DIGITAL TRANSFORMATION OF EDUCATION LANDSCAPE: THE 'PHYGITAL' LEARNING FRAMEWORK

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ABSTRACT

Education is an important prerequisite for development of human capital in any economy. However, if the education ecosystem is inefficient in terms of the quality of education provided, it would fail to inculcate required competencies and skills in the youth, thus, inhibiting the potential of economic growth. The objective of this paper is to propose a new framework of learning, called Phygital (blend of physical as well as digital components) learning which attempts to explore the convergence of personalised education content delivery, development of competency and talent aligned career discovery through extensive use of advanced digital technologies like Artificial Intelligence. We have developed a conceptual framework for the proposed model in this paper, which has the scope of being developed into a model for higher secondary and higher education. The framework would meet the twin objectives of enhanced student learning and delivering quality education to a large number of students.

Keywords/Index Terms: Digital, Personalised, Competency, Education

1. Introduction

Educational system and the process of imparting key educational and life skills to the young population are one of the most important duties and responsibilities

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of the governments, the world over. However, a large part of the world today is faced with a challenge in fulfilling this responsibility towards its masses. The complete ecosystem[1] created to impart education and skills has proven to be inefficient which is reflected in the poor quality of schools, low spending by the government on education and skill development as well as inefficient means of delivery adopted at all levels of education imparted (primary, secondary and higher education).This has been the leading cause for creating a large number of 'unemployable' unemployed youth.

Education sector being central to the prosperity and growth of the economy, impacts human capital, productivity, wages, development of entrepreneurial ability and thus, Gross Domestic Product (GDP) growth (Zinny, 2016). Education is also expected to narrow down inequality and make the avenues available to end poverty. However, the current education systems in Emerging Economies or Emerging Markets[2] are only widening 'social gaps' instead of narrowing them. The immediate cause of learning shortfalls is the poor service delivery that amplifies the effects of poverty and exposes deeper system level problems, both technical and political; thereby allowing poor quality schooling to persist (The World Bank, 2018).When the foundation of learning is weak, the higher education system inevitably becomes misaligned to the larger ecosystem.

When the education system is failing to provide a strong foundation to the development of skills required by the youngsters to be gainfully employed, then, the 'skill gap' becomes an enormous challenge for all the stakeholders, viz., unemployed youth, education providers as well as the prospective employers.

Existence of a skill gap is a concern not only for emerging economies but for the world at large, because a major proportion of the global workforce will be supplied by the emerging economies. However, the emerging economies are unable to keep the 'teaming millions' gainfully employed by generating enough jobs. According to a recent Economist article, in India, the working age population is at its peak, yet the proportion of its working age population actually at work is falling, thus reflecting on the number of meaningful jobs being generated for the young population. The ratio of employment to working age population in India fell from 54 percent in 2008 to 52 percent in 2014 (Just the Job, 2017).

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1 The word 'ecosystem' here refers to a complete system consisting of educational institutions, the institutions that frame policies for regulation of such educational institutions, the systems for teacher training etc.

2 This is a term first appeared in 1990s and is now widely used. To define emerging economies in broad terms, we consider those countries that have started to grow but have yet to reach a mature stage of development and/or where there is significant potential for economic or political instability. Therefore, emerging markets include those countries that have reached a minimum level of GDP and are in the growth phase of development cycle but the economies of such countries are particularly vulnerable to external and internal factors, (Pearson Education, n.d.)

New Skills will be required in future and these skill sets are fast changing. Industry 4.0[3] and the automation technologies which are being adopted at a rapid pace in the developed world are bound to penetrate the manufacturing and other industries in the emerging economies as well and as a result the present type of skills training will soon be redundant. Hence, the requirement of the future is to enhance student learning, improve learning outcomes and impart students a strong foundation of skills required by them to be skilled workforce of the society in the future. In order to achieve this goal, it is required to focus simultaneously on imparting training to the trainers/teachers who are important players as well as stakeholders in the process.

The skill gap cannot be bridged by only setting up or building new universities and schools but by leveraging technology and building new models which can not only improve the efficiency and productivity of the teachers but also enhance learning in students. It would be much easier to identify the lack of critical skills in kids and devise lesson plans to bridge the existing gap sooner than before.

Unless learning is complete and desired competencies as well as skills are developed during the course of education, the goal of education is not met and it would be only a wasted opportunity. The objective of this paper is to propose a new framework of learning, called Phygital (blend of physical as well as digital components) learning. The word 'Phygital'[4] here means use of both physical as well as digital mediums for delivery of content to the learners. 'Physical' delivery of content happens in a classroom environment with the physical presence of the teacher in the role of a facilitator – who leads and facilitates discussion of content earmarked as the syllabus. While the 'Digital' medium of service delivery refers to the time the learner shall devote on the digital learning mediums. These can be through portals, platforms where the teacher uploads content or refers link from where the learning material becomes accessible to the students.

The framework developed in this paper, thus, attempts to explore the convergence of Personalised education content delivery, development of

3 Industry 4.0 is basically regarded as a new phase of industrialisation in which computers and robotics will function together with "robotics connected remotely to computer systems equipped with machine learning algorithms that can control robotics with minimum human support" (Grant Thorton, Confederation of Indian Industries (CII)).

4 Phygital (Physical plus Digital) is a marketing term that describes blending digital experiences with physical ones (Search Customer Experience, n.d.).

competency and talent aligned career discovery through extensive use of advanced digital technologies like Artificial Intelligence.[5]

The paper is organized as follows: Section 2 presents a brief literature review. Section 3 explains the proposed Learning Model that can be implemented to achieve the objectives of enhanced student learning and delivering quality education to a large number of students. The last section (4) concludes the paper.

2. Brief Literature Review

Inadequacy of skill sets and under-educated workforce affects an organization's performance and stability. This is more in the case of some industries as compared to others. Melguizo and Perea (2016) identify regional and sectoral patterns in skill gaps of emerging regions. The authors use World Bank Enterprise Survey to evaluate a potential impact on firm's performance due to non-availability of adequately educated and skilled workforce. The authors identify 'Motor vehicles and machinery' sector as the most adversely affected sector that registers most problems in satisfying their demand for skills, which signal important barriers to productive diversification in the emerging world. The authors conclude that middle income economies face more difficulties in finding the rightly skilled workforce to match their requirements, which is consistent with the popular 'Middle income trap' hypothesis. Specifically, Latin American, European and Central Asian firms declare that inadequacy of skill sets is a major obstacle to a firm's performance. The authors however omit a large informal economy in their study and they do not distinguish between the various types of skills.

Digitisation or digital transformation of how education should be imparted to learners is the only way to go forward because this can help emerging economies to tide over the huge 'infrastructure challenge'(in terms of the number of schools, colleges and universities), required to impart right education and skills to a huge population.

This digitisation of learning has been facilitated by availability of and easier access to Internet in far-reaching areas across the globe. It has become possible to learn through internet as the global bandwidth speed has been increasing at a rapid pace brought about by the new improved technologies like 4G and fibre optic cables.

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5 The term Artificial Intelligence (AI) was coined in the year 1956 but has become popular in recent years."Artificial intelligence (AI) makes it possible for machines to learn from experience, adjust to new inputs and perform human-like tasks. Most AI examples that you hear today – from chess-playing computers to self-driving cars – rely heavily on deep learning and natural language processing. Using these technologies, computers can be trained to accomplish specific tasks by processing large amounts of data and recognizing patterns in the data." (Analytics Insights, n.d.)

The free form online repositories of knowledge like YouTube, Coursera, Open culture or Khan Academy have now become new instruments for global learning. Many of these new sources of learning are based on mass collaboration or online community. Massive Online Open Courses (MOOCS) has been indicative of a major change in the outlook and mindset of traditional imparters of education and these formal learning institutions have begun to take up easy-to-use digital tools to impart right education and skills to a larger number of students. Certain characteristics that are peculiar to digital learning are – (a) On-demand availability (b) Self-directed, (c) Customised, (d) Enjoyable and lead to profound engagement of learners (Hinchcliffe, 2017).

One of the major applications of new technologies is in the education sector and in this sector these technologies can be utilised to solve the real challenge of 'student learning'. The problem of low student scores and unemployable youth with inadequate skills does not plague only the emerging economies but also advanced economies. According to the OECD Annual Report for 2013, USA spends more than other developed countries on its students per year and also the new as well as experienced teachers in US earn more than their counterparts across the globe. For example, US spent $ 11,000 per elementary student, $ 12,000 per high school student and $15,171 on each person after high school. However, the spending on students and teachers has not translated into extra-ordinary student performance. The US students trail behind their counterparts in International Maths and science scores (US Education Spending Tops Global List, study shows, 2013).

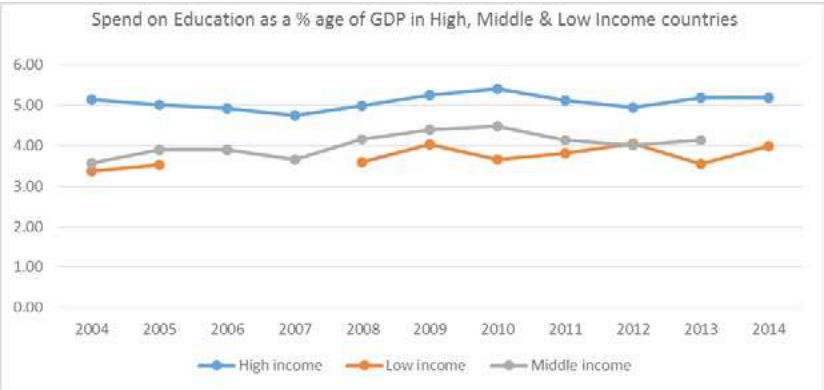
If we look at the data on what the various categories of countries spend on education as a percentage of GDP from the World Bank, it clearly reflects that both low and middle countries are progressively increasing their spending on education. However, the same is not being reflected in better learning outcomes or availability of skilled labour in accordance to the requirements of the employers (Table 1 and Figure 1).

Table 1: Spend on Education as a Percentage of GDP in High, Low & Middle Income Countries

Year	High Income	Low Income	Middle Income
2004	5.14	3.38	3.57
2005	5.02	3.53	3.89
2006	4.92	NA	3.9
2007	4.75	NA	3.67
2008	5	3.59	4.15
2009	5.26	4.04	4.4
2010	5.41	3.66	4.49
2011	5.12	3.8	4.13
2012	4.94	4.05	4.02
2013	5.18	3.54	4.13
2014	5.18	3.98	NA

Source: World Bank Website

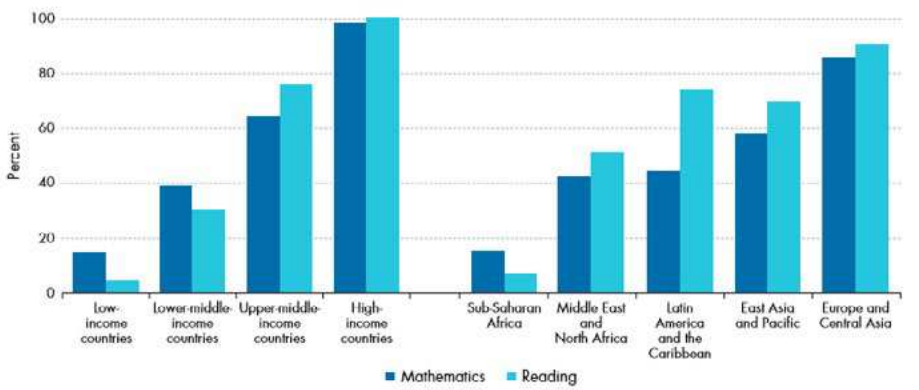
Figure 1: Spend on Education as a Percentage of GDP in High, Low & Middle Income Countries



Source: Plotted using data from Table 1

The World Bank has acknowledged this challenge as it warns of a 'learning crisis' in global education in its World Development Report on Education, 2018. The importance that World Bank attaches to the looming crisis in learning can be gauged from the fact that it is the first time a World Development Report has been entirely dedicated to Education. According to the Report, there is a huge variation in learning outcomes between low, middle and high income countries. For example, as per the assessment scores of literacy and numeracy (Progress in International Reading Literacy Study (PIRLS) and Trends in International Mathematics and Science Study (TIMSS)), the average student in low income countries performs worse than 95 percent of students in high income countries (Figure 2).

Figure 2: Primary School Students Who Pass A Minimum Proficiency Threshold



Source: WDR 2018 team, using "A Global Data Set on Education Quality" (2017), made available to the team by Nadir Altinok, Noam Angrist, and Harry Anthony Patrinos. Data at http://bit.do/WDR2018-Fig_0-5.

Note: Bars show the unweighted cross-country median within country grouping. Regional averages exclude high-income countries. India and China are among the countries excluded for lack of data. Minimum proficiency in mathematics is benchmarked to the Trends in International Mathematics and Science Study (TIMSS) assessment and in reading to the Progress in International Reading Literacy Study (PIRLS) assessment. Minimum proficiency in mathematics means that students have some basic mathematical knowledge such as adding or subtracting whole numbers, recognizing familiar geometric shapes, and reading simple graphs and tables (Mullis and others 2016). Minimum proficiency in reading means that students can locate and retrieve explicitly stated detail when reading literary texts and can locate and reproduce explicitly stated information from the beginning of informational texts (Mullis and others 2012).

Source: World Development Report – Overview, 2018

The Report acknowledges the fact that if there is inadequate learning during the school years, it eventually show up as weak skills in the workforce. Hence, work skill shortages and low learning outcomes are two sides of the same debate. If basic foundational skills are not learnt by students at secondary and tertiary levels of education, it will eventually make them 'unemployable - unemployed' when they are ready to join the workforce. This leads to low job quality, lack of labour mobility and lower worker incomes (The World Bank, 2018).

With technological intervention, the way we impart education can and would drastically change. Though digitisation is impacting education sector in a big way, the role of the teacher is only prone to enhancement in future. According to a recent McKinsey Report, the importance of human interaction is evident in two sectors that so far have a relatively low technical potential for automation. One of those two sectors is Education (Chui, Manyika & Miremadi, 2017).

However, the current technologies in vogue do have the potential to enhance student learning and using technologies like Artificial Intelligence (AI) in higher education can serve the purpose of easing the workload and thus reducing the number of teachers required by taking over some of the routine tasks performed by teachers today. For example, AI enabled 'chatbots', which are equipped with Natural Language Progressing (NLP)[6] have the ability to answer questions about homework, helping students through paper work and deliver 'Personalised Learning'.

Personalised learning (PL) refers to the process of making education tailor-made to suit each individual learner, focusing on peculiar characteristics of each learner. The concept of 'PL' can be taken as an extension to Blended Learning which gives more responsibility to the student, enables learning at the pace of the learner and emphasises more on discovery based methods of learning rather than having direct instructions from the teacher. Similarly, 'Adaptive Learning' too enables students to choose their own pace and place of learning. In order to deliver 'Personalised Learning', the educational tools with adaptive sequence would be used, these tools would collect information about student behaviour, use it to form patterns, analyse the data collected in real time and take split second decisions about the student based on the data.

6 Natural Language Processing (NLP) is defined as "Natural language processing (NLP) is a branch of artificial intelligence that helps computers understand, interpret and manipulate human language. NLP draws from many disciplines, including computer science and computational linguistics, in its pursuit to fill the gap between human communication and computer understanding." (Analytics Insights, n.d.)

Technologies like Augmented Reality/Virtual Reality[7] are being used to enhance teacher instruction by bringing the outside world in the classroom and make the learning more experiential.

Even the learning spaces are being re-designed to make the learning more collaborative, friendly and fun to facilitate student learning (Newman, 2017).

Malcolm Frank and his co-authors refer the use of new technologies in sectors like education as "digital with purpose and digital that matters" (Frank, Roehrig, & Pring, 2017). They opine that new technologies would never take away a teacher's job and student learning cannot be accomplished without the skill and expertise of a good teacher. However, technology is sure to play a role in 'enhancing' the job of a teacher. It would make them more available and focused to student learning by sloughing off the 'administrivia' element that could be now performed more effectively by the machine. The authors quote the example of Assessment and Learning in Knowledge Spaces system (ALEKS) being developed by Tata McGraw Hill. This system is applying new technology to improve the student learning by using adaptive questioning to determine exactly what a student does or does not know in a particular course, while periodically re-assessing student to ensure retention.

In India, we have ensured that our children attend school by passing the Right of Children to Free and Compulsory Education Act (RTE), enacted on 4th August, 2009. After passing of this Act, though we have achieved universal enrolment at the elementary level (classes I to VIII), the Gross Enrolment Ratio (GER)[8] have been falling with successive levels of education. In higher education the enrolment rates in India are not encouraging and in fact are lower than most developed countries. In higher education India's enrolment rate stands at 23 percent as against 87 percent in the US, 57 percent in UK and 39 percent in China.

The other challenge is to ensure that learning takes place in classrooms. In this regards, India has a lot to accomplish. The Planning Commission in 2012 acknowledged that there has been a gap in the quality of learning in schools though considerable success had been achieved with reference to ensuring that all children attend schools (Planning Commission, 2012). The government

7 Virtual Reality (VR) is "an artificial, computer generated simulation or recreation of a real life environment. It immerses the user by making them feel like they are experiencing the simulated reality first hand by stimulating their vision reality and hearing", whereas Augmented Reality (AR) "is a technology that layers computer generated enhancements atop an existing reality in order to make it more meaningful through the ability to interact with it" (Virtual Reality Vs. Augmented Reality, 2015)

8 GER is the student enrolment as a proportion of the corresponding eligible age group in a given year.

realised the need to collect data and focus on improving learning outcomes[9] at elementary level (National Council for Educational Research and Training, 2014) and employability in technical programmes (AICTE, 2019).

The Annual Status of Education Report (ASER) based on the yearly surveys that are conducted every year since 2005 in India give a comprehensive picture of reading ability and arithmetic ability of children in government as well as private schools in India. It is a rich source of information on the quality of learning happening in Indian schools. In 2018 ASER report noted that though some Indian states had shown a considerable improvement in children's reading and arithmetic ability, the change at the National level has been small. The Report noted that "only are we not creating a sufficiently literate population but that most of our population is functionally illiterate" (Annual Status of Education Report (Rural) 2018, Provisional, 2019). This is indeed discouraging for a developing country like India which has one of the youngest populations in the world. Similarly, if we look at higher education and the skill development scenario in India, we find that the students passing out from the higher educational institutions lack the requisite skills and hence fail the test of employability. According to the India Skills Report 2019, the employability of technical graduates stood at 63 percent and employability for MBA and polytechnic graduates stood at 47 and 46 percent respectively (India Skills Report, 2019). This proves that there is ample scope for improvement of employability of the Indian graduates so that the skill gap between required skills by industry and the available skilled manpower is bridged.

Various national bodies like National Council for Educational Research and Training (NCERT) and All India Council for Technical Education (AICTE) have taken several measures to ensure improvements in the quality of education delivery in India through the years.

One of the measures that have been recognised as 'critical' is adoption of technology at various levels of education delivery. The draft National Education Policy (NEP) has provided additional focus on adoption of technology. It has clearly defined objectives for inclusion and adoption of technology at elementary, secondary and higher education levels. The Report notes that adoption of technology needs to be strengthened and enhanced in areas like teachers' training, use of ICT tools for improving teaching-learning processes, increasing access of quality education to remote areas and students, increasing flexibility for students in academic framework and increasing effectiveness of learning-assessment tools.(Ministry of Human Resources Development, Government of India, 2019).

9 Learning Outcomes are assessment standards indicating the expected levels of learning that children should achieve for that class. (Ministry of Human Resources Development)

Therefore, various stakeholders like educators,[10] policy makers and students recognise the need for increased use of technology in education. However, since continuous interaction between teacher and the learner is an important aspect of the teaching-learning process, and because the quality of such interactions does play a pivotal role in improving learning outcomes, it therefore becomes critical to study the role of technology in making the process effective. These aspects have been discussed in the paper in subsequent sections.

III. The Background of Learning Models

A. The Blended Learning Model

As the term indicates 'Blended Learning' mixes or blends both online (digital) and face-to-face (classroom setting) learning. Since this mode of instruction delivery combines the benefits of both the modes of delivery, it is going to be the predominant mode of instruction in the near future. Blended Learning is a well-designed learning experience in which content, support materials and activities via synchronous and asynchronous learning events are delivered in a variety of modes like tutorials/lectures in classrooms to videos and other forms of online content. This type of learning environment provides multiple ways to access content and demonstrate learning at the learner's own pace.

The concept of Blended Learning is not new, however, the contemporary definitions of this concept also take into account the role technology can play in enhancing learning and delivery of content (Hobgood, n.d.).

Personalised Learning or Competency based learning is another term which is frequently used by educators and is touted to be the need of the hour. In June 2015, at a Summit hosted by Western Interstate Commission for Higher Education Co-operative for Educational Technologies (WCET), the leaders agreed on the definitions of the terms like 'Personalised Learning' (PL) and 'Adaptive Learning' (AL). PL was defined as "any customization of learning by an instructor" while AL refers to "technology that monitors student progress in a course and uses that data to modify instructional time".

Though many educators still use the terms PL and AL interchangeably, a clear distinction comes out between the two terms if we look at the interpretation provided by the Gates Foundation. Gates Foundation was involved in funding many projects to deliver 'Personalised Learning' to post-secondary students with an aim of increasing the college completion rates as well as delivering high quality education. The Foundation accepts 'Personalised Learning' as a method of instruction (academic term) whereas Adaptive Learning is considered as a tool or technology to deliver Personalised Learning (marketing term) (O'Connell, 2016).

10 Educators and teachers are used as synonyms.

B. Challenge of Conflicting Objectives

There are basically two aspects of the challenge faced by the education sector. The qualitative aspect involves focusing on student learning and improved learning outcomes by providing enabling learning environment. The second aspect is a quantitative one which involves the challenge of educating a large number of students. There is a trade-off between the two aspects. If the stakeholders focus on the qualitative aspects, they are unable to fulfil the demand of education on a massive scale. Hence, the conflicting objectives of *Personalised vs. scale*; *face-to-face vs. reach*; *quantitative vs. qualitative* have to be dealt with effectively. If these challenging scenarios were not formidable enough, increasing pressure to incorporate advanced technologies like Artificial Intelligence,[11] Cognitive Intelligence, mobile, apps, streaming media etc. in the learning models have raised the stakes and complexity.

C. The Current Process of Learning

The current process of learning pivots significantly on physical infrastructure of classroom teaching. The Digital mechanism of teacher-student interaction is largely relegated to emails, newsletters, announcements and scores updates.

In most developing countries, there is limited use of digital medium as far as teaching-learning process is concerned. By virtue of experience as academicians, we have briefly described the main elements of current classroom-based learning mechanism. Most of the time the learning institutions follow fixed curriculum with fixed time limits of the individual topics to be covered.

The structure of imparting knowledge in the current process of learning is largely a 'Chalk & Talk' based teaching to a classroom of students. This element is teacher dependent, while students have distributed attention of notes-taking and listening to the teacher. The teacher may give some home-work/assignment on the taught topics and students are required to submit the completed questionnaire for checking and grading by teacher. The home-work checking by teachers can be a time consuming process and also creates undesirable competition for marks/grading among the students.

The 'Tests' of student's competency is a weekly, fortnightly or a full semester based event. The stress on students is maximum leading to these events and learning is concentrated during this period.

Thus, the current process of learning is 'teacher centric', the personalisation element in terms of the method of delivery as well as content is missing and statistics suggest that learning outcomes are very poor. This is the state of

11 "Cognitive Intelligence (CI) refers to computing that is able to act as intelligent agents that not only understand individuals' mental states but also have the capability to socialize with individuals much like individuals interact with each other". (What is Cognitive Intelligence?, n.d.)

education at all levels and in many countries of the world. Additionally, there is a lack of focus on skill or competency development early on in the cycle of education. Hence, the desirable level of competencies and skills are not being obtained by the learners till the time they reach the job market.

4. The Proposed 'Phygital' Learning Framework

The proposed Learning Model developed in this paper focuses on objectives of (a) Enhancing student Learning, (b) Incorporating Personalization of Learning, (c) Flexibility in terms of content, time and type of delivery, (d) Quantitative and continuous calculation as well as analysis of student scores on lesson plans, (e) Enhanced job of the teacher whose expertise is used to develop more creative contents and delivery mechanisms, (f) Focus on measurable competency development in students early, on in the education cycle, (g) Charting a focused and Personalised career development path for each student. Figure 3 illustrates the key elements of this model.

Figure 3: The Proposed 'Phygital' Learning Framework

Source: Authors

The key elements are now discussed in detail in the following sections.

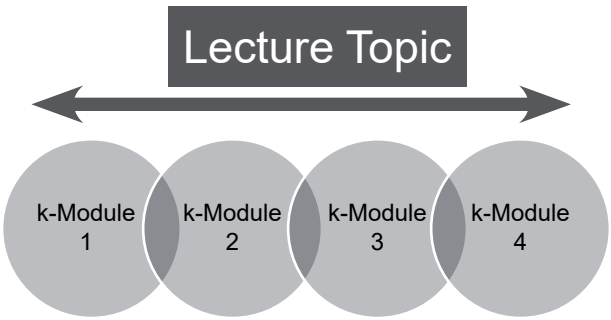
A. *Knowledge*

This will involve *'Fragmenting* 'the topical knowledge into granular knowledge modules, thereby increasing the knowledge absorption ability of a wider spectrum of students. This would make learning easy as the knowledge is spaced out giving enough time to the learners to delve on the topic and understand it completely.

The fragmentation mechanism retains the progressive nature of knowledge curve and pre-determined curriculum structure. Thus, the integrity of the curriculum is maintained, while enabling flexibility through the 'knowledge

modules' (k-modules) enclosed within the lecture topic. Each of these 'k-modules' would be self-sufficient and designed to achieve a knowledge objective in itself (Figure 4).

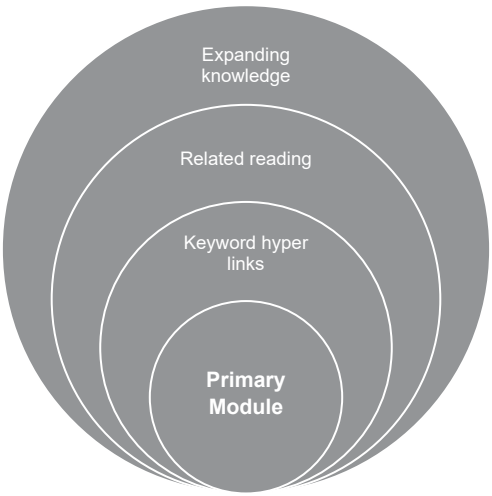
Figure 4: Topic Fragmentation into Modules



Source: Authors

A new addition to the knowledge module will be the incorporation of 'hyper linking' of keywords with more details and deeper dive on the context of the keyword. Also, there would be incorporation of enough related reading of support subjects or topics for enabling a 'beginner to have intermediate level of competency in the related topics that supports the primary lecture topic (Figure 5), e.g., while studying a lecture topic on Monetary Economics, the related topic could be exchange rates, libor rate calculation or Financial Conduct regulation as support topics. This method would broaden the understanding of the student, while still staying on the primary lecture topic. This is not feasible in traditional classroom style lecture due to paucity of time and difficulty in having a teacher with expertise in multiple domains.

Figure 5: Progressive Expansion of the Knowledge Module



Source: Authors

B. Interaction or Delivery: The Phygital Engagement Process Flow

The students would engage with the Digital version of 'k-modules' and complete the short assessment of the modules to score for level of understanding on the topic. The system would continuously monitor the learning path and assessment score (through a rules based algorithm) to highlight the 'k-modules' and topics 'least to most' understood by the students. This clustering of 'k-modules' on the 'least to most' understood scale of 1 to 5 or similar scale would then be viewed by the assigned faculty, who is prompted by the system to now focus on the classroom lecture preparation accordingly.

The classroom engagement is then related to emphasis on the 'least' understood modules by maximum number of students. This improves the direct interaction between teacher and students to become more specialised and highly productive. A follow-up system would also be incorporated in this stage of interaction and delivery of knowledge. In this stage, the faculty would upload the 'k-modules' discussed and explained in the classroom on the system and save the lecture document in the respective modules. This would increase the knowledge base of the system by capitalising on the expertise of the faculty, thereby raising the 'Knowledge Index'[12] of the system. The system, in turn, would prompt the students to re-learn on the uploaded document/explanation on the classroom lecture and complete the respective assessment. The system re-calculates the competency score of the affected students' cluster and allocates the student to a particular category based on the level of understanding. The rules for calculating and defining categories are based on pre-determined rules and structures of curriculum. The AI/ML system learns from the rules engine and utilises 'Predictive Analytics algorithms'[13] to propose the following:

1) To the students: areas of strength and further deepening, as well as, suggested topics and modules for gaps in knowledge.

2) To the teachers: the probability of future competency scores of each student as well as the emerging career directions. It also highlights the cluster of students who are likely to score low competency scores in future.

12 Knowledge Index term is used to indicate that when the teacher would go on uploading the content or the learning material to the system, it would slowly increase the available content – thus signifying increasing value.

13 Predictive Analytics are data mining techniques which use methods of statistical analysis, Machine Learning, data modelling etc. to predict future instances with a certain degree of probability. (From Predictive Analytics to Prescriptive Analytics, n.d.)

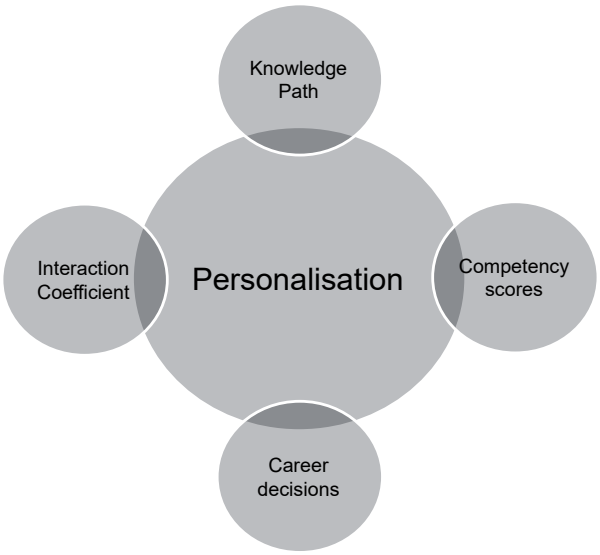
This enables the Artificial Intelligence (AI)/Machine Learning (ML) system to utilise the Prescriptive Analytics algorithms[14] for re-learning intervention path or possible counselling for students' cluster falling in lower competency scale. Also, it would be able suggest career development intervention and specialised interaction for students' cluster in higher competency scale. The model can incorporate following parameters to formulate the clusters: (a) Assessment & re-assessment scores (b) Learning paths (c) Engagement levels in Digital Grid & classroom and (d) Peer interaction. The learner interacts on various levels in this model. The first is learners' interaction with the system; second with the teacher (both on digital as well as physical platforms); third is with the peers and lastly, with any other stakeholders in the education cycle. Based on the volume and quality of interaction by the student with reference to Knowledge content (keywords, k-modules, topics), Competency (goal setting, assessment and scoring) and Career development (soft skills, interests, functional skills), the system would assess the value of the interaction coefficient. This co-coefficient – which is calculated as a numeric value would provide the input variable for personalisation.

C. Personalization

Once the system calculates the interaction co-efficient, it provides a numerical input for personalizing the knowledge content delivery. There would be a learning path which would be prescribed to all students who take up a particular subject module. However, it is not necessary that the same prescribed path would be followed by all students. Each student would have conditional flexibility in terms of carving out one's own learning path. The data that the system would collect on different learning paths followed by different student clusters would enable the system to carve out Personalised content delivery programme for each individual learner. This would happen as the system would progressively accumulate huge amounts of data by recording learning behaviour of the students, which would enable AI to form patterns and identify as well as predict the Knowledge content sequence (or, learning path) delivery, prompt feedback to faculty for timely interventions, if needed; make discovery of career choices for students and also give predictive visualization of competency scores. Figure 6 reflects the desired personalization matrix.

14 Prescriptive Analytics is an innovative concept based on predictive analytics which goes further by providing real rules applicable to business. The prescriptive model enables the decision makers to take immediate action, based on probabilistic forecasts (from Predictive Analytics to Prescriptive Analytics, n.d.).

Figure 6: Personlisation Matrix with Key Elements



Source: Authors

D. Competency

Competency based education is highly effective because in this type of education the curricular design aspects are fairly transparent. Though, the time taken to demonstrate various competencies may be different for different students, however, the learning outcomes at completion of a programme for each student remains same. This type of education gives a fair degree of flexibility to both the learners and the education providers. The education providers see a potential to plan, organise and deliver educational opportunities and experiences better than what is possible through a traditional academic institution. The progress of the learner is more transparent in competency based education as it is not based on accumulation of credit hours, scoring minimum average grade points and passage of a certain amount of time. The learners in this education system acquire and demonstrate their knowledge and skills by engaging in learning exercises, activities and experiences that align with clearly defined programmatic outcomes. They receive proactive guidance and support from faculty and the learners earn credentials by demonstrating mastery through multiple forms of assessment, often at a Personalised pace (A National Consortium for Designing, Developing and Scaling New Models for Student Learning, 2014-17).Thus, our Learning Model incorporates the elements of competency based education. It allows flexibility to learners on time taken to complete the course as well as focuses on learners' achieving the desired level of competencies towards the end of the programme by progressively assessing them through correct types of assessments. However, incorporating principles of competency based education into the model will be a complex process.

According to a study conducted by Lisa McIntyre-Hit, the participants agreed on 18 principles for effective practice regarding developing competencies; 15 principles for effective practice regarding developing assessments; and 16 principles for effective practice regarding identifying and leveraging resources (Mcintyre-Hit, 2016).

Hence, considering the above volume of principles and quantitative parameters, the Competency model deployed would need sophisticated Statistical techniques for Descriptive and Predictive modelling. Artificial Intelligence/Machine Learning would work towards pattern recognition and predictive as well as prescriptive intelligence in competency development and intervention.

E. Career Development

A unique feature of the 'Phygital' Learning Model developed by us in this paper is that the data collected by the system during the progression of the programme by the student clusters would use current technologies of AI and ML to chart out a definite career development path for each individual learner. This would definitely be a much valuable feature of this model and in the long run would definitely make a contribution in developing skilled and competent workforce, thus, fulfilling the real purpose of education.

The system would progressively collect data about each individual learner; these data would be assessment scores, learning paths followed, data on the other disciplines on which the learner showed interest, the learner's cognitive abilities, Leaner's social skills, teamwork, competencies developed during the programme, competencies on basic foundational skills like literary and mathematical abilities etc.

The analysis of these data would be continuously processed by the machine and based on the analysis; it would pre-emptively suggest career development path for each learner.

In summation, the complete learning system of the proposed 'Phygital' Learning Model has five basic tiers or modules – Out of these five discussed above, we identify Knowledge, Competency and Career development as pre-determined data sources, whereas Interaction/Delivery and Personalization are regarded as 'Dynamic Data' Sources.

Knowledge content will be built as per curriculum decided by the regulatory authorities and academic institutions that would award formal certificates and degrees to the students. Similarly, the Competency module and Career development module are data sources that would have pre-defined rules to associate inter- and intra-module relationship.

The Interaction/Delivery module is the dynamic data source which monitors the interaction of students with the system, with teachers and with peers. These interactions are not pre-defined but provide new information to the system about the actual learning path followed by students and the interaction quality and quantity. The Interaction module is the pivotal point which links the pre-defined data sources with the actual delivery and behaviour of the system through the Personalization module.

For the processing of these dynamic data, the use of AI and ML is recommended. AI/ML algorithms would be both 'Unsupervised' and 'Supervised'. An unsupervised algorithm does not have outcomes defined and is at liberty to explore and discover patterns & relationships within datasets; while supervised algorithms have defined outcomes against which results are generated by the system. Unsupervised is akin to a child being given a football and is free to discover various uses of the ball and its play; while supervised would be closer to the child being given a football and shown the target as a goal post to reach. The AI/ML would use the 'Unsupervised Algorithms' for pattern recognition and to discover data relationships and associations that are continuously forming during the dynamic data creation. Once the relationships have been identified, algorithms would be required to interpret the relationships. Some of the interpretation algorithms required would be ANOVA, Decision Trees[15] etc.

The clustering process segments the student categories and can be analyzed for topic-interest levels, deviation in competency-knowledge gaps, highlighting latent talent, discovering data relationships which are not visible in a standard database query.

Once the significant data discovery and associations are identified and processed, the system is ready for Predictive and Prescriptive modelling. This provides the input for Personalization module. In this stage multiple supervised algorithms are required for delivery.

The Educationists would have already defined the specific outcomes expected from the system in personalizing Knowledge content delivery, learning paths, etc. in terms of the level of competency required in a particular skill and specific learning outcomes. The system, based on the interaction of the students with various sub-systems and stakeholders, would predict and recommend the most optimal learning path for students, would indicate the possible peers with similar talent or evolving competencies, teacher intervention points, etc. Based on the analytical needs various predictive algorithms would be required at this stage for both linear and non-linear patterns in data.

15 ANOVA, Decision Trees are different Machine Learning algorithms.

A discussion on various algorithms that would be used for predictive analytics is out of the scope of this paper. However, it would be safe to mention that algorithms like Decision Trees, Regression analysis, K-Nearest Neighbours, highly effective and flexible Neural Networks and Naive Bayes for probabilistic determinants would be used to conduct predictive analytics on the dynamic data being generated.

5. Conclusion

Innovations in the education sector have taken place at several levels, be it on the content development side, on how students learn (Gardener's Multiple Intelligence Theory)[16] or how should the content be delivered to learners. Also, there are unique characteristics of individual learners which change at different stages of education (Primary, secondary and higher education).

Digitization of the education sector is inevitable, and it is also necessary in order to ensure delivery of 'quality education' which is linked to development of desired competencies, skills and achievement of specific learning outcomes. Presently, access to quality education is a prerogative of few select learners in some countries. For the masses the quality of education that is being delivered to them is only a 'wasted opportunity' as the desired outcomes are not being achieved within the allotted time frame. This is true at all levels of education, be it primary education or secondary and higher education.

Poor quality of education is the main cause of the emerging skill gaps in countries where the unemployed youth struggle not only because of dearth of jobs but also because they are unable to meet the skill requirements of the employers. Thus, rising unemployment levels in the countries compromise the economic growth, trapping the middle income countries in the level of development that does not allow them to leap to the advanced economy levels.

Therefore, delivering quality education should be one of the key agendas of the governments the world over. Also, the educators should be ready to leverage the latest technologies to solve the challenge of quality vs. quantity of education delivery.

However, one must remember that the role of the teacher/instructor or faculty would be the central element which cannot be done away with the onset of digitization of this sector. In this regard, the framework presented in this paper is different from the models that only serve the purpose of content delivery using digital aids. On the other hand, in the discussed framework, the face to face interaction of teachers as mentors with the learners is being stressed to

16 The theory of Multiple Intelligences developed by psychologist Howard Gardner in late 1970s and 1980s posits that individuals possess eight intelligences namely linguistic, logical-mathematical, spatial, musical, bodily-kinesthetic, naturalistic, interpersonal and intra-personal. (Gardner, 1983)

enhance learning outcomes. In fact, the future would see the skill and expertise of a teacher to be one of the most valuable skills. Incorporation of technology will only enhance the role of the teacher. It will, in future, play a dynamic role of a guide, a mentor, a wise person who would help a person to shape the person in a way as he/she would have determined to be.

References

A National Consortium for Designing, Developing and Scaling New Models for Student Learning (2014-17), What is competency based education?, Retrieved from A National Consortium for Designing, Developing and Scaling New Models for Student Learning: http://www.cbenetwork.org/competency-based-education/

AICTE Strategy to improve Quality of Engineering Students (2019), September 24, Newsd.

Analytics Insights (n.d.), Retrieved from SAS: https://www.sas.com/en_us/insights/analytics/what-is-natural-language-processing-nlp.html

_____(n.d.), Retrieved from SAS.com: https://www.sas.com/en_us/insights/analytics/what-is-artificial-intelligence.html

Annual Status of Education Report (Rural) 2018 -Provisional (2019), January 15, Retrieved from ASER Center: http://img.asercentre.org/docs/ASER%202018/Release%20Material/aserreport2018.pdf

Chui, M., J. Manyika & M. Miremadi (2017), Where Machines can Replace Humans and Where they Can't (Yet), McKinsey & Co.

Frank, M., P. Roehrig, & B. Pring (2017), What to do When Machines do Everything, Wiley.

From Predictive Analytics to Prescriptive Analytics. (n.d.). Retrieved from Data Skills-Understanding the World: https://www.dataskills.ai/from-predictive-analytics-to-prescriptive-analytics/

Gardner, H. (1983), Frames of Mind: The Theory of Multiple Intelligences (10th anniversary edition), New York: NY: Basic Books.

Grant Thorton & Confederation of Indian Industries (CII) (2017), India's Readiness for Industry 4.0 -A Focus on Automotive Sector, CII.

Hinchcliffe, D. (2017, September 27), The Digital Transformation of Learning:Social,Informal,Self Service and Enjoyable. Retrieved from www.znet.com: http://www.zdnet.com/article/digital-transformation-of-learning-social-informal-self-service-enjoyable-mooc-education/

Hobgood, B. (n.d.), Blended Learning, Retrieved from Learn NC: http://www.learnnc.org/lp/pages/6722

India Skills Report, 2019 (n.d.).

Just the Job (2017), The Economist, September 16.

Mcintyre-Hit, L. (2016), A Delphi Study of Effective Practices for Developing Competency-Based Learning Models in Higher Education.

Melguizo, A., & J. R. Perea, (2016, January), OECD Library, Retrieved from http://www.oecd-ilibrary.org/docserver/download/5jm5hkp7v145-en.pdf? expires=1509124259&id=id&accname=guest&checksum=93E977E17B79D2A7B95EE5C46966CF2E

Ministry of Human Resources Development (n.d.), Learning Outcomes at Elementary Stage, Retrieved from mhrd.gov.in: https://mhrd.gov.in/sites/upload_files/mhrd/files/Learning_outcomes.pdf

_____, Government of India (2019), The draft National Education Policy 2019, Retrieved from www.mygov.in: https://innovate.mygov.in/new-education-policy-2019/

National Council for Educational Research and Training (2014), Learning Indicators and Learning Outcomes at Elementary Stage, Retrieved from National Council for Educational Research and Training: http://www.ncert.nic.in/departments/nie/dee/publication/pdf/LI_Final_Copy_Revised_29.12.14.pdf

Newman, D. (2017, July 18), Top 6 Digital Trends in Education. Retrieved from www.forbes.com: https://www.forbes.com/sites/danielnewman/2017/07/18/top-6-digital-transformation-trends-in-education/2/#28174cd62e79

O'Connell, A. (2016), The Blurry Definitions of Adaptive Vs. Personalised Learning - Does it Matter?, Retrieved from Campus Technology: https://campustechnology.com/articles/2016/12/20/the-blurry-definitions-of-adaptive-vs-personalized-learning.aspx

Pearson Education (n.d.), Emerging Markets Defined. Retrieved from Pearson: http://www.pearsoned.co.uk/bookshop/article.asp?item=361

Planning Commission (n.d.), Education, Retrieved from Planning Commission: http://planningcommission.gov.in/hackathon/Education.pdf

Search Customer Experience (n.d.), Retrieved from TechTarget: https://searchcustomerexperience.techtarget.com/definition/phygital

The World Bank (2018), Learning to Realize Education's Promise, Washington DC: The World Bank.

US Education Spending Tops Global List, study shows (2013, June 25), Retrieved from CBS News: https://www.cbsnews.com/news/us-education-spending-tops-global-list-study-shows/

Virtual Reality vs. Augmented Reality (2015, October 2015), Retrieved from Augment.com: https://www.augment.com/blog/virtual-reality-vs-augmented-reality/

vvbbnn (2019), jjj. hh: ggh

What are Learning Outcomes? (n.d.), Retrieved from Center for Teaching Support and Innovation: https://teaching.utoronto.ca/teaching-support/course-design/developing-learning-outcomes/what-are-learning-outcomes/

What is Cognitive Intelligence? (n.d.), Retrieved from IGI Global: https://www.igi-global.com/dictionary/the-foundation-of-cultural-intelligence/35759

Zinny, G. S. (2016), Education 3.0: Facing the Challenge of Human Capital Building in Emerging Economies, in G. S. Zinny, Innovation in Emerging Markets (pp. 215-232), London: Palgrave Macmillan UKCY.