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Smartphones and NFC Technology Applied to Interdisciplinary Action Towards a Multidisciplinary Vision

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Abstract
This work aims to offer a daily basis picture about student´s performance and evolution, besides a wide view based on formative assessments in different subjects that will offer the possibility to one teacher interacts with another using an asynchronous interdisciplinary methodology, a resource which can help in collaborative social actions of educators and managers, as proposed by Habermas.

1. Introduction

In search of continuous improvement, the best teaching and learning processes execute the PDCA cycle: plan, do, check and act [1]. However, the rationality of these processes has led to the atomicity of the disciplines that, with the absence of a social and collaborative vision, end up favoring technicality and positivism, compromising the student's emancipation. When applied to education, Habermas' Communicative Action [2-3] suggests that interaction through interdisciplinary subjects can restore social vision in the educational process. The proposal is to use technology, formative evaluation and collaboration among educators to offer a better multidisciplinary teaching [4-5]. Indeed, it is necessary to prepare individuals with scientific knowledge, critical sense and sociocultural maturity.

Many people believe that the world would be better if the education were put in the first place. The Global Education First Initiative (GEFI) was launched on 26th September 2012 supported by the United Nations, for a period of five years, with the following priorities: putting all children in school, improving the quality of learning and promoting the global citizenship. Investing in education around the world seems to be the way to have egalitarian, healthy and prosperous societies [6]. Brazil, one of the leaders of the GEFI, has a huge responsibility with its population that expects a transformation in its educational reality that counts on complex and challenging academic environments due to the cultural, economic, political and social factors.

Improving the quality of education is not an easy task when it is necessary to consider all the aspects involved. This work is focused in both real and virtual classroom proposing a management system to monitor multidisciplinary teaching and learning, using the technology of permanent evaluation offering the possibility for corrective and effective actions [7]. Formative assessment can be an excellent tool for improving the quality of teaching and learning [4].

However, due to the atomization of the current school curricula, the formative assessment, when disconnected from a multidisciplinary education, can lead more to

technicality and curriculum compliance and less to a holistic education of the citizen.

Regarding the teachers, the pedagogical practice can generate an isolation between them if developed only through the curricular structure. In the occurrence of problems on teaching and learning, the conclusion and corrective actions are delayed, since the exposure of the assessment results and the communication with the fellow teachers do not happen in the necessary form and intensity. In this scenario, collaborative social action gives way to scientific procedures, techniques and methods in the service of a reason with questionable results.

2. Theory of the Habermas' Communicative Action

One of the fundamental factors of Horkheimer Critical Theory is the improper way in which modern industrial society understands reason, letting itself be mastered by it, a challenge already proposed by the Frankfurt School (1931). In this theme, the critic is about the instrumental reason, the basis of what Horkheimer called Traditional Theory, used as an instrument for scientific rationality and removed from a social context. The criticism to the scientific rationality is the lack of social issues from the reason examination, since they are considered subjective and irrational, which could not be solved in the perspective of the relation between means and ends, and stayed away from questions concerning the economy and the efficiency of the means. Critical Theory tries to show that reason in modern industrial society does not intend to know the Man in his rationality, but only to use it as an instrument of domination, oriented to pre-establish contents, formatted according to specific concepts and interests, many of which sometimes unrelated to historical praxis [8], which represents human activity in society and nature.

The second generation of the Frankfurt School offered an alternative to the Theodor Adorno´s contradiction, when it was proposed as a result of the cultural industry, the mass culture, which enslaves the man as opposed to that expected by the emancipation of knowledge and reason. The communicative action of Jürgen Habermas [3] offered another point of view, where knowledge must be established not only by the interaction between subject and object, but also and especially by mutual social understanding, where reason gets more independency from normative contexts.

Also in the educational context, critical analysis is the goal of any evaluation process, in addition to its objective of improving the quality and effectiveness of the teaching and learning process. In this sense, it can be considered the Habermas' intellectual project, which seeks to develop "criticism" in two senses: the first is that of a social theory, where it is intended to validate its foundations, while the second sense is that of a Theory Exposes injustices. The basis of this theory lies in the understanding of "communicative action," the assumptions of an "ideally free community," and the rules that allow people to come to rational understanding

The dynamics of the class, the frenetic life of the students and teachers, the growth in the volume of information and new knowledge, among others, hinder the conclusions that allow coordinated interdisciplinary actions.

Interestingly, with the use of technology, the communicative reason can be applied to the analysis of the formative evaluation processes, thus allowing the student's state of formation to be presented in a complete way [9]. Also due to the use of technology, it is possible to orient educational and pedagogical actions based on a consensus, although asynchronous, where the interactions occur at different times.

The application of communicative reason to the analysis of evaluations presupposes a multidisciplinary interaction, where conclusions and actions are established socially in the process of dialogical interaction of the actors: managers, educators, parents and pedagogues, offering more rigor, efficiency and meaning through which Habermas Flame of speech. The absence of a multidisciplinary communicative process leads to technicality, which makes obscure the failures that may occur in the teaching and learning cycles.

For Habermas, technicalism must itself be evaluated, criticized and debated in order to discover its ideology, which can make the human being just another instrument of technology. These analysis must be brought to a holistic and social sciences context. Formative evaluation, for example, is an important technique where one can measure the effectiveness of teaching, its receptivity, its reflection and maturity. This evaluation also provides fundamental information for the pedagogical planning and the use of the methodologies to be adopted in a dynamic system, which seeks the excellence in the formation of the student. But that immersion in a communicative analysis does not occur, as Habermas proposes.

The current assessment and decision-making techniques in teaching and learning can not include many problems of human practice, nor offer the visibility that enables communication and multidisciplinary management [10]. According to Habermas's ideas, we must analyze communicative processes, always with an emancipatory aim, where the analysis lead to actions that aim a dialogue and reciprocity between the subjects. These need to pacify the understanding through agreement among the actors involved. Habermas proposes that every conclusion and decision-making must come from the argumentation of what can be accepted and validated by the social group and not only from the awareness that one has of the ends.

This process of communication can only be fully realized in an emancipated community, with mature, informed members and with the right tools, creating possibilities for the existence of a model of identity, formed in reciprocity and in the idea of a true consensus. In this scenario, the speed, veracity and accuracy of the information, as well as its availability, are fundamental so that the actors can play their role in an integrated way that reaches the communicative

reason, as proposed by Habermas.

3. The Assessment in a Multidisciplinary Management System

A formative evaluation is a pedagogical process integrated to teaching and learning, whose main function is regulating and improving the student's learning. For this, the teacher must assume some responsibilities such as: using a permanent and intelligent feedback system that effectively supports the students, as well as, adapting the teaching according to the needs and also facilitating an interactive communication of the students among themselves and of the students with the teacher. In addition, the student must be actively involved in the learning and evaluation processes, in order to organize his own learning process considering the results of the self-assessment, the cognitive resources and the teacher's feedback [11].

Many school institutions remain attached to the traditions, including the differences between students, with homogeneity and standardization in pedagogical practice. The Brazilian school has not created spaces to be attuned to the new demands, and it has difficulty in absorbing the cultural and technological inovations, the new language codes, as well as the different customs of the different social groups. On the other hand, within the same school, some of the different cultures affirm their values and their contents or resist against the impositions of cultural domination [12]. Discussing the construction of a multicultural curriculum leads to a broader issue: "the capacity of education to embrace diversity," ie, the issue of the cultural diversity must be discussed in order to welcome the members of a cultural minority [13].

As foreseen in the National Curricular Parameters, the school has a great challenge to overcome in the discussion of themes and issues related to cultural plurality and diversity. Taking into account this condition allows the school community to understand its own value and promotes the elevation of self-esteem and reduces undue expectations [14]. In this way, a new conception of the organization of didactic situations is necessary, starting from the knowledge about the teaching processes: a set of content organization modalities that uses concepts of Multidisciplinarity and Interdisciplinarity besides the Globalized Methods, recognizing in these, the work by projects.

The relationships and the way of linking the different learning contents that form the didactic units configure the organization of the contents. It is known that the more related the content is, the more potent the understanding becomes. In this sense, different proposals and experiences break with Disciplinarity, when themes are chosen and through them, attempts are made to establish relationships between contents of different disciplines. The following are two ways of organizing contents [15]: a) through the logic that comes from the formal structure of the disciplines, where contents can be classified according to their nature in: Disciplinarity, Multidisciplinarity, Pluridisciplinarity and Transdisciplinarity; b) through the forms of organization centered on global or integrating models, where the contents are organized according to their capacity to understand a reality, which is always manifested globally. This proposal can be termed as Globalized Methods described in Decroly's interest centers, in Kilpatrick's project methods, in Freinet's middle studies and in Hernandez's work projects.

After studying the forms of content organization, it is possible to propose a mechanism capable of consolidating the information of each student, especially with a multidisciplinary view of contents, as a structure capable of offering a holistic view of the development of the same. Nevertheless, it will also be a tool for educators, who will act in an articulated but punctual manner on the specific contents.

In addition, actions will occur within the teaching and learning cycle, in time to correct any distortions between what was presented and what was learned by the student.

Here we intend to explore the teaching and learning cycle, with emphasis on follow-up, which uses formative evaluation as a strategic tool for the pursuit of excellence in the quality of education. Therefore, understanding what it is to teach is a fundamental element in this process [16]. In the classroom, face-to-face or at distance, the comprehension of the intended content may not occur. It may also occur that there are no more developed forms of thinking, as well as mobilization for other studying and learning actions. Therefore, the act of teaching has two dimensions: intentional use and result use, that is, the intention to teach and the realization of the intended goal.

4. The Unitag System

The UNITAG is a management system that uses the National Curriculum Parameters for High School and aims to integrate formative assessments and an interdisciplinary treatment in a plural and multicultural environment. Tests applied in a high school classroom intend to demonstrate the contributions and benefits of this system to improve the quality of Teaching and Learning. It consists of the following modules (Figure 1): data/answers collection of the training procedures using RFID (Radio-Frequency Identification) tags and smartphones with features such as NFC (Near-Field Communication) [17]and Bluetooth [18]; consolidation of the answers on the teacher's smartphone for presentation and transmission to pedagogical coordination, and data processing where the information is organized according to the knowledge matrix to generate the Student Progression Picture (SPP).

Figure 1. UNITAG System.

Module for Data/Answers Collection: The data collection assumes the use of students' smartphones in the classroom [19]. It was decided for the RFID technology, the radio-frequency identification, where few movements can offer the agility necessary to obtain the answers with the least impairment of the class in progress [20]. This module uses the Response Diagram (RD) where the student uses the smartphone to choose an answer for the formative assessment proposed by the teacher.
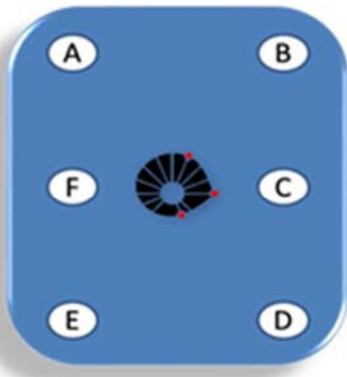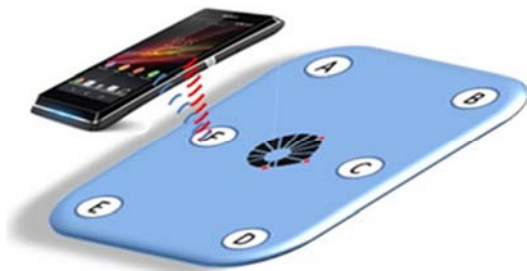

Figure 2. *Response Diagram (RD).*

Figure 3. *TAG NFC at RD.*

The RD (Figure 2) is a carton with passive NFC RFID TAGs. These TAGs are posted and organized (Figure 3) to be used by simple positioning of smartphones to select the answer to be sent to the Consolidation and Transmission module located on the teacher's smartphone. A Bluetooth local network was initially chosen because of the low cost and simplicity, making it easier to address the security issues. In order to have the Bluetooth network formed with the members of the classroom, it is necessary to carry out a pairing process between the detectable devices in the reach of the network. The configuration of the Bluetooth network does not need to be redone for each lesson. The student will initially be identified by the academic record number (RA). This identification can be changed as necessary following the network management procedures defined on the teacher's smartphone. During the formative procedures, the commands recorded on the tags (NFC TAGs) that compose the RDs are sentences with the teacher's smartphone ID (destination) and the letter of the answer associated with that specific TAG [21]. The source smartphone name identifies the student who sent the response, thus allowing the consolidation module to treat the results of the formative procedure.

Module for Data Consolidation and Transmission: it runs on the teacher's smartphone, originally intended for the Android operating system, because it is widely used by the population and can be developed through Android Studio, an integrated development environment for the creation of solutions that are Android platform-oriented. The consolidated data are answers to the questions that integrate the formative procedures executed in the classroom. In principle, it was decided to use WiFi (IEEE 802.11) technology for the transmission of data collected in the classroom to the treatment module, which will be described below. The consolidated answers, in the place and in the time of the teaching, can offer subsidies to the teacher to make corrections and repeat the presentation of themes, in order to clarify doubts that can aggravate with the time. In this case, the evaluation will be integrated into the learning cycle, feeding the process, as suggested by the PDCA (PLAN - DO - CHECK – ACT) interactive four-step management method, used for quality control and continuous improvement process. This consolidation can be presented to the students anonymously, allowing them to make a self-evaluation and reconsider their conclusions about the subject matter, as well as the organization of the information that leads to learning. It is the reflection, often unconscious, that builds neural structures for specific knowledge. In all cases, the aim is to correct deviations of teaching and learning the sooner as possible and, if possible, still in the classroom. These responses will be sent to the ANALYTICS module (Figure 4), which will be responsible for processing them for individual and group analysis, also important for the planning of multidisciplinary pedagogical actions, which may contribute to a better school management.

Module for Information Processing: will be executed in a computer for coordination and pedagogical planning. Developed in an integrated environment (Eclipse + ADT), it must offer strategic information in a condensed and easy-to-view format. The high number of formative assessments and the need for immediate visualization/mobilization, for quick actions, could only be addressed using computational tools and communication resources integrated with instantaneous procedures [22], with low acquisition, installation, maintenance and expansion costs. In the same way the visualization and identification of actions, can not be lost in a cluster of data that increase daily. It was decided to follow the structure of knowledge and understanding proposed by the NCPHS (National Curricular Parameters for High School) [14]. The knowledge matrix (Figure 5) proposed by the NCPHS is structured in such a way to develop the concepts, skills and abilities necessary for students in each area of knowledge, considering the common and specific basis of each region. For the purpose of this work, however, it will be considered only the common base, with regional issues as a didactic complement to be addressed by educators in their respective regions and according to their own pedagogical strategies.
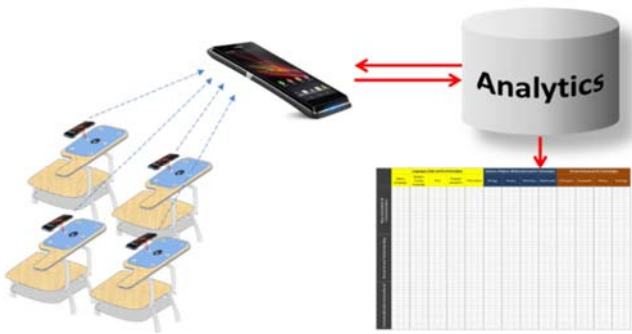
Figure 4. *Results Transmission.*

Figure 5. *Knowledge Matrix.*

The data structure to be used in formative assessments and pedagogical analysis, also considers the areas of competence [23]. A teaching by competences needs to organize the knowledge from learning situations that have meaning for the student, that allow to acquire an instrument to act in different contexts and, especially, in unusual situations, where creativity is the fundamental factor. It is, therefore, about teaching the knowledge in a contextualized way, considering the experience and the references to real practices. This teaching vision makes the evaluation process even more sophisticated and requires the organization of the disciplines, because without them it would be practically impossible to present and verify a formal education. The Student Progression Picture (SPP) (Figure 6) must therefore follow this model so that the student's stage of evolution can be quickly identified, as well as allow the identification of their performance in each subject treated within the proposed curriculum. The results of the formative evaluations are only qualitative and not quantitative, i.e., a signal of acquired knowledge is attributed or not, being able to verify the effectiveness of each evaluation in the composition of the line of Concepts, Competences and Skills. This way, if acquisitions of Concepts and Competences, but not Skills, are considered satisfactory, for example, the whole set can be re-evaluated in order to ensure the consistent development of the specific contents.

Figure 6. *Student Progression Picture.*

DESCRIPTION OF THE PROCEDURES: This methodology uses the Student's Progression Picture (SPP) to identify possible actions to be developed through interdisciplinary pedagogical projects. The SP is a graphic representation that allows the visualization of the evolution of the content and its assimilation in the areas of knowledge defined in the High School curricular reform: a) Languages, Codes and their Technologies; B) Natural Sciences, Mathematics and their Technologies; C) Human Sciences and their Technologies. The SP is fed automatically by the results of the formative evaluation procedures, which are collected in the classroom and transferred to the integrated

multidisciplinary management module. The work of recovery can then be developed by the group of educators, using for this an integrated vision and a coordinated and organized action in specific interdisciplinary pedagogical projects.

DESCRIPTION OF RESEARCH AND TESTING ENVIRONMENTS: The tests are organized in three (3) areas, according to their main purpose: 1) Formative assessment (Classroom); 2) Integrated management (Coordination); 3) Teaching projects (Teachers' Room).

Formative Evaluation: This work wants to demonstrate that the main field of evaluation is the same of teaching and learning. More than space, and also time, should be for the presentation of contents, for debate, for projects and for interaction. Therefore, in this area will be carried out the formative evaluations proposed by the teacher. In it too, the results will be collected, consolidated and presented in real time, in order to offer students and teachers a vision of possible distortions between teaching and learning. These results will also be transmitted to the integrated management environment, where they will be treated and used to monitor the quality of teaching and the planning of interdisciplinary pedagogical actions.

Integrated Management: In this area the results of the evaluations applied in the classroom will be received, treated and organized according to the content. This organization must comply with the guidelines of the NCPHS. The offered content and its receptivity can be measured in an integrated and interdisciplinary way. In addition, this information can be viewed by different professionals, such as pedagogues, teachers and managers. The analysis can be integrated, faster than before and selective, especially regarding the individuality of each student and subject. The main element of analysis comes from the treatment of the data in the Student Progression Picture (SPP), which are tables that indicate the situation of each student in each specific theme of each subject, considering the situation in each sequence of concepts, skills and abilities. Used for a systemic view, the SPP can be a useful tool for monitoring the quality of teaching and learning, in order of planning specific pedagogical actions and school management.

Pedagogical Projects: In this area teachers, pedagogues and managers can suggest thematic axes for pedagogical projects related to the SPP. It is important to note that, the autonomy of teachers is preserved, moreover, their creativity and training becomes even more important, since they are responsible for developing interdisciplinary pedagogical projects that can correct the possible deviations in learning. In addition, this exercise enhances the teaching and learning cycle as the teacher can improve the teaching, the exchange experiences with colleagues and better know the profile of the students, the community, their culture, their language and their values.

5. Result

The solution was applied to high school classes and the need to adapt to the new tool was initially observed. In order to encourage the participation of the people involved, the objectives need to be clearly presented initially. After all the clarifications, students and teachers were willing to learn how to use the tool to perform the procedures. The time for the formative tests in each class was limited to 5 minutes, where the questions and the results were presented. The number of right and wrong answers was presented immediately after the tests and analyzed by students and teachers. The use of smartphones offered flexibility, mobility and low cost of training, deployment and maintenance. Teachers from two disciplines were invited to interact asynchronously to improve the learning of students with difficulties. The simple adoption of the solution has already improved the performance of students in both disciplines. The student and teacher quickly identified the flaws in the teaching-learning process and were able to correct them quickly. In addition, collaborative action among teachers made it possible to co-operate through the SPP and no meeting was needed to plan coordinated teaching actions.

6. Discussion

Evaluating is an unattractive procedure by tradition, after all there is a stigma about evaluation. In addition, many teachers do not like to prepare tests or even to correct them. Students also do not like to take tests of any kind. Where there is little time and resources to be used, there are problems and difficulties of relationship to be solved. However, poor quality education represents a high cost to be paid by the citizen and society. More than a technological solution, Habermas' communicative action can be an important alternative for teachers and students to reach the goals of integral formation of a participatory citizen and a competent professional. In the face of so many challenges, the use of simple, low-cost tools must also offer high availability to facilitate educational action.

7. Conclusion

Integrating content and verifying the effectiveness of teaching can be a fundamental tool in the search for excellence in teaching, even more in a coordinated and permanent way throughout the learning cycle. But it is very difficult to do it with few resources without compromising the time of teachers and students. Besides, it is not easy to address these issues in an educational environment with so many differences and to measure multidisciplinary teaching in a plural and multicultural environment. This solution aims to facilitate the formative assessments and offer a multidisciplinary view to teachers, pedagogues and school managers. It can be replicated to other levels of education with adaptations in the Student Progression Picture. The main benefit is a real time system that does not compromise too much the time of the class that usually happens during the acquisition of multidisciplinary teaching indicators. In addition, the system can be adapted for non presential classes by changing the connection between student and teachers.

The solution can be used to define the pace of the content development, as well as the points to be reworked.

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