Chapter 5
Learning Effectiveness Enhancement Project "LEEP"

Riadh Besbes

Abstract The overall objective, to which the project will contribute, is to improve teaching and learning effectiveness within academic institutions by exploiting data mining methods on collected databases for educational knowledge extraction. These teaching and learning databases are accumulated from quantitative "measures" done through indoor classroom visits within academic institutions, online web access learners' questionnaires and answers, paper written statements' analysis of academic exams in STEM education (science, technology, engineering, and mathematics), and online elementary grades seizure from written traces of learners' performances in STEM exams. Findings of these processes, elaborated by researcher's team within beneficiary organizations, are disseminated through diversified publication and are the subject of multiple professional meetings, especially, teachers' training sessions. The project's data mining strategy in educational context will support and develop teachers' expertise, enhance and scaffold students' learning, and improve and raise education system's performance. This is a project that combines data mining analysis methods with educational and cognitive science findings. It attempts to unify these two paradigms, generally distant from each other. New strategies of educational assessment, training, and innovating are designed and are able to enhance significantly the effectiveness of teaching and learning performances in academic institutions such as secondary schools. The use of these methods aims to identify and better understand the learners' profiles, teaching practices, characteristics, and context details in which teachers and learners act. These tools for decision support are exploited by the researcher, an educational

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inspector and expert in educational assessment, to generate, make available, and process databases on teaching practices, learning performances, and learners' profiles.

Keywords Blended learning · Assessment for learning · Knowledge extraction · Profile recognition

5.1 Case Overview

5.1.1 Objectives

Franklin Delano Roosevelt said, "We cannot always build the future for our youth. But we can build our youth for the future." Marc Prensky declared that all education should be based on actual student accomplishments in the real world. As one of the many consequences of this approach, student will be an active "partner" in better pedagogy rather than just a passive listener to a lecture. There is enough adaptable potential in ICT that can ensure an important principle that characterizes such educational direction: "general skills for all, individual examples for each student". Thus, well exploited technology is able to support keeping students usefully engaged and motivated in learning. Learning Effectiveness Enhancement Project should use the opportunity to create productive and student-centered learning environments that has overarching objectives: to improve ability to personalize learning and individual progress, to enhance student engagement and motivation, to strengthen teaching effectiveness, to equip teachers and stakeholders with useful data that helps to shape interventions, to sharpen educational policies, and to lighten the learning pathways.

5.1.2 Target Groups

Secondary school inspectors, teachers, and students of math, language, science, and social studies disciplines.

5.1.3 Executive Summary

The project's data mining strategy in educational context will enhance and scaffold students' learning and improve and raise education system's performance. This project facilitates educational and scientific management strategies design to evolve significantly the effectiveness of learning process. These strategies' designs are inspired from evolutionary and modular computer system treatments implemented in academic institutions and school Websites. Tools for decision support and consequence of research in data mining using intelligent recognition and extraction feature algorithms; these systems extract knowledge from learners' performances in educational context. They generate and make available digital databases accumulated from quantitative evaluation. The use of these methods aims to identify and better understand the learner profiles and context details in which learners act. These tools for decision support are exploited in order to generate, make available, and process databases on learning performances and profiles.

5.2 Background

5.2.1 Government Policy for ICT in Education

One of the roles of the UNESCO Institute for Statistics (UIS) is to contribute to benchmarking and monitoring the integration of and access to ICT in education, through the establishment of internationally comparable and policy-relevant indicators. UNESCO reports have non negligible impact on illustrating the importance of ICT in education. The Tunisian government has begun to develop efforts in the issue of ICT's integration in education since the 1980s, enhancing infrastructure and training human resources. Despite this policy related to the implementation and use of ICT in Tunisian primary and secondary education, it has not translated to practice. There are not enough recommendations for the integration of ICT in all subject areas across all grades. The contribution of ICT to quality teaching and learning is not adequately illustrated in classes, except for very few successful experiences. ICT issues related to teaching practices, and learning activities (including digital literacy and issues of assessment), as well as teachers training need to be explored with a strategic view; a view that plans priorities and policies to concretize pedagogical actions leading to meaningful impacts on learning and positive student outcomes.

5.2.2 Purpose

One of the important findings that emerged throughout our study and investigation in schools was the effective use of educational data as an instrument for transformation at every level of the system. The data was used both to identify underperformance and to target constructive feedback. The best schools emphasized data analysis and student target setting as the central components of their educational methodology. These schools have been guided for their work through the way they use data to set ambitious but realistic targets for each individual student. Teachers interviewed in our research regularly mentioned the use of data as a vital aspect of the approach to school improvement. Schools are using data increasingly well for their students' performance within their institutions. Consistent cross-subject approaches to data analysis and a focus on early intervention are immediately processed when the data suggested that students were not on track to fulfill their potential. Data analysis at school level enabled school leaders to understand which teachers were performing at a high or low level (Besbes). This information was then used to guide performance management and professional development. School leaders became particularly skilled at this type of data literacy. Local authority managers and teachers were all challenged to perform well in order to obtain better student data that was subject to rigorous analysis.

Our ICT system aims at improving pupils' exam results and making significant changes in the overall effectiveness of schools and the quality of teaching. However, the data analysis tends to generate in quantifiable terms:

- Students' learning style identification,
- Early detection of learning disabilities and targeted assistance,
- Provide ongoing and specific teachers training,
- Controlling, with affinity, the learning process efficiency,
- Provide databases generated by the global system,
- Promote intelligent exploration of educational data,
- Promote effective management of academic systems,
- Guide the implementation and monitoring of the reform work in teaching and learning processes.

5.3 Initiative Description

5.3.1 Features and Innovation

The first innovative process is exams educational analyses. It is done according to taxonomies developed by science education research (Bloom). Results are hosted on the project cloud Website within the academic institution. Learners proceed to granulate response grades seizures of their written examinations via the Website by exploiting a dedicated interactive grid for learners' result treatments. Then the system generates a detailed classification of learners' outcomes targeting detailed weaknesses and strengths of their performances. Global and individual statistical treatments reveal main learning features of every student and common "patterns" of learners' groups. This classification makes teachers discover their pupils' characteristics so that learners will be delighted when they act and interact in an autonomy supportive environment, feeling secure that they spontaneously ask for rationales, discuss, and defend their opinions, contributing deliberately in their knowledge construction. Innovative and well-grounded assessment ensures accountability and creates ways to improvements and future investments.

Hopefully, a rational understanding of students’ learning styles has a positive impact on their own teaching. In literature, Myers–Briggs type indicator, Kolb–McCarthy’s learning cycle, and Felder–Silverman learning styles model have been widely used to classify students’ learning styles in multiple modalities and multiple disciplines. This classification encourages teachers to provide a variety of learning activities such that each learning style is addressed. Multiple questionnaires are used online, within the LEEP project, to collect, record, and process students’ answers. Learning style features are classified and consecutively, dissemination of different findings strengthens reflexive thoughts, and then training session on the issue will be positively needed. Indeed, it will lead to extract efficient and appropriate teaching and learning acts.

5.3.2 Mining Learning Styles

Learning styles are groups of characteristic strengths and preferences in the ways they pursue to get and process information. Students have different learning styles; however, teaching effectively in any professional capacity requires working well in all learning style modes. According to Fielder’s research work on learning style models, students deal with knowledge subjectively. Indeed, information is processed within four cognitive stages: input channels of information then its perception, how it is processed and understood. If learners can easily accept information flow through visual presentation, pictures, diagrams and flowcharts then they are identified to be visual learners. If they feel that information is conveniently conveyed through written and spoken explanation, they are verbal learners. When this information is concrete, practical, oriented towards facts and procedures, it is perceived by sensing learners. But when information is conceptual, innovative, oriented towards theories and meaning, it is perceived well by intuitive learners. At the processing stage, active students learn by trying things out and with others. Reflective learners process by thinking things through and work alone. For understanding stage, when students treat information in sequential way with small incremental steps, they are identified as sequential learners. They prefer presentations that proceed from the specific to the general; they are also inductive learners. Global learners are holistic, they learn in large leaps and they understand when they proceed from general to specific. They prefer presentations that proceed from the general to the specific, they are also deductive learners. Figure 5.1 shows an example of results obtained from the questionnaire and students’ answers identifying their three preference rates. For this class, we see that visual preference is dominant, as a consequence, teachers’ practice can adapt accordingly.

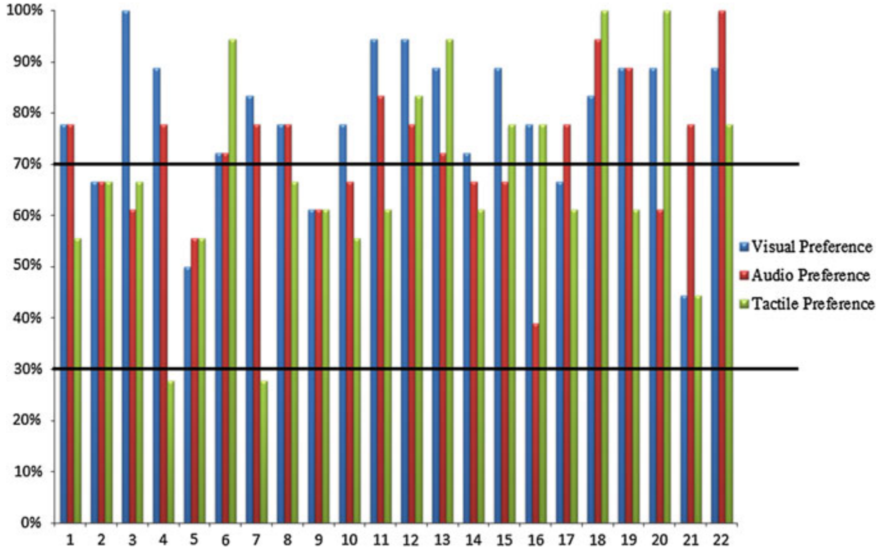


Fig. 5.1 Questionnaire results on class learning styles preferences

5.3.3 Mining Examination Characteristics

The pedagogical expert analyzes exams' content of STEM disciplines especially, mathematics and physical sciences. He affects each question with its elementary grade, and its code type according to Bloom's taxonomy, as clarified below. He identifies the assessed objectives and determines appropriate remedies corresponding to incorrect responses. As shown in Fig. 5.2, the results of his analysis will be the basis of subsequent treatments on the Websites. A specific goal of

Grade	Objective code	Objective statements	Remediation strategies
1,00	A_1	Directly calculate the charge and energy from their formulas	Memorize the formulas of the voltage across a capacitor and the energy stored by a capacitor
0,75	A_2	Write the chemical equation of the esterification reaction, and name the ester	To know that acids loose -OH and alcohols loose -H to form water and ester with the combination of remaining groups. Memorize the nomenclature of esters
1,00	B	Know how to use the tangent at the origin to determine R and E	τ is determined from the tangent at the origin of the curve i (t) and exploiting u_C (t) = 0.63 E you find E.
0,50	C_1	Write the differential equation from the Kirchhoff's mesh rule	Correctly apply the law of the Kirchhoff's mesh rule and replace i by Cdu_C / dt
0,25	C_2	Find the concentration of a solution from an initial sampling	Exploit the fact that a sample and original solution have same concentration

Fig. 5.2 The results of his analysis will be the basis of subsequent treatments on the Website

learning is defined as the formulation of what the learner will do, how he will behave to demonstrate that he has achieved the overall objective. By evaluation, teachers discover whether those objectives are achieved according to taxonomies of the cognitive domain. Taxonomy, defined by Legendre, is a systematic and hierarchical classification of target skills, independent of content objectives, clearly defined and arranged in a continuum of increasing complexity of development and in a logic natural progression of the learner. Bloom developed a taxonomy that classifies the cognitive learning into six levels of understanding as it will be described. Cognitive knowledge covers the different modes of acquiring knowledge and ways of linking them and uses them. We distinguish five levels in this area. The acquisition of knowledge [coded A1]: This is the recall of specific facts or general methods, or processes. It concerns essentially memory cognitive acts that retain the content and the form of information. Comprehension [coded A2]: The ability to organize data to achieve a certain result, to discover a new material by using content already known. Learner holds, therefore at this level, the content but he changes the form of information. Application [coded B]: The ability to use general and abstract representations to treat specific and particular cases. Analysis [coded C1]: It is the separation of a whole into its constituent parts in order to explain it all. Synthesis [coded C2]: On the contrary, bring together several elements without previous relations between them, so as to make a coherent whole. Evaluation is the most complex level; it assumes that student mobilizes all his resources to be able to make judgments using internal or external criteria to an object. Statistical distribution of the five question type rates according to content treatments of physical and chemistry sciences examination is illustrated in Fig. 5.3.

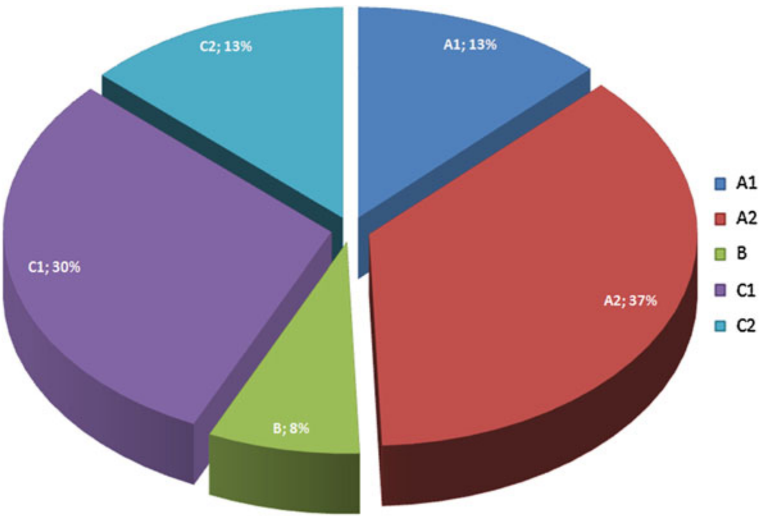


Fig. 5.3 Rates' distribution of the five cognitive types of questions according to Bloom's taxonomy

5.4 Outcomes

5.4.1 First Project's Results: Students Learning Styles

Histograms on Fig. 5.4 from assessment questionnaire analysis show that these class students possess high visual and auditory preferences. Visual learners prefer to learn by seeing charts, diagrams, illustrations, handouts, and videos. Their tendency is high for seeing information presented in a visual rather than in written form. Auditory students learn best by hearing information. They tend to get a great deal out of lectures and are good at remembering things they are told. However, their tactile capabilities are average. As consequence, their teachers are encouraged to convey knowledge by practical activities when opportunities arise. Kinesthetic students learn best by touching and doing. Hands-on experience is important for them.

5.4.2 Second Project's Results: Classrooms Observations

Teachers from three disciplines: mathematics, physics, and sciences are observed within indoor classroom sessions. They are observed while they are teaching the same students that we identify learning styles in previous section. Each teaching and learning observed act is measured by its time duration within class session. All acts are gathered in five educational categories. We see in Fig. 5.5, statistical results about the three visits within those five sets. We can interpret those results by the

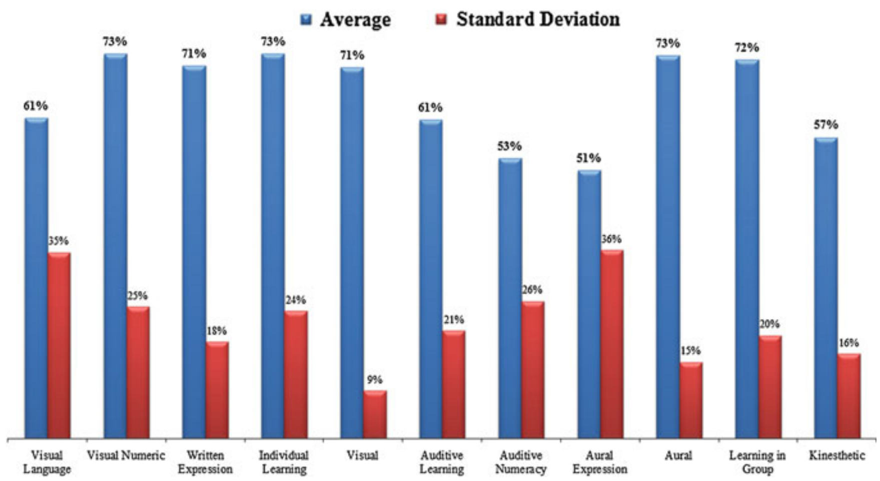
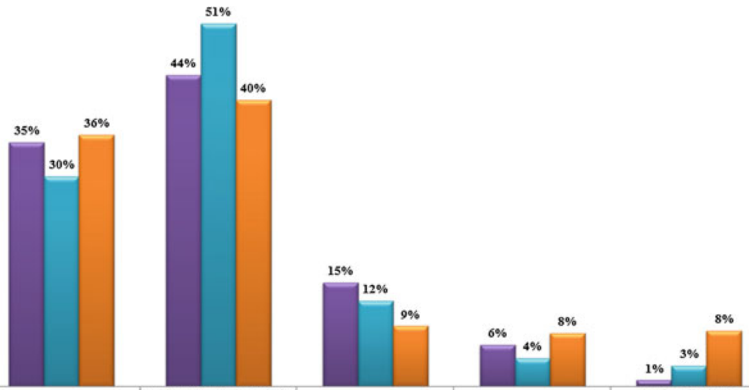


Fig. 5.4 Student learning styles results from visual-aural-kinesthetic self-assessment questionnaire on institution's Website



	Students' Interaction	Teacher Extracts knowledge from Students active participation	Teacher Imposes knowledge on Students	Teacher Evaluates Students knowledge	Teacher illustrates knowledge with examples from every day life
Mathematics	35%	44%	15%	6%	1%
Physics	30%	51%	12%	4%	3%
Sciences	36%	40%	9%	8%	8%

Fig. 5.5 Statistics on global teaching practices within MPS classrooms

following findings. Students interact well within their class in all observed disciplines a third of total duration. They answer their teacher’s questions, they ask their own questions, they suggest alternatives, and they provide rationales. Teachers, mostly, try to extract knowledge from their students within a four time longer duration than the imposition time duration. They spend enough time on evaluating students’ knowledge assimilation and they try to give examples from everyday life about the content they teach.

5.4.3 Third Project’s Results: Exams Analysis

Mathematics exam and its written performances are treated for the same class students. Figure 5.6 shows, within its first graphic (pie chart), the exam’s evaluated objectives partition. The second graphic (histograms) shows processed average correct answers’ rates. The pie chart visualizes the rate 7.5 % of the total exam questions that invoke memory for direct responses. Those questions are coded A1. The comprehension and application of mathematics contents on specific situation reach the rate of 37.5 % (coded A2). A rate of 12.5 % of exam’s questions evaluate students’ capabilities on graphical processes (coded Bgraph). Answers which need analysis, synthesis, and evaluation within the known and unknown situations have the rate of 42.5 % (C1 and C2). It is a relatively high rate according to students’ level and the official statements about those rates.

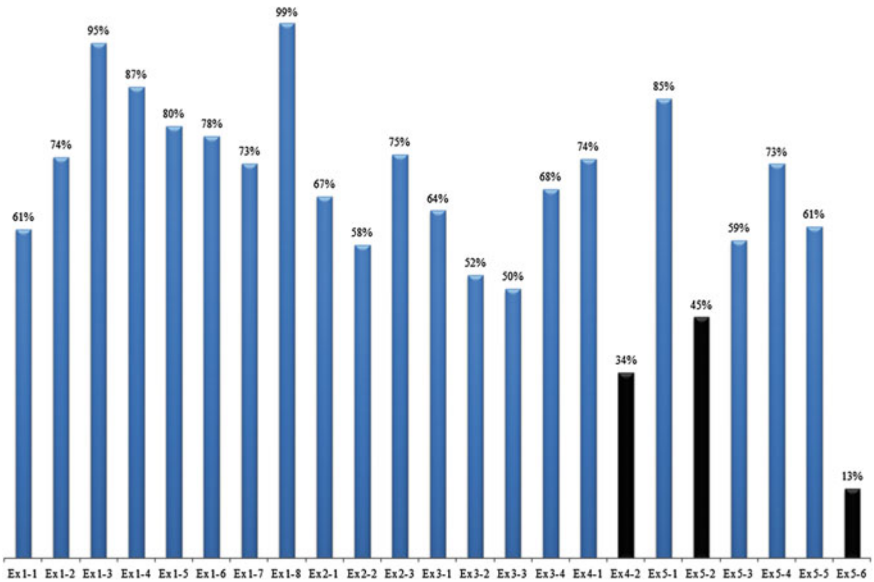


Fig. 5.6 Evaluated objectives partition and average correct answers' rates

As a main exam feature, progressive difficulty is clearly not well respected. We observe on second histograms of Fig. 5.3 that the increase in rate of correct answers is located in the first questions (Exercise 1: questions 1, 2, 3). Also, global results are very acceptable with right answer rates that are over 50 %.

5.5 Conclusion

Creating and sharing relevant knowledge are critical as are new methodologies of evaluation for learning innovation. The relevance of diagnosis is highly dependent on the complete observation of the operative. The use of online questionnaires, computerized interactive grid as observation tool, exams pedagogical analysis, and students' performance, make an advance on the state of the art in this field. Indeed, it needs educational diagnosis skills to quantify in real-time relevant criteria for the recognition of actors' profiles and the process of teaching and learning. Criteria for equity confer more justice and rigor with associated indicators to assess. These quantified indicators will constitute a generated raw data source from which we can extract relevant and vital knowledge. All processes are done under data mining treatments for decision support, recognition, and extraction of educational features. This is the project's main interdisciplinary aspect that leads to exploit the power of data process algorithm to investigate pedagogical concepts. As an innovative analysis and integrated approach, LEEP aims promising strategies for changing learning environments, and for spreading and sustaining innovative practice on a wider scale. The research program objectives focus on transforming teaching practices and learning environment to be most effective. These objectives, which lead as major principles to innovative learning environment, are listed as follows: to make learning and engagement central, to ensure that learning is social and often collaborative, to make teaching and learning highly attuned to learner motivations and emotions, to make learning acutely sensitive to individual differences, to adapt learning demand to each learner without excessive overload, to use assessment consistently with learning aims, with strong emphasis on formative feedback, to promote horizontal connectedness across activities and subjects, in and out of school.

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Author Biography

Riadh Besbes, Ph.D. in computerized engineering systems, conceived a fuzzy hierarchical system for teaching effectiveness assessment. He spent the last eight years of his professional career as an educational inspector. He had the triple missions of evaluating, training, and innovating among secondary school teaching and learning. In these years, he has used his interactive grid as an observation instrument during his classroom visits. He was able, with this instrument, to quantify teaching and learning practices, acts, behaviors, and attitudes during class sessions. At the end of each class visit, 16 statistical curves were obtained that constituted the subject of professional discussions and training sessions. The software is built as an instrument to help identify and track causes of major weaknesses and strengths of teaching and learning practices.