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# Exploratory Apprenticeship in the Digital Age with AI Tools

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**Abstract:** Along this decade, advances from Cognitive and Computing Sciences disturbed the college campus, namely via the availability of online courses (MOOCs) and tools, and also the secondary schools with e-learning environments. The technological impacts helped to democratize traditional university education and brought, to everywhere in the world, the teaching of wonderful professors through Internet (YouTube). Yet, the lectures are still alive and the old fashion pedagogy seems in good health, most of the students don't participate fully in the process of learning. What is missing is a profound shake-up of mentalities, new initiatives to accelerate learning research and the discovery of the resilience of the whole process. Artificial Intelligence and Information and Communication Technologies (ICT's) in general are sound proposals to open alleys till a happy solution, and in this paper we try to show some ideas about the disruption of the traditional classroom scenario due to the availability of innovative online resources and computers (tablets, smartphones, laptops).

**Keywords:** distribution, mobility, intelligence, e-learning, assessment, interdisciplinarity, gaming, cognitive science, neurobiology, education and learning.

## 1. Introduction

“Most digital learning tools used in schools are unsatisfactory and only test the knowledge the pupils already have.”

Lecturing is a non effective way of teaching due to the attention problem (a human being has troubles to keep attentive more than 20 minutes). There are evidences that suggest embracing active learning methods because they lead to better learning and greater retention. For example there is increasing evidence, in STEM (Science, Technology, Engineering, Mathematics) disciplines and in particular computer science, that poor teaching disproportionately impacts students from disadvantaged and underrepresented groups (Freeman, et al., 2014), which is a matter for further discussing in emerging countries.

Teaching better is not an issue, the key challenge is time (TED talks have less than 20 minutes) and our ability to maintain focus. The consequence is poor knowledge acquisition and learning, lack of those attending classes, and tendency for cheating in exams, projects or assignments. At the end, the whole efficiency and productivity of the education system decreases, studies suggest that the effect is only a little bit better than in MOOCs, the enrollment reaches into thousands, but the students retention are low. (Onah, et al., 2014).

What is necessary today is an active learning perspective and this means students engaged with the materials and contents (Talkabout video-based discussion tool, demos in video clips, Slide Share in LinkedIn, TED Talks, ebooks), deeply participating in the class and collaborating with each other and the teacher, rather than listening and memorizing, students need to be motivated to demonstrate a process by simulation, analyzing an argument, or applying a concept to a real-world situation. Therefore, the care in organizing materials (modules around concepts) in Moodle is essential.

For this research is essential fill the gaps around the following research question: How to design Educational Computer Programs (ECPs) to provide the necessary features for a student to be pushed to learn? There are two main challenges associated with this.

First, awake his curiosity and afterwards open his imagination, along an expansion process able to create some mystery connected to the unknown. The whole purpose in class is to attract the student's desire and serve his passion to learn. Children need motivation, dedication, goals to attain (focus), trust, discipline, persistency and responsibility. And, also the same occurs with the university students, according to neuroscience and cognitive science research. The teacher starts to make a relation and pushes students to start thinking, reasoning and, later on, to adopt critical thinking (Paul and Elder, 2002), creativity and innovation come afterwards.

Second, ECPs need to examine student responses (and questions) to tasks (the same occurs when students play videogames) and thereafter mimic the way students think (eg. making choices). The computer is learning an approach to science, and it will later try to solve a different problem the same way a student might. Therefore, it is opening new understandings of learning and new avenues of teaching and assessment as a result. The computer is learning (due to artificial neural networks) to solve novel and new problems (from experience), which means we can test different educational interventions before ever getting to a classroom. And, this tactic is surprising new, but it depends strongly on the kind of teacher. More, a careless one is harmful to the students.

The use of the virtual teaching assistant Jill Watson along online classes for AI, by Georgia Institute of Technology, and regarding answering questions with distinct and clear solutions, is a case to follow (ScienceDaily, 2016), even students tend to ask the same kind of questions over and over again. The practice will help to meet enough mistakes (different contexts) increasing its knowledge base.

The challenges associated with the inception of such ECPs in classroom environments involve: infrastructure characteristics, pedagogical practices and curricular adherence. A synergy between those aspects leads to a life-long learning experience. ECP designers should rethink the role of students and educators in classroom environments. Students must be able to associate their learning activities with real-world challenges. Educators must guide the students during this process, identifying their core-competencies and supporting the development of other complementary competencies.

There is no silver-bullet regarding the design of ECPs. Advances in knowledge representation and reasoning, intelligent agents, semantic web standards, are allowing the knowledge interoperability between web-based systems. Such technologies open space for flexible learning environments. For example, nowadays, we have several alternatives for educational apps (application programs), such as ebooks, virtual laboratories, and serious games. The students and educators are using them for punctual activities, generating profile fragments of the students and teachers. What about the use of those fragments for learning analytics? One of the challenges resides in the data collection (Koch and Rao, 2014; Koster, et al., 2015) and open knowledge representation.

Examples of innovative ECPs that are moving towards this concept are: Edulab21, from Ayrton Senna Institute (Brazil), and the startups Geekie (Brazil) from Claudio Sassaki. Decomplica and Evobooks are initiatives to follow in next years, because they look to the foundation of the troubles with current education, get insights from neurosciences (also explored by Google DeepMind) and cognitive science, and try to improve the engagement of students. Developing responsibility and commitment is a step forward, but students need to be involved during the whole learning process.

The remaining of this paper is organized as following: Section 2, presents the concept of Active Learning; Section 3, presents the possibilities and benefits of the usage of technology for education; Section 4 presents Flipped Classroom methodology as an alternative for more appealing classroom experiences; Section 5 presents a synthesis about the importance of assessment for learning retention; Section 6 presents an overview about an integrated educational ecosystem as the alternative for the usage of technology to support education, and finally the Section 7 presents our exploration conclusions.

## **2. Active learning**

When we observe what is going on education today we conclude that our teaching, in high schools and university colleges, is not so efficient and this is associated with the teacher and students sides. Reading the definition of active learning, “process whereby students engage in activities as reading, writing, discussing or problem solving, all promoting analysis, synthesis, and evaluation of class content”<sup>1</sup>, we conclude that the responsibility of learning is on the side of the students (learners). Meanwhile, teachers are always in charge of the overall process, promoting interactions (questioning and answering, recommendation), pushing relations among ideas, motivating queries and designing experiments to get the desired outputs. And, they may fail! An alternative is inviting students to come together to play and experiment with the help of a teacher.

Active learning involves students in doing assignments, preparing the next class by reading contents, writing essays to get new knowledge, enlarging learning and acquisition, and “thinking about the things they are doing” (Bonwell and Eison, 1991). Therefore, the process is mindful, experiential, and engaging.

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<sup>1</sup> <http://www.crlt.umich.edu/tstrategies/tsal>

In MOOCs, talkabout discussion groups (treated here like educational technology, and not social technology) appear now as an advantage for improving class performance and for learning by collaboration thus boosting online learning experience for participants. Global diversity of the participants themselves (in university, grouping students from diverse backgrounds push interactions, relationships and more enthusiasm) seems a motive for attraction and increasing the desire of acquiring more knowledge about other cultures and societies. Including optional discussion groups into the courses is popular and also a factor for greater cohesion of the students. Enrollees who participated in discussions did better (a half letter grade in improvement) than their peers on course assignments. Text-based discussion chat rooms or fixed discussion groups have been less effective in improving enrollees performance, at least according a Stanford University account.

### **3. Use of technology**

Active learning can be boosted with technology, and Artificial Intelligence (AI) may play a key role (intelligence amplification or IA to scaling), in monitoring the involvement of students with the contents and in finding where doubts are present (Coelho, 2016). Even, AI will make technology disappear according to (Hindi, 2015), because its current ingenuity pushes everybody to explore it in the space of education as a trivial thing (problem reduction, trial-and-error, goal guidance).

Education research suggests the student attention in lectures starts to wane every 10-20 minutes therefore to renew attention from both sides in the classroom, along current scheduled time period (1 hour, 1h30 minutes, or 2 hours), students need to be reminded by phones to interact, via questions and answers, or by exploring other devices (tablets, for example with Socrative) to discover the answers students are asking within limits (checking texts, seeing figures and images). A moral code will be: short interruptions will occur every 10 minutes in order to follow the flow of ideas, and the participation of students in making exercises and quizzes (automatic discovering of difficulties in answering right, collecting the number of interactions and switching on alerts about doings). Think and breathe the sufficient period of time to go further on.

Flipping the classroom is inevitable if everybody wants spending the time productively, implying the use of recorded lectures outside of class and also homework-like activities in class. Moving first exposure outside of class frees up time in class to do disciplinary work, leaving to the teacher the key role of calling our attention to the main items and the importance of certain topics. Instead of providing basic content exposition, during the class, both sides may explore other disciplinary connections, conventions, and controversies. Yet, criticism has been advanced concerning the overhead of flipping.

Classroom learning has three phases: (i) exposure, (ii) process and (iii) feedback, according to (Walvoord and Anderson, 1998). In the traditional and classical model, (i) exposure to content is obtained through face-to-face lectures, students (ii) process this information on their assignments, and the (iii)feedback is given through grading tests and papers. Is this approach efficient in achieving the desired outcomes? The answer is no, and several alternatives have been explored to increase the average low

rate of approval (low productivity), obtained in the portuguese public universities during the first round (first call to exams).

The increase of possible second and third calls for exams for those not approved is complemented by alternative exams during the next semester (13-15 weeks), new courses or other practices to help students to recover from rejection. During the semester, some teachers try to start with some part of the appointed book (50 pages), already read and understood, or with every next class already studied in advance due to the availability of slides in Moodle management system.

Students are, in general, opposed to these aids, and look to lectures as meaningless, starting the semester with a frequency of 70%, of the total registered ones, and going from 50% (in the middle of the period) to 10% (final week). This lack of attendance, and interest, justifies the repetition of exam calls, but it is a step backwards. From the efficiency point of view, it is a repetition exercise for those left behind.

Thinking a bit about learning we discover that face-to-face lectures are an ineffective teaching approach on new content, because they are too fast, take a lot of time, are transient and one-sided. Any other way may be better (tutoring, but only for a few), because students' skills, to think and to write in some discipline what the Faculty values most, require that they process information deeply and we know this from cognitive studies.

Recently (Vicente et al., 2016), neurobiology research on learning repetition of actions (role of habits and routines) discovered two neural pathways (direct and indirect) in the brain, that are not related with the function behind but with anatomy. Before, scientists were convinced that the pathways had opposite functions (the first one connected with reinforcement, do this because it is good, and the other one linked with non stimulation of the action, ie. do this because it is bad). By using optogenetics, it was proved, with the light, that the direct pathway was associated to reinforcement and the indirect one linked with the inhibition of action, but otherwise a kind of generalization (a slow learning, done step by step, to get an habit). The group of John Gabrieli, at MIT, is doing new efforts to understand learning (via interdisciplinary studies, combining cognitive science with economy, neuroscience, engineering, and public policy), and along improving it at all levels of education.

Following the frontiers of learning science, a new look at both key mechanisms of learning, that are important for education, has been showing the interplay of teaching and learning, and between knowledge and skills. The exploration of digital tools (pace of innovation) brought active learning experiences, in several countries, and also sound outcomes.

The traditional processing phase, when students work on assignments, involves the most difficult part of learning, making meaning from ideas. Students need to think about their thinking (critical period) to promote learning, and the help of teachers is rather important. The alternative of team work can mix the efforts of students and allow some of them be passive, covered by the active ones.

The third facet of learning, feedback, is often miscarried by teachers, due to the high quantity of students (that is why lecturing was imposed). In brief, the traditional

paradigm wastes a lot of the time of teachers with preparing and delivering lectures, correcting exams and assignments, and skipping due feedback (correction of exams: analysis of solutions). In most cases, the dialogue between teachers and students is very poor, the struggle to comprehend challenging exercise results in disengagement, not in increased effort. They can avoid the discomfort of those tasks by calling them boring ones (Leonard, 1992).

Till now, there are no real alternatives to the conventional tutoring systems used in schools. They only test the knowledge that the students already have or imitate it. Instead of adopting heavy systems we need light and flexible tools able to have empathy with users and able to stimulate them in a clever and open way (motivation is the key). The outcome is: inspired on video games by providing never ending new challenges that outthink the players. What kind of skills are desirable, but not limited, to achieve this effect?

- Deep learning technology with active learning algorithms,
- Intuition and insight,
- Sense of time and elan vital,
- Think outside the box,
- Scale and expand with learning,
- Be versatile and adaptive,
- Think based upon experiences (learn by example) and identify patterns.

What goal is a player trying to achieve in a video game? The straight answer is: compare gaming with the educational classroom scenario, imagine the teacher as a player and students as challengers. The focus on goal prediction is also the aim in education, yet like in machine language translation the solution is not autonomy but semi-autonomous driving.

In education, the software is able of improving its accuracy over time, because the more data the algorithm has, the more accurate it becomes. Predictive AI will be necessary on account of goal recognition (the issue of outcomes achievement to be measured). Therefore, in education we have a similar situation, and semi-autonomous driving and fault-tolerant planning (the same as with driving a car) are a good direction.

Social intelligence is also necessary in education, on account of the presence of particular behaviour: everybody observes, collaborates and switches allegiance. The teacher and students work together to achieve common goals (when this is false we get problems and bad results: that is why Super Mario got social intelligence and is no longer simply a reactive character controlled by the user). In 2016, computer games approached human-machine interaction, driving assistance and adopting AI as a driver.

#### **4. Flipping the classroom**

A more efficient approach redistributes the responsibility of the three phases of learning. In the flipped classroom, first exposure to content moves outside of class time and becomes the students' responsibility. First exposure comes from technology enhancements or from traditional sources. It is disputable the association of some

tasks to students, in particular online quizzes or in-class quizzes. Grading will be done automatically by personal response systems, or manually by teachers as happens today.

When using recorded video lectures to provide first exposure to content, students can watch these lectures (or shorter chunks or modules) over and over again, learning at their own pace, what seems attractive for learning purposes. Today, there are effective techniques in engaging students in online learning. The same does not occur with intelligent tutoring systems (ITS), very repetitive and using fixed knowledge. Innovation, creativity and out-of-the-box situations are not allowed in ITSs.

Moving exposure outside of class allows disciplinary work (connections, discussions), and students can work in pairs or groups along projects (solve real problems instead of toy examples), analyze data or text, or write reports and make arguments. So, they process ideas, practice skills (talk), and deepen their understanding as they receive feedback from teachers, i.e. provide deliberate practice, a major push for developing expertise. Otherwise, teachers guide students into the discipline, and improve students' thinking and writing skills.

## 5. Assessment

“The essence of boredom is to be found in the obsessive search for novelty.  
Satisfaction lies in mindful repetition.”  
George Leonard. 1992.

Education requires assessment and empathy with the technological devices and the multiple intelligent artificial agents installed in the classroom to detect signals (about undoing and backtracking, not doing assignments, interactions with tools and computers, reading slides, consulting Google for querying about additional materials) and identify skills fulfillment.

Gathering evidence of student learning is necessary to judge which changes are more urgent and guide further practice. There are not only interactions among students and teachers, but also with AI installed to provide help and to anticipate commands. There is a diversity of tools, such as platforms, workbenches, apps, multi-agent systems, recommender systems, or tutoring systems, and the need of training and evaluation strategies to register the outcomes.

Some fresh new examples of AI are helpful to motivate our imagination for using it in the classroom: Stanley driverless car from Google, Watson from IBM for Q&A conversation, Amelia from iPSoft, Google Photos contextual analysis, SegNet, AlphaGo from Google Deep Mind, XiaoIce chat, Spot and Atlas robots from Boston Dynamics, ASIMO from Honda, Translate Common Sense from Google, or Global Brain from Viv.

Service providers allow for searching large text collections by feeding their search engines with descriptive keywords. Yet, the words tend to be highly ambiguous, and quickly show the limits of current search technologies. Computer scientists have now developed a novel text analysis technology that considerably improves searching very large text collections by means of AI. Beyond search, this technology also assists authors in researching and even in writing texts by automatically providing background information and suggesting links to relevant web sites. Also,

identification of photos/images (through pattern recognition and deep learning) will be advisable for education purposes.

Mathvolution is an online platform for Mathematics, adaptive to the needs of the students. The problems are grouped in levels of difficulty and a diagnostic tool is able to discover the student's evolution in acquiring knowledge, and to detect easily which are the concepts that offer resistance to our understanding. Study can be an attraction, but students need to be self motivated, and the determinant drive is the satisfaction of playing with concepts. In order to improve skills, more aid is a solution to achieve progress or retrocess. And, online aid is desirable to make students more responsible.

The proliferation of application software (apps) with AI in smartphones (Hindi, 2016) made possible to transform phones in order to adapt to some situation. More than 20 apps (algorithms from the startup Snips.ai), connected to Citymapper and Google Maps, try to make life easier to humans. For example, the app's natural language processing and machine learning software identifies an address, guesses that the owner of that phone is going to do and provides a pre-filled solution. Snips aggregates data and links to the apps that are relevant. Snips learn a lot about the doings, habits and preferences by applying algorithms to the received messages, calendar, contact lists and background locations, and tries to predict what is next in the context of the routine workings of a phone, a kind of discovering outhink trends. This case of intelligence and mobility, with smartphones, may suggest similar experiences in education, eventually within the context of large multi-agent systems.

Let us compare the key ideas behind Deep Blue (Chess) and AlphaGo (Go). The first program used values to assess potential moves, a function that incorporated lots of detailed chess knowledge to evaluate any given board position and immense computing power (brute force) to calculate lots of possible positions, selecting the move that would drive the best possible final possible position. Such ideas were not suitable for Go. A good program may capture elements of human intuition to evaluate board positions with good shape, an idea able to attain far-reaching consequences. After essays with Monte-Carlo tree search algorithms, the bright idea was to find patterns in a high quantity of games (150,000) with deep learning based upon neural networks.

The program kept making adjustments to the parameters in the model, trying to find a way to do tiny improvements in its play. And, this shift was a wayout to create a policy network through billions of settings, ie. a valuation system that captures intuition about the value of different board position. Such search-and- optimization idea was cleverer about how search is done, but the replication of intuitive pattern recognition was a big deal. The program learned to recognize good patterns of play leading to higher scores, and when that happened it reinforces the creative behaviour (it acquired an ability to recognize images with similar style).

Socrative ([www.socrative.com](http://www.socrative.com)) empowers a teacher to engage and assess his students as learning occurs via forum and e-messages. Through the use of real-time questioning, will instantly grade, aggregate and provide visuals of results to help identify opportunities (student understanding, performance and progression metrics) for further instruction. Educators can initiate formative assessments via quizzes, quick question polls, exitTickets and space races all with the Socrative Teacher app. Real-

time responses for every student allow to differentiate instruction and answer of every student. Immediate classroom comprehension tests provide the necessary information to modify further teaching. ExitTickets data allow students to set their own goals and access direct learning. And, long term data empowers both teacher and students to see the academic progress in real-time and over the course of the semester.

Let us jump to another scenario, the open classroom context, where students are distributed along the introvert-extrovert spectrum. Each one has healthy curiosity, but shyness impeaches them to speak up and ask questions that come to their mind in the moment, keeping them quite or waiting for a next occasion that never happens. What does occur in that space? In general, there is the noise of conversations, uneasy students not following the flow of the teacher reasoning or falling behind the matters, engage in a complot to boycott the work of the teacher talking. Students give up from class, don't interrupt the teacher, but annoy (and distract) him when in charge of explaining and helping students to understand the intricacies of some themes. The misery of such a situation is terrible, because those attending are not following what is projected on the screen, and often play games in cell phones.

How can we transform this introvert tendency to listen, and challenge them to act and dispute? Big ideas are always the outcome of some conversation, when arguments are face-to-face and everybody is pleased with the interchanges. What they need are tools for smart thinking, some kind of mindware, lots of demos, video clips and experiments of a living content, and the possibility to make relations and contest the teacher.

The game of education can be similar to some other sports where coach and players need to do a lot of practice, but everybody knows what is the score and what is missing. Evaluations are the right data to assess why the results are poor. Teachers, as coaches, need to incentive students to evolve, to train more, to push conversations where they test the free ideas and become non-conformists! Technology comes afterwards to explore and support intentions, and supply the context awareness.

What is missing now to aid teachers and students in order to focus education plainly? A straight answer is some sort of personal (digital) assistant (PA) able to interact via natural language (speech) to disentangle a diverse set of imbroglio within the distributed environment of a classroom (following Watson innovation). For example, teachers need to search for suitable reports and papers, detect fakes of students, do automatic grading of multiple-choice tests, recommend preferences on different sort of resources, and, otherwise, students request always texts, images, photos, video clips (small demos), MOOCs to work more. So, these PA's may adapt with empathy to the type of teacher and to the student profiles, exploring deeply what is available, mainly through Google and YouTube. The make up of PA's is crucial to help those with difficulty of finding the right goodies.

Often, personalization may fail to match to the right student. Another way is go beyond personalization and look for social signals, to the ability to evaluate the user behaviours, moods, and gestures, ie. to optimize for discovery and diversity. This opens the discussion of the proper algorithm (app) to drive a student for the exploration of knowledge. Suppose we adopt serendipity or pleasant surprise, in order to motivate some one to desirable findings by accident (chance), ie. some thing new

and entertaining. This is a case of content aggregation and the learning algorithm can easily be a factor of attraction and happy guidance.

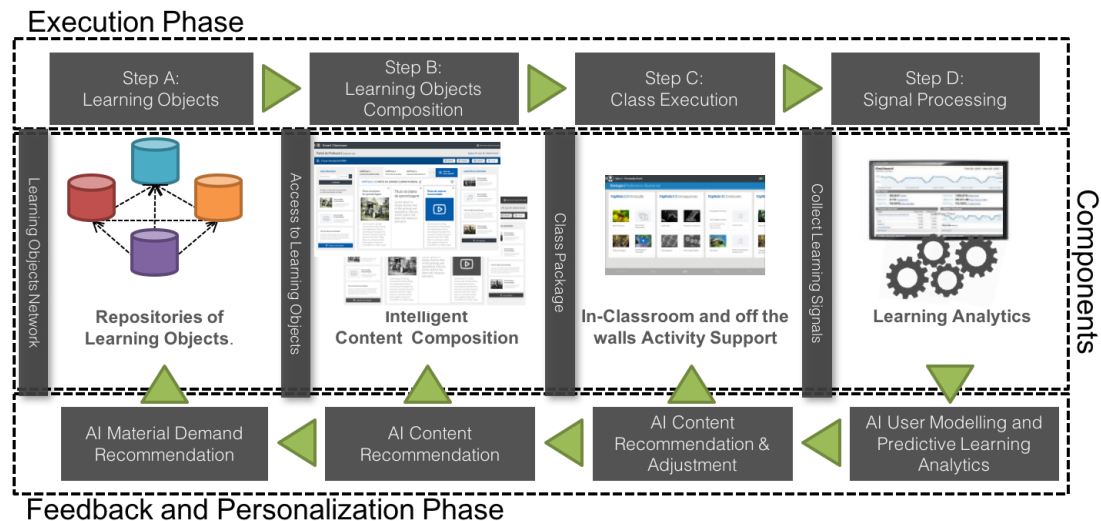
In background, we need a multi-agent (MAS) model attentive to the purpose of those interactions and connected to an online environment and, possibly, open to distance learning. A large learning environment of some discipline requires personalised tutoring and the monitoring of teacher/students behaviours by filming the class. The work of both sides may be supported by metrics (teaching/learning analytics), prediction of teacher/students outcomes in order to allow corrections and the satisfaction of those engaged in acquiring new knowledge. Several examples of MASs were tried, such as MASCE (Maidi and Attia, 2008) for collaborative learning, the ALLEGRO (Viccari et al., 2007) based on instructional planning and case-based reasoning, the architecture for distance learning (Turgay, 2005), or even the adaptive e-Learning/e-Teaching on the web (Fernández-Caballero et al., 2003).

Recent breakthroughs, around capturing intuition and learning to recognize patterns (visual identification), with the consistent advances along the whole decade allow us to be cheerful with computers now able to perform both logic and intuition, and closer to a general artificial intelligence (we are still more flexible in thinking, anticipating, imagining and creating future events). Yet, the importance of technology is now sustainable because sound technical ideas are behind, we did not reverse engineering the algorithms and computations of the brain. “It is a very aggressive time-frame”, said Christof Koch (April 6, 2016).

## **6. Think about the Ecosystem**

The use of computer technologies complements formal or informal education. Educational system designers must think about the teaching and learning process before building digital teaching platforms. The pedagogical plans, educational contents, assessment and learning feedback should be integrated to allow the support of AI algorithms, learning analytics or statistical measures.

Those algorithms are intent to analyse the students learning performance according the teacher pedagogical behaviour, learning style and students behaviour inference to provide warnings and suggestions that can improve the learning performance and support the teacher pedagogical activities. To accomplish this, we must think about an ecosystem of the digital education (Figure 1).



**Figure 1:** Integrated Ecosystem for Digital Education

Teaching with the support of educational technologies should not differ from traditional "analog" methods and support the three stages of learning (exposure, process and feedback). Usually, a teacher of mathematics preparing a class about trigonometry, will search for concepts such as sine, cosine or tangent at a school library, ask for word-of-mouth suggestions, online websites, or even reuse previous classes materials. We classify this as the **Step A: Learning Objects (LO)**.

After the selection of Learning Objects, the teacher, based on experience gathered by years of student observation, will organize the contents considering the average educational performance of students. We classify this as the **Step B: Learning Objects Composition**.

Once the teacher organized the class, it is time to provide the contents to the students and teach. We classify this as the **Step C: Class execution**. Finally, the teacher will go home, or to another class, the analysis of the success of the class will be measured by assessment feedback, emotional responses, or, in the next students essay. We classify this as **Step D: Signals Processing**. Those steps, are the core scenarios of a class, before the Execution Phase.

The Execution Phase is the holy grail of teachers. It can use different kinds of LO, different personalization features, different pedagogical practices and different methods of evaluation. The essence remains the same. The role of educational technology regards the design and adaptation of Components to support each Phase of this process, allowing a Feedback and Personalization Phase to support the teacher activities.

Let us repeat the exercise of imagining the mathematics teacher preparing a trigonometry class from a different perspective, the AI perspective of an Integrated Ecosystem for Digital Education. For that, we start backwards, from the Step D: Signals Processing will be the beginning. At this point, we can analyse the students interactions with the educational contents from the Step C. The time spent at each question, their number of tentatives for solving puzzles, comments, among an infinite set of signal capture possibilities. AI algorithms can cope with the Step B and use the

Learning Objects from Step A by processing and reasoning over the learning signals, leading to the identification of patterns, measuring the students learning performance, identifying competences to be developed, measuring the engagement withing a class and consequently suggesting content compositions based on a measurable class learning profile.

The challenges to accomplish such ecosystem reside in open architectures, metadata standards, communication protocols and policies regarding data privacy and security of students and teachers.

The benefits are far from being explored. For example, the detailed usage logs for in-classroom data collection and analysis can be used to analyze and infer pedagogically relevant datastreams. Those datastreams can be used to measure the student engagement in Real-time or After-class.

Real-time measures support the teacher during their classes. Those measures are challenging since it has to stabilish a time-frame of signal analysis, eg. last 30 seconds of data, which variables to choose such as students eye tracking, page navigation, open content, the type of content, students emotional inferences, among others. Majorly, the research focus resides in the analysis of context similarities between what is being thought and what are the reactions of the students to it.

After-class measures support the teacher after and before the class, it computes the percentage of students that were engaged at each timestamp, supports the teacher by presenting a timeline of the class. The research at this stage can be extended by deep-learning algorithms to infer the model of learning from students or groups, recommender algorithms, infer the behavior of students based of past actions, and other big data statistics to support class preparation.

Generally, when dealing with this kind of data, it is an open ground for research to identify what type of students and teachers events may be important to build richer models of student learning.

One of the challenges resides in assessing how well a student learnt the subject matter, without explicitly testing for that in an exam. It is thus necessary to incorporate the metrics into a greater model of student learning, for instance a knowledge map, based upon which new content could be suggested in accordance with what the student already knows, how engaged he or she is, the learning style, and other extracted metrics to personalize each student's learning experience. Alternatively, the metrics may be used to design specific interventions in the teacher's activities, for instance, alerting him/her that the class' engagement level is dropping. Nevertheless, such interventions must be designed together with educators to augment the teacher's experience, and not disrupt his/her day-to-day work.

## **7. Conclusions**

In this article we presented our insights and proposal to design more attractive ECPs that provides the necessary features to push students to learn. Stimulate big ideas, be creative, follow up what was misunderstood and make good connections is what

ambivert students desire to be prepared to interfere and to be far of current passers-by of a school.

With the support of intelligent apps and agent technology we may manage the challenges around Active Learning and Flipped Learning inception inside classrooms. We presented an alternative to allow new and surprising ways to aid teachers and students. Teachers can benefit by a data-oriented analysis of their students learning performance. Students can change their behaviour, to find creative landscapes, to think about what is in the learning process and acquire new pieces of knowledge.

Fostering greater usage of assessment results we explored the challenges around students performance improvement's and engagement providing the amount and quality evidence to support a solid basis for action, in particular to automacally suggest and guide changes and shifts in teaching and learning on compuses that will aid later to attain higher levels of knowledge retention and student accomplishment.

Motivation, the desire to do things, is now a key for learning and teaching (social activities), and an ECP supported by an Ecosystem of educational technology is also in charge to stimulate those involved in education to be continually interested and committed (engaged) to a task, or to make an effort to attain a goal. There are difficulties in education (how people learn, observable outcomes, metrics of success), and an easy wayout is always to experiment and try things out.

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