Edukas Environment: Towards an Integrated Dashboard for Education Management in Smart Cities

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***Abstract*—Education is considered one of the basic needs of every citizen and plays a key role in country development. Throughout history this area has faced a number of challenges and paradigm shifts. Nowadays, the presence of pervasive computing might help the teaching-learning process using huge datasets through user interaction with these new technologies. This research describes the Edukas Environment, a conceptual model that uses educational governance, computational intelligence and strategic planning to assist school and smart city managers transform the teaching-learning process, benefiting the whole educational chain of events.**

***Keywords*-education; governance; computational intelligence; strategic planning; smart cities**

I. Introduction

Considered one of the basic needs and rights of every citizen the education whose a key role to the development of a country [1]. Throughout history, education faced a number of challenges and paradigm shifts. Nowadays, managers and institutions are concerned with retaining students and making learning interesting, efficient and effective. Parents, in turn, are committed to understand children's performance and help them with learning. Teachers and educators want to understand the real situation of the teaching-learning process, with accurate information that might guide and create value through learning. Finally, students want to learn.

In this context, the dynamics of the teaching-learning process has faced rapid transformations promoted by the outstanding advances of Information and Communication Technologies (ICTs) and business models. According to Stuchlikova [2], the forecast is that knowledge doubles every three years. This means that much of the knowledge acquired during a degree, for example, will be obsolete until its completion. In that paper, the author also quotes some challenges that education is already facing, such as:

- *Creative school*, which should act differently for each student, seeking to fully develop him, as opposed to standardization.
- *Self-learning promotion*, with several initiatives to promote self-study, including offers of courses for all ages and areas of knowledge.
- *Virtual world and virtual teachers*, with applications where even teachers can be suppressed from the classroom.

Gartner Inc. [3], [4], in turn, exposes key business and technological trends that will influence fundamental and higher education, as shown in Tables I and II.

Table I
Business and Technology Trends on Fundamental Education

Business Trends	**Technology Trends**
The Shift to active learning	Artificial intelligence
Change the definitions of schools and students success	Virtual/Augmented Reality
Personalized learning	Digital assessment
Analytics everywhere	Adaptive learning
Privacy and Trust	Digital ecosystems

Table II
Business and Technology Trends on Higher Education

Business Trends	**Technology Trends**
Competency-based education	Open microcredentials
Reinventing credentials	Digital assessment
Analytics everywhere	Predictive analysis
Ranking	Adaptive learning
Breaking Boundaries	VR/AR Comeback
Revenue diversification	Hybrid integration platforms
Increasing political intervention	Institutional video management
Innovative learning spaces	Artificial intelligence
Personalization	Listening and sensing technologies
Students recruiting	Robotics Telepresence

In face of these challenges and trends, Arold e Pistilli [5] describe that the key to succeed is integrate students with the technological transformations, i.e., provide integrated and accurate information (internal and external to the school) of students for parents, educators and school managers, in order to support decisions that will be taken over the learning process.

As an example of student integration with ICTs, Meneghel [6] emphasizes the increasing use of Virtual Learning Environments (VLE) and Virtual Labs (vLabs) to improve Distance Education (DE). Based on these concepts and

due to the high level of interaction between the student and the learning objects, it will be possible to construct a large educational database that allows the recognition of behavioral patterns. Moreover, the system may acquire information that could be used to generate indicators that measure students performance, contributing to the teaching-learning process improvement.

In this context, this research introduces a model that connects the concepts of Smart Cities, Strategic Planning, Educational Governance and Computational Intelligence. The objectives of this framework, called Edukas, are: (i) create a real-time dashboard to allow public and school managers to identify the strengths and weaknesses of the teaching-learning process for cities and schools; (ii) establish a best practice guide for educational governance; (iii) use computational intelligence, learning analytics and educational data mining tools to recognize student behavior patterns in e-learning objects; and (iv) promote educational opportunities and improvements.

Considering the research objectives, this paper is organized as follows. This first section defines the proposed theme and presents its general objectives. Section II presents a literature review of the main topics that compose this work. Section III shows the discussion on the key topics and describes the Edukas environment conceptual model. Finally, section IV, exposes the conclusion, as well as some future works.

II. Background

This section comprises the definition of the key topics related to this research. First, the concepts of smart cities and some experiences are addressed. Next, we define corporate and educational governance, as well as computational intelligence and strategic planning.

A. Smart Cities

In the 1990s, with the arising of the new ICTs and the growth of their relationship with urban spaces, the "digital city" term appeared. The objective of digital cities was to provide technological resources that would encourage innovation processes in public, business and commercial environments, as well as to democratize access to digital equipment and networks [7].

In recent years, several authors started to call these environments "smart cities". However, it is not possible to find, in the literature, a consensus on the definition of this term [8]. In general, the authors state that the use of sensors, radio-frequency tags and other technological resources by urban centers has evolved the "digital city" to a new era, called "smart city". This new kind of cities make intensive the use of ICTs resources such as identification of the environment in which they are inserted (IoT), intelligent analysis of possibilities (Computational Intelligence), and the the production and analysis of large amount of data (Big Data) [9].

Associated with the technological advances, there are United Nations researches [10] that show the importance of these systems for citizens, as approximately 54% of the world's population lives in urban areas. In 2050, this number will reach 66%. In face of this rapid growth it is necessary to maintain the quality the population life [8]. Therefore, it is of fundamental importance to ensure the proper functioning of the various systems that make up a city, especially public services, such as health, safety and education [11].

In order to keep competitiveness in the 21st century and due to the new world economic and technological scenario, cities need to obtain and use the best available technological resources, in favor of a systemic approach aimed empowering their citizens with the best available educational tools. By doing so, it will be possible to attract and create new opportunities as well as general develop knowledge and creativity of the population in [12].

In the literature, there are several examples that demonstrate the incorporation of ICTs in urban environments. We can mention the city of Songdo in Korea, in which everything is interconnected by the Internet. There are intelligent systems that allow the reprogramming of the city's traffic lights in real time, according to the traffic of the tracks and the presence of automated waste collection systems, in which garbage is sucked directly from people's apartments [13]. There are also interesting projects being developed in Masdar/United Arab Emirates, Amsterdam/Netherlands, Paredes/Portugal, among others [7].

B. Corporate and Educational Governance

Corporate Governance (CG) is a good practice system in which organizations are directed, monitored and encouraged, taking into account the relationships between owners, directors, executive officers and other control bodies. Good CG practices convert principles into objectives, which preserve the resources, optimize the value of the organization and facilitate the access of external capital, contributing to its longevity [14].

The CG plays a key role in today's business. Its application often defines how the organization is accepted and recognized by the society. Good CG practices are essential for private sector and led economic growth and promotion of social welfare, which depend on increasing investments, capital market efficiency and company performance [15].

In reality, CG considers the organization stakeholders needs, both internal and external, and their drivers. A driver is understood by any situation (internal or external) that may influence the organization and its stakeholders needs. These needs must be considered, addressed and used to direct the organization's objectives.

To apply the CG in educational field, it must be defined as the process that guarantees the efficient and effective use

of resources to enable the organization to achieve its goal of teaching. It is important to consider the key stakeholders as well their drivers in the Table III shows examples identifying stakeholders, their drivers and their needs.

Table III
STAKEHOLDERS AND EDUCATIONAL GOVERNANCE DRIVERS

Stakeholders	Needs	Drivers
Government	Quality education. Well-formed citizen.	Education policies, approval rate, evaluation results, public acceptance.
Society	Well-formed citizen. Economically productive.	Job market, individual and collective desires, economy, technological trends.
School Management	Well-formed citizen. Individual capable of performing professionally. Operational efficiency.	Regulatory policies and laws, market positioning, financial health, operational efficiency, learning, technological trends.
Parents	Well-formed children. Sons capable of achieve their goals. Feedback. Synergy with teachers.	Learning, communication, technological trends, child training, economics.
Teachers	Reliable Information. Learning process. Synergy with parents. Identify improvement points.	Learning, communication, technological trends, teaching methods.
Students	Learn. Being engaged. Feel himself part of the process.	Learning, engagement, trends, communication.

As shown in the Table III the first column shows who is the interested. The second column disclose what they want from an educational institution. Finally, third column shows which drivers can influence their needs. For example, a student needs to be engaged. He or she is influenced by technological trends, it means that as technology evolves, the student hopes to use it in his/her learning process. Information about stakeholders, needs, and drivers is not limited to those displayed by Table III.

The stakeholders can be direct or indirect. Direct are the ones who are directly involved in the teaching-learning activities, e.g., the school managers, parents, teachers and students. The indirect are people that do not have a direct involvement in the activities but have expectations related to its results, e.g., government and society. Figure 1, bellow, represents the relationship between the actors, their drivers and the management of an educational organization.

According to Figure 1, the Governance and the Educational Management establish the relationship between the drivers, stakeholders, senior management and management. To simplify the figure, only two departments of the school were presented, Management and Pedagogical Coordination. These departments may vary in each school. However, for good educational governance, it is crucial that the school structures and stakeholders are well-defined and adequate, for example, due to technological advances it may be necessary create a innovation department.

The trends exposed in the tables I and II along with the drivers introduced in the Table III, influence the needs of

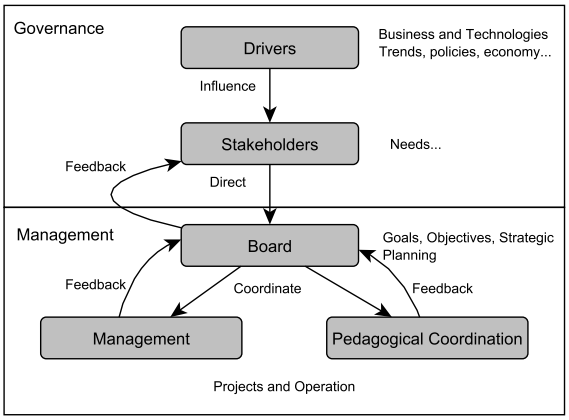

Figure 1. Macro-model of Governance and Educational Management

the stakeholders. These needs are dynamic and time-varying. Therefore, it must be interpreted and analyzed by the board to define the goals, leading the institution to achieve the stakeholders needs.

The main objectives defined by the board, in turn must be interpreted by each management area, which should elaborate area objectives that shall contribute to lead to organizational objectives. It is critical that these areas work together and develop appropriate objectives. Those objectives will be translated into action plans, projects and other activities to be applied in each area to achieve the objectives.

Another very important aspect of the model is the feedback, starting by the most operational levels towards the most strategic ones. This flow of information is relevant for both area and organizational objectives to be assessed in relation to their service. Thus, corrective actions can be taken as soon as possible, avoiding waste and correcting the path towards the goal. The purpose of the feedback is to ensure the alignment of the objectives with the needs of stakeholders.

C. Computational Intelligence, Educational Data Mining, Warehousing and Analytics

Educational Data Mining (EDM) is an interdisciplinary research area that deals with the development of methods to explore data originating in an educational context. EDM uses computational approaches to analyze educational data in order to study educational questions. This area exploits statistical, machine-learning, and data-mining algorithms over the different types of educational data. Its main objective is to analyze these types of data in order to resolve educational research issues. The EDM process converts raw data coming from educational systems into useful information that could potentially have a great *impact on educational research* and practice. There are some common tasks in educational context. Some of them might be addressed using computational

intelligence algorithms [16], [17]. These tasks are explained below.

1) Classify Students Profile: The objective of this task is to identify the students profile providing useful information to understand the skills, the fitness and the context of each student. Classifiers such as random forest, decision three, kNN, etc., are usually applied in this context. Moreover, providing a useful profile might be a first step to recommend an adequate path for students that aim to achieve a great intellectual development.

2) Analysis and Visualization of Data: The objective of the analysis and visualization of data is to highlight useful information and support decision making. In the educational environment, it can help educators and course administrators to analyze the students course activities and usage information to get a general view of a students learning. Statistics and visualization information are the two main techniques that have been mainly used for this task. Information visualization uses graphic techniques to help people to understand and analyze data. Visual representations and interaction techniques take advantage of the human eyes broad bandwidth pathway into the mind to allow users to see, explore, and understand large amounts of information at once [16], [17].

3) Providing Feedback for Supporting Instructors: The objective is to provide feedback to support course authors/teachers/administrators in decision making about how to improve students learning, organize instructional resources more efficiently, etc., and enable them to take appropriate proactive and/or remedial action. It is important to point out that this task is different from data analyzing and visualizing tasks, which only provide basic information directly from data (reports, statistics, etc.). Moreover, providing feedback uncover completely new, hidden, and interesting information found in data. Several DM techniques have been used in this task, although association-rule mining has been the most common. Association-rule mining reveals interesting relationships among variables in large databases and presents them in the form of strong rules, according to the different degrees of interest they might present. [16].

4) Recommendations for Students: The objective is to be able to make recommendations directly to the students with respect to their personalized activities, links to visits, the next task or problem to be done, etc., and also to be able to adapt learning contents, interfaces, and sequences to each particular student. Several DM techniques have been used for this task, but the most common are association-rule mining, clustering, and sequential pattern mining. Sequence/sequential pattern mining aims to discover the relationships between occurrences of sequential events to find if there exists any specific order in the occurrences [17].

5) Predicting Students Performance: The objective of prediction is to estimate the unknown value of a variable that describes the student. In education, the values normally predicted are performance, knowledge, score, or mark. This value can be numerical/continuous value (regression task) or categorical/discrete value (classification task). Regression analysis finds the relationship between a dependent variable and one or more independent variables. Classification is a procedure in which individual items are placed into groups based on quantitative information regarding one or more characteristics inherent in the items and based on a training set of previously labeled items. Prediction of a students performance is one of the oldest and most popular applications of DM in education, and different techniques and models have been applied (neural networks, Bayesian networks, rule-based systems, regression, and correlation analysis) [16], [17].

6) Student Modeling: The objective of student modeling is to develop cognitive models of human users/students, including a modeling of their skills and declarative knowledge. DM has been applied to automatically consider user characteristics (motivation, satisfaction, learning styles, affective status, etc.) and learning behavior in order to automate the construction of student models. Different DM techniques and algorithms have been used for this task (mainly, Bayesian networks) [17].

7) Detecting Undesirable Student Behaviors: The objective of detecting undesirable student behavior is to discover/detect those students who have some type of problem or unusual behavior such as: erroneous actions, low motivation, playing games, misuse, cheating, dropping out, academic failure, etc. Several DM techniques (mainly, classification, and clustering) have been used to reveal these types of students in order to provide them with appropriate help in plenty of time [17].

8) Grouping Students: The objective is to create groups of students according to their customized features, personal characteristics, etc. Then, the clusters/groups of students obtained can be used by the instructor/developer to build a personalized learning system, to promote effective group learning, to provide adaptive contents, etc. The DM techniques used in this task are classification (supervised learning) and clustering (unsupervised learning). Cluster analysis or clustering is the assignment of a set of observations into subsets (called clusters) so that observations in the same cluster have some points in common [16], [17].

9) Social Network Analysis: Social networks analysis (SNA), or structural analysis, aims at studying relationships between individuals, instead of individual attributes or properties. A social network is considered to be a group of people, an organization or social individuals who are connected by social relationships like friendship, cooperative relations, or informative exchange. Different DM techniques have been used to mine social networks in educational environments, but collaborative filtering is the most common. Collaborative filtering or social filtering is a method of making automatic predictions (filtering) about the interests

of a user by collecting taste preferences from many users (collaborating). Collaborative filtering systems can produce personal recommendations by computing the similarity between students preferences; therefore, this task is directly related to the previous task of recommendations for students [16].

10) Developing Concept Maps: The objective of constructing concept maps is to help instructors/educators in the automatic process of developing/constructing concept maps. A concept map is a conceptual graph that shows relationships between concepts and expresses the hierarchal structure of knowledge. Some DM techniques (mainly, association rules, and text mining) have been used to construct concept maps [17].

11) Constructing Courseware: The objective of constructing courseware is to help instructors and developers to carry out the construction/development process of courseware and learning contents automatically. On the other hand, it also tries to promote the reuse/exchange of existing learning resources among different users and systems [16], [17].

12) Planning and Scheduling: The objective of planning and scheduling is to enhance the traditional educational process by planning future courses, helping with student course scheduling, planning resource allocation, helping in the admission and counseling processes, developing curriculum, etc. Different DM techniques have been used for this task (mainly, association rules).

13) Stakeholders point of view: These tasks might be visualized by some group of stakeholders. Each of them have a different point of view, but all information might be provided by unified educational systems. The Figure 2 bellows, shows an overview of unified educational system.

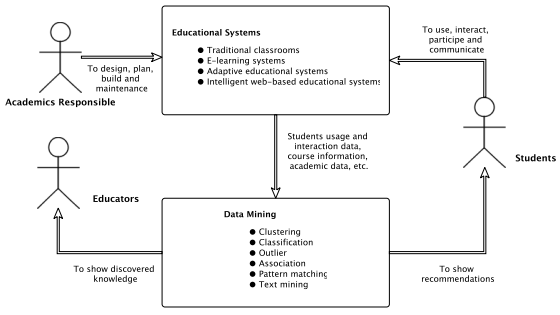

Figure 2. An Overview of Unified Educational System [16], [17]

As shown on Figure 2 above, we have 3 different points of view:

- Oriented toward students. The objective is to recommend to learner: activities, resources and learning tasks that would favor and improve their learning; good learning experiences for the students; path pruning and shortening or simply links to follow, based on the tasks already done by the learner and their successes, and on tasks made by other similar learners; etc.
- Oriented toward educators. The objective is to get more objective feedback for instruction, evaluate the structure of the course content and its effectiveness on the learning process, classify learners into groups based on their needs in guidance and monitoring, find learning learners regular as well as irregular patterns, find the most frequently made mistakes, find activities that are more effective, discover information to improve the adaptation and customization of the courses, restructure sites to better personalize courseware, organize the contents efficiently to the progress of the learner and adaptively constructing instructional plans, etc.
- Oriented toward academics responsibles and administrators. The objective is to have parameters about how to improve site efficiency and adapt it to the behavior of their users (optimal server size, network traffic distribution, etc.), have measures about how to better organize institutional resources (human and material) and their educational offer, enhance educational programs offer and determine effectiveness of the new computer mediated distance learning approach.

In short, educational data mining is a young research in the area and it is necessary to develop more specialized and oriented work educational domain in order to obtain a similar application level success as obtained in other areas, such as medical data mining, mining e-commerce data, etc.

Table IV
EDUCATIONAL RESEARCH AND PRACTICE

Educational Research and Practice	Computational Intelligence Task
Classify Students Profile	Classifiers
Analysis and Visualization of Data	Data Science
Providing Feedback for Supporting Instructors	Association-rule
Recommendations for Students	Sequential pattern mining
Predicting Students Performance	Neural Networks
Student Modeling	Bayesian Networks
Detecting Undesirable Student Behaviors	Classifiers
Grouping Students	Classifiers and Clustering
Social Network Analysis	Collaborative Filtering
Developing Concept Maps	Text Mining
Constructing Courseware	Existing Learning Resources
Planning and Scheduling	Combinatorial Optimization

As shown in Table IV, some common educational tasks research might support computational intelligence, providing useful information to decision makers improve the quality of general education.

D. Strategic Planning in Education

The "strategy" word has its origins in the ancient civilizations and military environments. The adaptation of this term to business environments resulted in the "Strategic Planning", which gives to managers the ability to arrange tasks, establish a mission, and determine the short, medium and long-term goals [18].

In the business context, the last decades were marked by intense discussions about the factors that should compose strategic planning [19], [20], [21], responsibilities [22], [23], [24] and ways of developing, improving and monitoring the implementation of the plans [25], [26], [27], [28].

In this context, the SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis [19], a.g.e., is a excellent tool to guarantee the the equilibrium between internal and external environments. The Porter's five forces [20] helps to determine the attractiveness of an organization and its products. In turn, the BSC (Balanced Scorecard) [29] methodology is a tool to measure the business performance through quantifiable and verifiable indicators, which are interrelated in a cause-effect strategic map.

In the educational field, several successful experiences with strategic planning in higher education institutions have been reported. The performed activities work to respond quickly and positively to the growing progress of the expectations attributed to the teaching-learning process, maximizing the chances of maintaining a competitive and relevant institution in the face of market developments [30]

A successful example was reported in Turkey [31]. Under current legislation and as part of a quality management program, since 2006, public educational institutions need to develop and maintain strategic plans. As a consequence, public resources become better managed, bringing several improvements in the social areas of the institutions. To keep the plans updated the institutions promote annual events to review the objectives and ensure the continuous improvement of the plans.

Another case of success is the Cheng Kung National University in Taiwan, which aims to become one of the world's 100 best universities, as reported by Chou and Li [1]. The framework allows gauging how much the BSC (Balanced Scorecard) objectives are aligned with the institutional objectives, resulting in a strategic map with cause and effect relationships.

Distance Education has also employed the strategic planning methodologies on its organizational processes. Carr-Chellman [32] states that planning has great importance to the success of an institution. Moreover, it is necessary to incorporate good practices to understand the implicit values in the teaching-learning process.

Design and realize strategic planning are complex tasks [33]. In an environment of increasingly challenges and uncertainties, such as education, the strategic planning may play a key role for the institution survival. As there are no available researches to attend the development of a concise and effective strategic plan to the education sector, it will be necessary to compare the goals and objectives with other sectors, as well as to base on errors and learned lessons from other areas. [34].

III. Discussion

Considering all information in the previous sections, the established relationship between smart cities, corporate governance, computational intelligence and strategic planning will result in a educational dashboard, which is a adaptable and replicable model of educational governance. This environment will support the teaching-learning process, providing to the stakeholders updated and real-time information about the educational healthiness within a school, city or even a state or a country.

Education governance is critical for the development and growth of educational organizations considering their environment. It consists of corporate governance applied on educational organizations. Even though corporate governance is widely studied, its application on educational environment have some specific issues that must be addressed. In educational management some reports and case of studies were found, however no practical application model of corporate governance in education was found. Therefore, research in practical education governance is important to prepare educational organizations for a new technological and connected world.

Educational data mining is an upcoming field related to several well-established areas of research including e-learning, adaptive hypermedia, intelligent tutoring systems, web mining, data mining, etc. The application of data mining and machine learning (all these aspects are called computational intelligence) in educational systems has specific requirements not present in other domains, mainly the need to take into account pedagogical aspects of the learner and the system. Although the educational data mining is a very recent research area there is an important number of contributions published in journals, international congress, specific workshops and some ongoing books that show it is one new promising area [16], [17].

In the strategic planning area, there were found several researches whose analyses the influences of the strategy in the classroom, whether in present or distance education. Also, there are studies that report the experiences of the creation and adoption of some strategic activities. However, there were not found researches that comprises the both aspects, providing a real-time analysis between planned and performed activities, which uses computational intelligence algorithms and educational governance best practices to achieve the learning-teaching objectives in a smart world.

The Edukas environment, in turn, is subdivided in three main layers, as shown in Figure 3. In the lowest layer are the systems that can be accessed by students or education managers. The middle layer records all resulting data from the interaction with the systems, forming a educational big data. The highest layer uses all of the stored data, the corporate governance model, computational intelligence algorithms and strategic planning to generate tangible information to

the stakeholders.

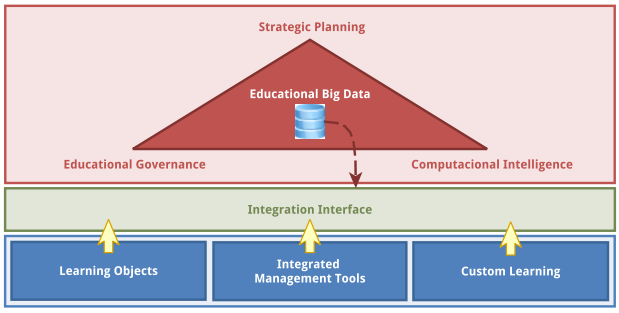

Figure 3. Conceptual Model of Edukas Environment

As shown in Figure 3 Edukas environment is based on three disciplines Strategic Planning, Educational Governance and Computational Intelligence. Strategic planning provides the direction to reach the goals, Educational governance establish the goals and monitor if the organization reach them or not. And finally, Computational Intelligence provide real time analysis information to the other disciplines. Therefore, the three disciplines are related and integrate themselves.

These disciplines are supported by a educational big data that collect data from different types and sources. Edukas classified the data in three groups: Learning Objects, Integrated Management Tools and Custom Learning. First, learning objects consist of data use to teach and learning, those models are applied to the teaching-learning process and their effectiveness are validated. This group considers different technologies trends such as, Artificial Intelligence, Virtual/Augmented Reality, Digital Assessment, Adaptive Learning, Listening and Sensing Technology and Robotic Telepresence.

The second group of data is Integrated management that consist in heterogeneous data from different management systems (ie. Learning Management System, Enterprise Resource Planning, Content Management) those data are integrated to be used as input of the three disciplines. The integrated management group considers some technologies trends, such as, open micro credentials, predictive analytics, hybrid integration platforms and digital ecosystems.

Finally, the Custom learning group aim to help the teaching learning process to identify attributes for each students and act in the best way to each one, providing a personalized learning and helping teacher to identify and solve gaps in the teaching-learning process. This group considers some technologies trends, such as, Adaptive learning, artificial intelligence, digital assessment, listening and sensing technology, predictive analytics and hybrid integration platforms.

Using the three disciplines and integrating the data groups defined in Edukas Model we compile a framework to help educational organizations to develop themselves considering the challenges and technologies evolution.This framework provide an assessment method and define a road map to the organizations in order to evaluate their current situation and define actions to reach their objectives.

The overall model is under a PDCA (Plan, Do, Check and Act) cycle, in this way, for each application of it, the results must be analysed and used to improve the model.

IV. Conclusion

In the academic literature we can find several strategic planning and computational intelligence researches applied to education. However, there are, comparatively, corporate governance studies in the educational field. In this work we present a model looking to integrate data produced in the several activities occurring in the area of education, and treated with computational intelligence tools, to generate comprehensive strategic plan and governance scenarios for teachers, schools officials, and any other people interested in the development of education.

Report on Research in Development

Currently we are deploying a set of pedagogical and management computer environment in several schools of the State of São Paulo and Paraná, in Brazil, to generate a huge and varied set of educational information data (a Big Data on education) where we shall apply and test the model presented in this paper.

Also, it is important to develop some particular work on Computational Intelligence:

- Standardization of methods and data. Current tools for mining data from a specific course may be useful only to its developers. There are no general tools or re-using tools or techniques that can be applied to any educational system. So, a standardization of data, and the pre-processing, discovering and post processing tasks is needed. One of the difficulties about providing accurate information is related with get accurate data. There are many ways to implement data structure to support this sort of data. To standardize this data might be a way to improve data quality and resulting decision.
- Integration with the e-learning system. The data mining tool has to be integrated into the e-learning environment as another author tool. All data mining tasks (pre-processing, data mining and post-processing) have to be carried out into a single application. Feedback and results obtained with data mining can be directly applied to the e-learning environment.
- Specific data mining techniques. More effective mining tools that integrate educational domain knowledge into data mining techniques. Education-specific mining techniques can help much better to improve the instructional design and pedagogical decisions. Traditional mining algorithms need to be tuned to take into account the educational context.

On the strategic planning pillar, there are a lot of work to do. Alongside with the development of the computational intelligence algorithms and with the provided results by them, we will create a generic strategic map, with common objectives, goals and its relationships. These indicators will be created under the BSC directives and aligned with educational governance model. Its registration will occur on a computational system named Strategi, which is ready to use.

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