Source Argyris and Schon

Here the context of a learning situation is examined (mental models). The organisational culture plays a large role in any learning and if new learning is needed then the culture must be changed. This fits exactly with point ten listed in the constructivist brain. The psychologists, Bavelas and Leavitt showed in a famous set of experiments in the 1940's that if you don't tackle these primary beliefs, you can end up with beliefs that have nothing to do with reality, but you believe just as vehemently as a cold hard fact. . It also links neatly with the mechanisms of the constructivist brain. This is known as Cognitive Dissonance. (Festinger 1985, Freeman 1978) What is needed is management or guidance rather than control. This recalls the idea of a steersman or, in modern parlance, a "mentor".
Valiant attempts to adapt the traditional pedagogy along these lines in schools were made by Maria Montessori and Jean Piaget. Montessori showed that pupils were quite capable of learning on their own with the help of a teacher as a guide or mentor. (Montessori, 1994) They responded well to choose i.e. choosing what to study and the manner in which they do it. This is not popular among educators as it is much more difficult to assess and is much more time-consuming than traditional methods. The modern education system decides on the content of the knowledge, the method which this will be imparted and the results that are correct. It teaches at Bateson's level 2 rather than level 1 which produces knowledgeable robots with little adaptability to different circumstances. This theory involves connecting with the emotions.
Jean Piaget's influence lay in his theory that there are levels of cognition and that people will not learn unless they are mentally at the cognitive stage to understand what is being offered (Piaget 1969). In other words, if someone does not understand a concept, it does not necessarily imply ignorance but

maybe that the learner is not yet ready for that learning. In education, it can be interpreted as meaning that learners must be ready (i.e. mentally prepared) to receive the information that is being taught. They must understand WHY they need to know before they learn to know. This connects with the ideas of Bateson (ibid).

A recent addition is on-line learning. On-line learning is not new. It has its origins in the US army where is was widely used in the training of new recruits. Over the last twenty years, it has grown in popularity and the lockdowns caused by the Coronavirus have greatly intensified the use of on-line learning. However, the approaches often used in online learning do not encourage active learning or lead to deep understanding. This is exemplified by the early versions of MOOCs which were mainly content based with little interaction required from the learner. This situation is now changing and has been driven further by the onset of the Covid pandemic. Technology Enhanced learning (TEL) is now being actively adopted and researched to provide a more engaging and interactive learning experience. (Passey, 2019)

3. A New Pedagogy

Any new educational approach should be set firmly in Level 2 of Bateson's taxonomy (REF) and enable them to take charge of their own learning. It should use TEL **to** engage the natural, creative side of the learners. According to Philipps (1988) Laurillard (1993) argues that the only use of technology which can meet these aims is the "multimedia tutorial simulation", characterised in terms of guided discovery learning. Her schema is based on forming an information rich environment in which the student has control in discovering knowledge, but the discovery is supported and scaffolded by extra guidance functions which provide support and feedback for subsequent learning. These functions are analogous to the coaching and scaffolding at critical times proposed in the Situated Cognition Theory. Laurillard argues that different media *forms* have different affordances, i.e. provide a different level of support for various kinds learning experiences. She identifies five media forms: narrative, interactive, communicative, adaptive and productive. According to Conole and Fill (2005),

> "*Narrative media tell or show the learner something (e.g. text, image). Interactive media respond in a limited way to what the learner does (e.g. search engines, multiple choice tests, simple models). Communicative media facilitate exchanges between people (e.g. email, discussion forum). Adaptive media are changed by what the learner does (e.g. some simulations, virtual worlds). Productive media allow the learner to produce something (e.g. word processor, spreadsheet)*."

This system and any other learning system need to address the issues of collaboration, curiosity, control, and context.

Collaboration

In the authors views, the ability to work alone is not a bad thing but it is more important to learn to work cooperatively. The Netherlands is currently trying to change its university funding system to reduce competition between academics for research grants, cutting the time spent on largely unsuccessful funding applications Strong incentives should therefore be created for learners to communicate with other learners. This could be verbal communication or the use of modern technology and social communication devices to connect to their peers in other faculties, universities and countries in either a synchronous or asynchronous manner. The benefits of this communication mainly arise from the peer to peer learning that takes place during these exchanges.

Learners need to be encouraged to work together in one large group or small teams. IPO can be an issue, but it would be better if all knowledge that is discovered is shared between the whole group. This fits with the concept of open education. Learners teach each other and in doing so, they must uncover the ideas and concepts behind their own beliefs thus becoming tutors themselves and utilising, albeit unconsciously, Argyris's double loop learning cycle. Any new pedagogy should emphasise synthesis

rather than analysis. The systems thinker, architect and futurologist, Buckminster Fuller (1961)invented the term "Tensegrity", (tensional integrity) which has applications in education where he believed that if one could construct a state of "creative tension" amongst the learners, then new ideas would emerge. It has strong links to the "Gestalt" theories in psychology. Even the poet, Shelley, defined poetry as a synthesis of myth, metaphor and reality. (Taylor 1919)

Curiosity

Objectives can be set for the learning, but they need not be precisely proscribed. The learning process should be allowed to follow its own path in a Montessorian or Piagetian manner. The group must have freedom to experiment and pursue new ideas within the boundaries of the study. This encourages interdisciplinarity and creativity. It incorporates the best of Montessori and Piaget ideals where the students can make choices in their learning. They set the agenda and the way they learn. The learners are encouraged to take charge and have responsibility for their learning. It recognises the non-linearity of the student behaviour and allows it to flourish. Because all knowledge is interconnected (holistic), the exact, precise knowledge that will be learnt cannot be defined in advance. It is emergent rather than determined.

As an example, in economics, supply and demand is an important topic. There are many established ways of looking at "supply and demand" from simple linear curves to utilising sophisticated mathematical techniques. It is important to find the right question. The question "What is the law of supply and demand?" is not a good one as learners can easily and quickly find the answer on the Web and the learning is over. A better question would be "How does supply and demand work?". Learners would then maybe find several explanations which they have to understand. Even better would be "What is the best way of explaining the behaviour of supply and demand?" this has the extra advantage that the learners have to start making judgements. A very good question (in the new pedagogy) would be "Devise a way of teaching your peer how supply and demand works". This combines all the previous comments plus their knowledge of how they themselves want to be taught. The students will be given the opportunity to start wherever they choose and to use their own experiences of "supply and demand". It could include ethical, moral and ecological aspects to the problem. The experience of the guide (mentor) will be essential here.

Control

To enable the students to learn from each other, teachers must cease presenting themselves as professors or experts but more as a guide for people who wish to discover new knowledge that will help them in their career. (One recalls the origin of the word Cybernetics - the Greek word "kubernētikós" meaning steersman.) Their function is that of a controller of variety – helping the student to attenuate the variety of knowledge that exists and amplifying their ability to access it. The teacher is no longer setting up the experiments as this would contradict second order cybernetic principles. Instead the learners are themselves the experimenters but because of the collaborative and communicative aspects of the pedagogy, they can realise the subjectivity of what they are doing.

For online learners there is more than the subject to learn: They need to learn the technical way of using the e-learning system which they are using. It is therefore important to provide a model of e-learning in which the participant can quickly explore the system and also learn how to communicate online.(Phillips, 1997) Salmon (2000,2002) has developed a model of structured e-learning activities which has the purpose of creating greater *interaction* and *participation* between participants in e-learning courses. She believes and has experienced, that for online learning to be successful and happy, participants need to be supported through a structured developmental process. The model is a "scaffolding" model. Scaffolding means gradually building on participant's previous experience. A structured learning scaffold offers essential support and development to participants at each stage as they *build up* expertise in learning online.

Context

Because, of the cybernetic view that all knowledge is interdisciplinary and should encompass a holistic perspective, the subject matter should include ethical, moral and social and economic aspects. Using the success of smart algorithms and robots, the emphasis in teaching can now be less on HOW to do something by WHY one would want to do it, or even, should one be doing it. Obvious examples are nuclear power, genetic cloning and fracking.

Building on these influences, a new pedagogy would follow an: holistic and interdisciplinary approach. It would use open source material in so far as the students will take advantage of the internet and all it provides in the spirit of Wikinomics. Students take charge of their own learning and literally "teach themselves". There should be management or guidance rather than control. The students are prosumers; There needs to be maximum interaction and communication between students (peer-to – peer) and the learning should use the latest technology. (M-learning and gamification)

These features are heavily influenced by cybernetic and systems thinking however the scientific process is still important. Learners will be encouraged to follow the PDCA philosophy -Plan, Do, Check, Act – which does not contradict any of the above features. It is an example of recursive learning as the cycle can be applied at all stages of the learning.

Another link with the constructivist theory is the role of emotions in learning. There is much work being done on what is termed "emotional learning" and these ideas must be incorporated into any new pedagogy. These ideas are extensively documented. (Goleman 2019) There are for major activities – self-awareness, self-management, social awareness and relationship management.

> *According to numerous studies over the last 30 years, Emotional Intelligence (EQ) is the most reliable indicator of success. It is more highly correlated with high performance at work than either IQ or personality type.* (Rodes et .al, 2017.)

When one is becoming more emotionally intelligent, one is increasing the granularity of one's concepts which enables to brain to make better predictions. Beer (1997) would say one is increasing the variety inside to cope with the enormous variety outside. Asby's law (1956) will apply here.

Part of this process could be termed "recategorisation," The more concepts you know and the more instances that you can construct, the more effective you can recategorize in this manner to master your emotions and regulate your behaviour. We can only guess how other people feel, so trainees must be encouraged to talk about their feelings (Goleman, ibid)) define their concepts such as what is work, how does one measure motivation? It is now agreed that people in close contact do synchronise their emotions.

4. Evaluation

Any new pedagogy must be able to respond to the following observations:

a) There are certain fixed and determined facts that the new generation need to know. The proposed pedagogy is too free – one does not know where it will lead.

One must question if there are any such incontrovertible facts. Let us consider research into Dinosaurs, Over the past fifty years, the "facts" have changed, such as: they did not exist; they were slow -moving, cold-blooded reptiles; they were hot -blooded, fast-moving reptiles; they were smooth skinned; they were feathery; they could not adapt to a changing environment or they were wiped out by a meteorite crashing into the earth. The same could be said about that most logical of all subjects- mathematics. In the 1960's non-linear behaviour was classified as "pathological" and now it is the cornerstone of modern mathematics. Since the arrival of the computer, mathematics has changed out of all recognition and most of the mathematics taught in UK universities in the 1960's is no longer used. What is important is the way mathematics can be applied and used to model phenomena. The same comments could be made about architecture, (it is impossible to build the 829.8-metre-tall Burj Khalifa in Dubai with classical architectural techniques); medicine, economics and the biological sciences. Much knowledge is quickly out of date. It is very difficult to decide what "facts" should be put into learner's heads. Part

of the new learning include past knowledge, so the learner would not be ignorant of the "accepted facts" but the new pedagogy would allow further exploration. As Donald Rumsfeld famously said "it is the unknown unknowns that are interesting"

b) Can such a pedagogy be applied to all areas of knowledge

This is possible a valid comment. Certainly, dentists and doctors need to know what current best practice is, and the time for exploration and creative experimenting is best left to the research laboratory. But this paper is not dictating what precise formats for the new pedagogy, only general principles. The authors certainly do not insist that it should be applied willy-nilly to evert situation.

c) What is the balance between competition and cooperation?

In the authors views, the ability to work alone is not a bad thing but it is more important to learn to work cooperatively. Margulis (1970) in her work on biological symbiosis and Lyn Ostrom who received the Nobel prise for her work on cooperatives (Ostrom 1998) both advocate the evolutionary and social need for cooperation. The Netherlands is currently trying to change its university funding system to reduce competition between academics for research grants, cutting the time spent on largely unsuccessful funding applications Changes proposed in a major review of the education sector mark a turn away from a competitive philosophy, reflecting growing Dutch concerns that the costs of pitting academics against each other in pursuit of funding have begun to outweigh the benefits (Jongbloed et al, 2109)

d) Is credible assessment possible?

The idea of measurement and assessment is ingrained into our culture. Systemic thinking (backed by the quantum theory) shows that what is measured is greatly influenced by the measurer. They are not independent. The question is – what are we trying to assess? The emphasis of the new pedagogy is to teach learners how to learn. This is cannot be assessed by traditional methods. If assessment is desired, then new ways of doing it must be created. The learners could even be assessed on their mistakes, in the sense of what they have learnt from making them. Assessment procedures should not dictate the teaching. The assessment should be of the journey – not the destination.

e) Is certification needed at all?

Certification traditionally is a degree for example, but does it need to be? There are digital badges now as part of MOOCs. What is it that people need to have? The authors suggest they need some evidence of their learning but the format this could take is an open question. Employers are already rethinking their approach as there are currently known certifications e.g. BSc MSc PhD and professional body accreditations e.g. Chartered Engineer. This raises the question of quality assurance. New procedures would have to be thought through. It's the quality assurance that is probably the biggest issue for new evaluation as one can now register for online courses but what is their value? Is the university name enough?

f) How can learners know what they should study? They need experienced teachers.

It is true that a novice will not have the same holistic view of the subject as an expert. But this is one of the roles of the teacher – to guide the learners. Thus, the teachers can use their experience and knowledge to guide not to direct. If the learners make mistakes, these will become obvious and the teacher can in a mon-judgemental way enable to learner to learn from these mistakes

g) *It would be very difficult to run such a pedagogy in the existing university structure*.

In fact, the current organisational structures at modern universities are incapable of conducting such a pedagogy. To do so will mean a major restructuring. Despite these difficulties, the authors believe it should be done.

6 Practice

The ideas expressed in this paper encourage creativity and thus a definitive process will not be set out. Several learning ideas have been explored and linked to the new constructivist model of the brain. It is

left to the group (learners and teacher). to agree on objectives and suitable methods for achieving them. Some suggestions are now given.

- An optimum size for a group is generally agreed to be five members but still, there is a danger that some students will dominate, and others will be in the shadows or even opt out. Part of the learning process will be the ability of the learners to deal with this. Soft Skills (which include group dynamics) should be a voluntary part of the process. Bavelas (1951) showed that more communication is achieved when there is a central point. This could be the mentor. The central point is not a leader but just enables the flow of information.
- There will be sessions on emotional intelligence.
- The process could include peer-to-peer interaction using blended learning. (Rossett et al, 2006) The instructor will cease to be the central focus and the primary disseminator of information but respond to questions while the learners defer directly to the instructor for guidance and feedback. Instead of individual lessons focused on an explanation of the traditional "supply and demand" theories. Blended learning will intentionally shift the instruction to a learner-centred model who will explore the topic in greater depth and in contexts meaningful to them They can then make the jump to generalised conclusions i.e. it is an inductive rather than a deductive methodology. Educational technologies will be available to 'deliver content' outside of the classroom. In this method, 'content delivery' may take a variety of forms - online videos, collaborative discussions, digital research, and text readings may be used. Workplace activities will vary but may include: experiments, peer reviewing and project-based learning. Because these types of active learning allow for highly differentiated instruction, more time can be spent on higher-order thinking skills such as refection. The instructor who is interacting with the participants in a flipped situation will be more personalized and less didactic, and the learners will be actively involved in knowledge acquisition and construction as they participate in and evaluate their learning.
    - An important part of the blended learning experience is software that enables the participants and their mentor to communicate frequently and easily and also provide access to all the learning material. This is the role of the Learning Facilitator which will be supplied free to all participants. A learning Facilitator (LF) should have the following three functions:
        i. It is a repository of all materials that will be used in the course. This includes the videos, the presentations, selected reading and examples from practice. The user can customise the software and add to it relevant information that is felt to be useful to the studies.
        ii. It is a communication device which enables the students to communicate with each other and with their mentor. These communications can be accessed by the mentor and will be used as part of the formative assessment.
        iii. It is a log of the student's involvement on the course and can be used in the assessment process.

The assessment could have a normative and evaluative part. The normative part will be provided by the LF. The assessor will be able to see the extent of the cooperation of each learner. Those who fully communicated with their peers and mentor and joined in the collaborative work can be rewarded. The evaluative part will be a significant reflective essay of around 20000 words where the learner will assess what has been achieved, what he has learned, what mistakes were made and how the results affect his attitude to the wider context. It could also include a viva.

7 Conclusion

The exponential growth of technology, robotics and artificial intelligence means that the world is rapidly changing. Education is not exempt from this trend and new ways of engaging and teaching must be investigated. This paper looks at several theories and philosophies that underpin "learning" especially those theories coming from the System paradigm which the authors think is essential for

today's world. Based on these theories a new pedagogy has been proposed and an example given of how it would work. With the changes in the education sector forced upon institutions through the Coronavirus situation, many are now re-evaluating their approaches to education. We believe the time is right for change and to adopt new ways of learning. This paper has outlined our proposed approach based on our experience and grounded in existing theory

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