# Assessment of Education Process Management

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***Abstract*—One of the most important segments of the university education process management seems to be the student knowledge verification as well as support of the monitoring and assessment of the quality of educational programs and related processes. The organization of the examination tests, as well as, the process and methods of student knowledge verification can take a lot of time. This paper elaborates on various aspects of key checking areas related to basis data, information, and knowledge and wisdom skills. Additionally, authors present their experiences with using three different technological solutions taking into an account important human dimensions of the computer based test systems.**

***Keywords—Human Factors, Computer Based Test System, Software-based Course Evaluation System, Interactive Test, Student Knowledge Verification, Technological Platforms, Test Systems, Decision Support System, Educational Administrative Data Processing, Statistical Analysis, OLAP Technology, SAS Technology, Teaching Quality Process, Data Driven Evaluation, Data-Oriented Decision Support, Smart Educational Technology, Validation and Verification of Courses and Teaching***

## I. INTRODUCTION

Process management of education system at university is composed from a set of procedures processing, transfer and storage the data collection in order to increase the efficiency standard and to assist the operation, management, decision making process and control. First of all, the software enables the university administration (e.g. the Dean's Office, the Directors of Undergraduate and Postgraduate studies) of database, as well as, the use of information contained therein. An important goal of this research work is to share our experiences in several key areas of the education process at the academic institutions and highlight our direct involvement in the following domains:

- Managing the studies of Dean's Office.
- Quality management of educational process.
- Global Engineering College.

Being involved over 20 years at our universities in these tasks and challenges [1-16] we believe that two main factors in education process management are of key importance. One of them is the student knowledge verification. And the second is the quality of education management process, which these days is largely based on the evaluation of courses by students [5]. The developed systems were designed and developed having in mind the needs of both academic staff and the students. One of the design drivers of the system was to allow for extending already existing sets of test questions in the database. The academic staff needs to able to verify and assess the knowledge of the students in a more effective and less time-consuming manner. These aspects can be especially valuable during busy periods of the semester at the universities. Additionally, various raw data and information can be obtained for statistical research, allowing to evaluate the correctness of adopted methods for conveying knowledge, as well as, to improve the quality and possibly to increase the teaching level of classes being conducted. The developed system enables users to build an advanced database with important details of surveyed students. Such a database, allows analyzing collected data and trends over a longer period of time, using modern on-line tools of data warehousing such as OLAP (Online Analytical Processing (OLAP) and/or Data Mining (DM).
A comprehensive completed an analysis of such data was performed at the Wroclaw's University of Technology (WUT) in Poland as well as at the universities of Las Palmas in Spain, Hagenberg in Austria, UTS in Australia and UA in Tucson, USA.

Originally, the project of Global Engineering College (GEC) was initiated by staff members and students of the Electronics Faculty at WUT. The GEC project involves an introduction of elements of international cooperation of students at every stage of the education process as it prepares future graduates for variety of tasks and challenges, at both local and international levels. The key aspects of GEC are defined by the following four elements: international cooperation, language courses, international exchanges and Virtual Students Exchange (VSX). In the period of last decades our ideas were developed in cooperation with universities from Europe (J. K. University, Linz, ULPGC, Las Palmas), USA (UA, Tucson and NAU, Flagstaff and Australia (UTS, Sydney). Fruitful international cooperation needs to develop common working methods and ways of communication, and this is what the VSX serve. Increased efficiency in the context of the VSX originates from the fact that this action occurs at the substantive rather than

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institutional levels, where students and the faculty staff are enthusiastic actors engaged in collaborative actions.

Teaching cooperation and an exchange programs (over a period of 3 semesters) among three academic institutions: Northern Arizona University (NAU) in Flagstaff (Arizona, USA), Dresden College of Applied Sciences (HTW) in Germany and the WUT's Faculty of Electronics resulted in creation of the VSX project. Various collaborative activities involved testing various forms of collaborations, methods, solutions tools to assist its implementation. This resulted in publishing several reports on these studies [1, 6, 8, 9]. The project details these projects were reported on the pages of the Wall Street Journal [9]: *"The Wall Street Journal Home Page THE JOURNAL REPORT: BUSINESS INSIGHT, Global Business Expanding the 24-Hour Workplace Round-the-clock operations aren't just for call centers anymore", by A. Gupta, University of Arizona, Sept 15th, 2007, page R9.*

The icon of industrialization, Henry Ford introduced the three eight-hour long shifts manufacturing system in 1914. The scheme aim was to set-up a round-the-clock line assembly capability in a car making facility. At present, we are being witnesses of the advent of modern area 24-hour Knowledge Factories. Initially, the concept was primarily used to create 24-hour Call Centers and related support services for global communications networks. Currently, however, the concept is fast spreading across the entire world with various groups set up in clusters of three, four and more facilities, each six to eight hours apart [10]. Thanks to ever more efficient and reliable means of electronic communication, data processing tools, as well as, an increasing acceptance of offshoring and modern service support schemes, the concept is gaining critical momentum [10] and becomes feasible for much wider range and more sophisticated applications [5, 6].

A *multi-mind* model of group project cooperation was used on the continued experiment to confirm the efficiency and efficacy of so-called tri-site software intensive system development (production). Student teams at the faculty's staff at the University of Technology in Sydney in Australia, the Wroclaw University of Technology in Poland and the University of Arizona in Tucson, USA all worked on a single task, whereby each shift was picking up on work done by the previous group. Consecutively, their work was compared with results from a similar task executed by a single team at one site, only. Thus far, the results indicate that work was actually completed quicker and more efficiently when it was shared among the three teams [3-6].

## II. SOFTWARE BASED COURSE AND TEACHING EVALUATION SYSTEM

Such a system may be defined as a set of procedures serving the data collection, processing, storage and transfer in order to raise the efficiency standard and to assist the Faculty/University operation, management, decision making process and control. First of all, the software enables the administration of the dean's office database as well as the use of information contained therein. In this aspect the situation is most critical in the time just prior to the examination session until its completion.

It was not difficult to find out that the ongoing flow of information included the following:

- Data as generated by the faculty's academic staff, (i.e., mainly marks obtained by the students),
- Data as generated by the students, mainly data on choices made by the students: subjects, tutors, time limits, etc.,
- Data for which entering to the database requires personal verification and acceptance by a dean's office employee.

One of the most important factors in the quality management of educational process is evaluation of courses by students [5]. The test organization and verification procedures are very time-consuming and troublesome also methods of student knowledge verification can be considered in different aspects. The seminal paper [14] reports on experiences and experimental results related to the adaptation of three different technological platforms for executing student tests.

These tests cover various different checking areas such as: primary foundation data, information, and knowledge and wisdom skill tests were executed and verified. A special attention was given to human factors related to the use of computer based test systems. At first, the checking areas involved execution of the traditional tests, in which each student receives an identical set of questions. The second tier (type) of tests aimed at decreasing possible intercommunication among the students participating in test. This could be achieved by developing tests that significantly differ from each other possibly due to the order of questions and answers. The last tier (type) of tests is interactive and involves the use of on-line software tools.
In the above mentioned testing process, a teacher defines the collection of questions and specifies the amount of questions each student will be asked. The described approach also ensures that interactive test strategy involves an automatic mechanism of test/question difficulty level adjustment.

In our research, a special data-driven decision support system that at its core uses the SAS technology was designed and developed to support the student assessment and allow for monitoring the quality of educational process [12, 16]. Constructed as an integrated platform, the tool is able to support the management of teaching and learning process, and thus allowing for the execution of various comparative studies by the participating institutions. The main component of the system is the comparative statistical analysis engine that monitors the quality of teaching and learning. Other components include the mechanism for dissemination of analytical data and the facility for reporting the test results. The goal of this research was to identify, draw out and compare the important data related to the quality of teaching programs and obtained from the various database sets generated at the Electrical and Computer Science Department at the University of Arizona in Tucson, USA; the Faculty of Electronic Engineering in Wroclaw University of Technology, Poland; Software Engineering Program (the

School of Computing and Communication) at the Faculty of Engineering and IT of University of Technology, Sydney (UTS) in Australia; the Polytechnic University of Upper Austria in Hagenberg, Austria; and the Faculty of Computer Science (FCS) at University of Las Palmas de Grand Canaria (ULPGC), Spain.

The rationale, the details of the process involved the methodology, case studies, the test tools used for the analysis and the statistical results of the above work were presented in a special report [7]. This research relies on the effective application of knowledge methodology, as well as, on the experience with using test systems that run on different technological platforms at various institutions. The teaching process requires taking care of the grounding, and checking the degree of fixing in the memory of an information material after it has been passed on the students.

The selected collaborative classes/projects may be executed in many different ways. For example, repetitive courses serve to adjust and set the study material in the student memory. However, the role of tutorials and seminars represent different forms of teaching an learning that aim to assist in developing habits of creative and transformative thinking in students that is needed to acquire the deeper knowledge. A good habits of creative thinking combined with habits of logical concluding, help students to rationally utilise the experience obtained. On other hands, various classes and laboratory work are represent the compilation of both previously described forms, permitting students to obatain a proficiency in seekig alternative solutions and an adaptive use of acquired information and knowledge, thus permitting to conclude about the level of wisdom attained by students. The quality of the pedagogic process is determined by the following key factors:

a) resources (and sources) of the revealed information,
b) the scope (and limitations) of the conveyed knowledge,
c) the level of individual knowledge attained.

One needs to differentiate the impact of the above three factors. However, it seems, that for a certain regularity is evident, the higher the educational level is achieved (i.e., elementary school, secondary school, university), the more significant is the shift of the didactic process towards extending the scope of the conveyed knowledge and enhancing its level, while concurrently keeping the tabs on a minimum amount of revealed information [14].

## III. FUNDAMENTAL CONCEPTS

Provide for the attainment of a high knowledge level by students is the most difficult task within the educational process. Achieving good results is can be very difficult without significant efforts and hard work on the part of both students and teachers/tutors. An individual and direct contact between the teacher/tutor and the student is often considered to be a prime reason behind the success in the education area. A thorough and efficient assessment of the knowledge received by the student plays a vital role in the pedagogical process. The level of knowledge acquisition needs to be verified through various tests in order to assess the quality and effectiveness of the process. A relative ease of determining an evaluation mark (obtained results) in a partial transfer of test service (i.e., preparing, checking and issuing final marks) to the computer system represents a commonly used operation. The application of software based system speeds up the process of checking the test results. This particular phenomenon becomes a norm in the modern education system.

We would like to draw the reader's attention towards the fact that there are many educational practices and teaching modes, where a lack of activity of a teacher, and even his/her absence during the performance of didactic actions, is permissible or acceptable. Systems of correspondence courses, educational systems in vast territories, e.g. USA or Australia [1], or modern educational systems of the developed countries, operating on the basis of network or Internet computer laboratories represent good examples [14].

These facts alone make a solid rationale for the suggested solution. If a lack of a direct contact between a teacher and a student is acceptable for a selected form of pedagogic process to work, whereby a computer system will perform the verification of the student's progress, represents a natural consequence of such a decision. Indeed, such proceedings deprive the students of a direct contact with the teacher/tutor (this aspect may often adversely affect the pedagogic process); however, a sensible application of the proposed solution may bring a series of positive values into the didactic process. At present, the solution is often unavoidable owing to a high number of the learning people, the development pace of some advanced engineering disciplines and a high cost of education or territorial conditions. The suggested computer system solution allows the effective verification of the degree of information attained and the scope of knowledge acquired by students.

The skillful formulation of test questions and the proper lay-out of tests that permits effective verification of the knowledge acquired, and not only the information being at the student's possession, is a key to the success. The suggested solution assumes the collaboration among the academic staff, students and administrative personnel. It is suggested that the conditions to guarantee their effective collaboration should be set as follows:

- The dean's office or the faculty's school administration creates a list of students authorised to participate in the test based on the computer list of students enrolled to a given subject.

- The teacher or the professor, who leads a given subject, prepares a basic list of test questions along with alternative answers, indicating correct answers to each of the question on the list, also allocating a score to each answer. Moreover, he/she defines the criteria to pass the test, and sets the score ranges corresponding to individual sections on the marking scale;

- Students fill up personal test paper sheets with questions forming a permutation of the basic list. The answers marked off are introduced to the computer system with the help of the optical mark reader,

- Based on the information provided, each student gets an appropriate mark.

The above described scope of actions does not exceed what has been used by the university administration, teachers and students to date. The traditional approach for testing student knowledge assumes that every student needs to receive an identical set of questions. This contributed to the inter-communication and comparison of answers by the students who wrote a test, this may often result in mechanical filling up of tests without understanding the question contents or the correctness of answers.

The suggested solution assumes that out of a set of test questions prepared, a computer should generate a list of questions for each individual student on the list of the persons authorised for participation along with a set of alternative answers. An individual test gets its identification number which is then allocated to a selected student on the list of persons undergoing the testing. The generation of individual lists of questions is made is such a manner that it guarantees that:

- The test participant receives a personally addressed set of questions,

- The generated set of questions includes identical basic questions; that are, purposely located in a different sequence, which represents a permutation of the basic system.

The above elaborated procedures ensure equal chances to score well for all students who write the test as each of them answers exactly to the same question, albeit put in a different order. The system is able to validate correctly the mastering of the same subject scope due to the fact that both the quantity and the scope of alternative answers are identical for every student participating in the test,

The list of questions is composed of not more than 30. The multiply choice was used with one response only and *Ordinal* questions categories. There are no more than 6 possible answers. Questions are divided into the three groups as follows:

1. Student characteristics,
2. Lecture organization,
3. Lecture quality

Three main categories of *Ordinal* questions were applied such as: *stimulants, destimulants and nominals*. A set of prepared test questions is additionally equipped with a special test sheet designed for reading with the optical character reader, the former being marked with unique identifiers. Next, the tests are passed for filling up by the students who mark the selected to be true answers on test sheets. On the test completion, the answers are validated by the computer system. This test system solution is in current use by the project participants. The test system that was originally developed at Wroclaw University of Technology has been tested at other partnering universities [7]. Considering our experience with the test methods, it is suggested one needs to analyse to what extent the obtained survey results are biased (noised); and if needed execute a corrective action as required.

## IV. COLLABORATION IN THE GLOBAL WORKSPACE

In several papers [2-5] we have reported an innovative methodology that exploits cross time-zone and group-work metaphors. The methodology is applicable for project orientated teaching and learning, and particularly well suited for the system and software development work. In the presented case studies, students we were able to gain significant benefits from using 3 Time Zone (3TZ) and 24/7 methodologies, applying existent tools (both open source and COTS solutions), as well as, developing own collaboration tools while working on projects in software engineering courses. The 3 Time Zone and 24/7 approach is well suited to address tight schedule constraints and challenges related to system development projects. The scheme based on 3TZ and 24/7 mode of operation positively contributes to the teaching experience by engaging students and staff members in various collaborative tasks while addressing the ever changing project requirements and tasks divided among the participants.

Similarly, to other methodologies such as e-Learning or Massive On-line Course (MOOC), the 24/7 and 3TZ models belong to the categories of emerging teaching models that can potentially bring the benefits of global collaboration to all parties involved. This new model implies that geographic dislocation should not be seen as an obstacle or a barrier but rather as a great opportunity that can be leveraged, along with the time-zone differences [2-5].

The 3TZ and 24/7 model can improve the process of teaching and learning, as well as, to allow sharing both short and long term project activities so that various defined tasks can be executed by the project participants in a continuous mode and around the clock. Engineering graduates of ICT programs need to acquire not only knowledge of fundamentals as taught today but be able to see the bigger picture, be the lateral thinkers, be able to adapt and learn new technology quickly and be able to be engaged in effective communication globally [2].

Contemporary educational programs run at many technical universities are often missing rapid technological transformations in the ICT sector i.e., the Cloud Computing, Internet-of-Things (IoT), Wireless Sensor Networks (WSN), Big Data Analytics, Multimedia Data Convergence, etc. the 3TZ - 24/7 model concepts fits into the modern ICT

developments well, as it is able to support and improve the way students and future graduates study, develop their soft and hard skillsets, cooperate and practice their engineering professions after graduation and to keep up with the rapidly changing technology and engineering practices. It is our hope that the worlds of academia and industry will benefit from graduates that well trained to work on projects in a shared international workspace culture [4].

## V. CONCLUSION

The test system framework has been completed and is successfully used at our faculties. The system is user-friendly and operates very reliably. The total cost of ownership of the system, including the implementation, testing, operation and maintenance is very low. The system's key attributes are: equalization of students chances to score in the tests due to the assignment of the same set(s) of questions to each and every student, thus considerably limiting chances to provide the non-independent answers; a relatively short time is needed to prepare and mark the examination tests. Additionally, this research work explored various teaching and learning schemes that allow participating institution to share and gain a valuable experience with various teaching and learning methodologies and tools, while providing their students with both soft and hard collaboration skills in the international workspace context.

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