Journal of Modern Education Review, ISSN 2155-7993, USA
August 2023, Volume 13, No. 4, pp. 192–199
Doi: 10.15341/jmer(2155-7993)/04.13.2023/005

http://www.academicstar.us

Mind-Mapping, Total Quality and Open Resources for A Bioengineering Trans-Disciplinary Experience

Laplagne Sarmiento M. Cristina, José J. Urnicia
(Universidad Nacional de San Juan, Argentina)

Abstract: This report addresses the possibility of curricular transformation by rethinking the work plans for Bio-engineering through different experiences after students' institutional and regional labor contexts needs analysis and systemic aims matching. The theoretical framework is constituted by an amalgam of scientific-methodological approaches in an educational managing research proposal. The integrative design followed the specific educational vision of the Complexity Sciences which proposes critical analysis for the professional situations that future graduates would face. Within the project CICITCA 20/22 — ACE Models in Engineering Competences for Research Development and Deep Learning — dependent on the Electronics and Automatic Department, questions of an epistemological nature were raised in order to generate a brainstorming of innovative ideas and a thorough awareness of the objectives of the curricula, of content adequacy to current students' profiles and needs. Researchers and teachers, involved in the project, were divided according to the thematic nuclei and disciplinary axes of the study. Once the innovation mainframe was sketched, the team worked on suitable practice curricular relevance, interference of technological factors, unified modeling language sustenance and social models for quality devices in order to guide acquisition and learning processes in engineering student populations. The evolutionary correlate of the students' abilities and the appreciations on efficiently learnt content under this experiential context were analyzed by means of educational analytics.

Key words: language, quality, complexity, skills

1. Introduction

The team that presents this work aimed at the objective of meeting innovative practices to students' profiles and curricular objectives. Thus, it investigated the impacts of a series of innovations involved in the project "ACE Models in Engineering Competences for Research Development and Deep Learning". After an exploratory field research, the communicative and epistemological links between complexity sciences paradigm and competence focused curricular design was set. The learning adequacy and quality suggested researchers that future curricular modifications were to follow the 2018 CONFEDI Competences Manual (CONFEDI, 2018). The major aim linked sustainability with a practice where knowing and doing were fed back and demonstrated the efficiency of the design in the curricular disciplines. The evolution of commitment, social responsibility and attitudinal and emotional intelligence were recorded as an ethical level supposed to be sought throughout Bio-engineering students' training. The research proved the proposal to be a total quality device for training and forming better

Laplagne Sarmiento M. Cristina, Universidad Nacional de San Juan. E-mail: claplagne@unsj.edu.ar.

professionals under cognitive schemes, quality and efficiency parameters. It also meant a formative praxis and self-assessed evaluation with updated contents to solve functional and systemic design thinking problems in the field of Bio-medical Engineering. To promote future graduates' acceptance, integration and awareness over the uncertain professional developments of their labor in a world marked by complexity (Morin E., 2022) when entering the labor market was the guiding vision while designing the innovation. That background provided the questions to be answered by an action/research project also rendering the framework for state-of-the-art practices. In brief, once the general and specific objectives were clarified, the leading question referred to how higher level teachers can facilitate the achievement of those goals. These procedures emerged after an exploratory study based on learners, system and institutional and regional contexts' needs were analyzed. The answers were considered, suited and finally categorized in a coherent fashion to the curricular competences and objectives, students aimed profiles and the labor demands in the region. Technological devices use, accessibility and logistic as well as students' strengths and weaknesses training track were taken into account in order to create available curricular designs and practice (J. Cabero-Almenara & C. Llorente-Cejudo, 2000). The process to contextualize educational, social, communicative and epistemological parameters for contents and skills to be met to the syllabuses aims implied phases of pure creativity and critical thinking (Horkheimer M., 2003) and so, researchers involved in the innovation practices set for the production of basis mainframes. Those became innovation treatments and had to be tested in order to check the fulfillment of curricular contents and competences. The response to the specific questions meant synthetic and analytical devices and quantitative and qualitative tools use in the methodological framework devised for the acquisition of the following variables: mind mapping, self-assessment, total quality monitoring, skills and knowledge relevance and efficiency, after experiencing an open educational resources training in a trans-disciplinary learning treatment (Nicolescu B., 2018).

2. Innovation Materials and Methods

Building new social and educational models from the university has always been the added value of higher institutions (Šorgo A., Bartol T., Dolničar D. & Podgornik B., 2019). On the one hand, it is a challenge and on the other, it is the mission to which society itself refers to as its value, in a collective symbol full of improvement longings. Ideally, the college teaching staff forms and shapes society for the future. Hence the importance of managing updated curricula (Wedell M. & Malderez A., 2013). The added value that each teacher prints into his/her own space and practice must and can be modified gradually, so that students might have access to superior developments, while gaining a firm gnoseological basis above which certain specific and mandatory routines have to be incorporated. They can thus, facilitate life-long and in-service learning patterns that will last throughout the future professionals' working careers. Such skills and abilities constitute the competences meant to accompany graduates in their likely to become future market reality. Abilities to cope with innovations search and resources updating are certain to reach our graduates soon enough. To deal with that constant need, certain cognitive skills and neurological paths have to be framed into routine patterns while attending university training. They should have become accepted, assimilated and consolidated after the student has witnessed its advantages, a process which begins in the humble and innovative university classrooms ((Šorgo A., Bartol T., Dolničar D. & Podgornik B., 2019; Wedell M. & Malderez A., 2013). That is the social responsibility of academia. To be successful in this aim, curricular designs have to focus on the advances of neurosciences, methodologies innovation and total quality knowledge models. That is the mixture of state of the art STEM and Social Sciences progress (Battaglia N., Neil C., De Vincenzi M., Martínez M., 2016). Higher teachers should promote learning routines, procedures acquisition rhythms and knowledge methods development (Laplagne M. C. et al., 2020). To make the above hints, a fact in the designed practices in our research, the innovative treatment included a scaffolding curricular prototype anchored in the next four axes:

- hybrid or B-learning as a contextual framework using openresources,
- student-centered curricula or learning (SCL) as a disciplinary work methodology;
- unified modeling language (UML) in the synthesis and evaluation of competences;
- cognitive processing — as an aid to acquire critical thinking and
- Total quality models — TQM — to adopt an innovation oriented curriculum.

The fact of facing new challenges necessarily implied a synergy of efforts focused on effectively achieving the set goal (Laplagne M. C. et al., 2020). Changes meant disturbances and reactions could not always be the right or suitable ones. They implied a trial and error process. Time and actions were sometimes lost, although they were learning gains anyway.

Once the pilot experience results were obtained, the learning treatment innovation was spread out among the teachers' faculty in order to motivate other subjects' chairs, tutors and assistant teachers to join the experience and thus, letting the research team to get enriched data after a broadened experience. The newly interested teachers were attracted by the level of syllabus, fulfillment, enrollment and tuition withholding and students' skills and competences achievements.

3. Development of the Innovation

The newcomers made the study not only wider in samples and subjects, but also in thematic fields. Thus, the innovation prototype diversified into four axes in direct correlation to the field research. The study axes were STEM disciplines, Social Sciences, Educational Epistemologies and Linguistic Communication. Each of them had to be present in the innovative practice to produce a change and if possible, an improvement in the variables of curricular relevance, interference of technological factors, unified modeling language sustenance and social models for quality devices in order to guide the students' populations in their acquisition and learning processes in the disciplines, fields or subjects that participated in the study. The mainframe prototype was provided to teachers and adapted to the topic or unit where the innovation was to be applied as a treatment. And when the prototype was in motion, the research team recorded data during different phases. The expected developments that fit the study referred to certain skills, abilities, contents and competences in the four axes that needed to be analyzed. They all had a common foundation on the cognitive and neurological paths being formed. The three moments to record the corpus were

a) before the innovation

b) while attending it and

c) afterwards

c1) in the assessment instance and

c2) as a final metacognitive process.

Finally, it is important to mention that classes and thus, curricular design innovations catered for the latest research, state-of-the-art knowledge and innovative advances in a total quality quest guided by teachers and carried out by students themselves in an educational environment, where quality learning referred to learning schemes, acquiring study rhythms and developing competences methodology. To achieve that ideal quality learning, the innovation practices used hybrid learning, open resources, student-centered curricular models-SCM-didactic approaches, unified modeling language (UML) and mind-mapping as the subject synthesis, competences assessment and cognitive processing efficiency evidence collected in students' portfolios.

The topics that students searched over were, among others, recent advances in tissue engineering and anticancer modalities with photosynthetic microorganisms such as oxygen generators, basic robotics, nuclear reactors, bounded waves, automation and artificial intelligence, autonomous vehicles, green energy, environmental engineering, new materials and nanotechnology.

4. Results

The obtained outcomes showed that trans-disciplinary learning experiences enriched the achievement of skills and competencies. Likewise, they strengthened the creative and innovative spirit of the students. These demonstrated their efficient learning processes through their integrated knowledge, their critical capacity and the appropriate analysis, synthesis and redesign of the contents addressed. Students participated actively and collaboratively without complications. They were aware of their duties, rights and responsibilities.

They were successful in their educational needs, so they selected applications and websites which allowed them to achieve autonomous learning. They reasoned, designed specific solutions to each context, problem, challenge or project and applied particular knowledge to the search for cutting-edge information. The students' skills were appreciated and interpreted through educational analytics. The variables analyzed were curricular relevance, the implementation of new technological models, the support of the unified modeling language and the communicative interaction to consider quality Bioengineering devices. Students presented graphs and images, visual, holistic and integrative explanations through unified modeled language and mind maps using Classroom Maps. It was a significant experience and it was appreciated by the same subjects involved in the study.

The graphs and images below show examples of materials and methods used to make students become alert to UML and to TQ models for Bioengineering competence training and its due contents.

As it can be seen in the above diagrams, using UML can serve different areas and topics. They are useful to depict procedures as in Figure 1 in a MCIU (medical care intensive unit) or render the right procedural steps to complete a group project, as in Figure 2.

As regards the linguistic axis, the acquisition of new skills and abilities represented a way to effectively improve the competences work performance in the different areas of knowledge — whether oral or written; strengthening the creative and innovative spirit in favor of obtaining effective results. The main characteristic exhibited by this axis was horizontality, that is, the facilitator teacher or tutor and the participant student had both knowledge to share and an ability to be critical and to analyze the contents granted, supervised and understood by everyone else if the tasks were completed under schedule. Classrooms actors could carry out debates with their tutors or peer group under a formed criterion of comprehensible input at intermediate level, thus conforming to a linguistically effective and mature social competence to take in drawbacks. Students were aware of their educational needs so that, they selected apps and web sites to overcome or boost personal learning obstacles in an attempt to level up to the general class standard.

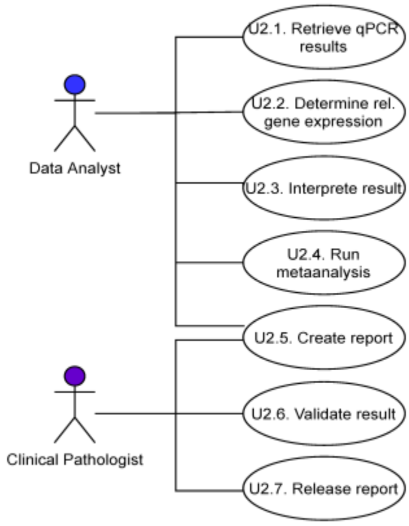

Figure 1 UML Medical Care MCIU Functions

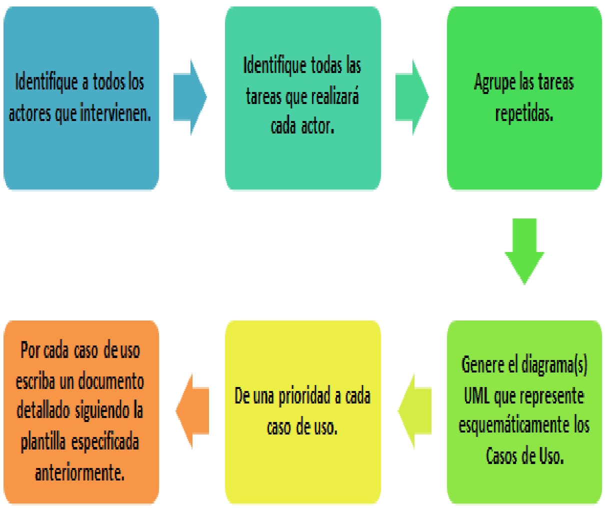

Figure 2 UML Relational Diagram for Project Tasks

Behavior in the other axes showed that most students — 71% of the universe — adequately experienced the implicit work demands as a positive and motivating challenge, which allowed them to reason and apply particular knowledge to their range of experience. They were able to choose when and where to study and learn, being able to value the costs of such scheduled learning in terms of time and opportunities.

The analyzed variables — curricular relevance, use of technological devices, unified modeling language support as content mind-mapping and social interaction proved to be an achievement, although they all displayed different figures according to the subjects and fields involved in the four axes. The evolutionary correlate of the students' abilities and the learning appreciations they retrieved later demonstrated they efficiently acquired under this experiential context the educational objectives.

Figure 3 shows the values that the axes achieved in the educational analytics.

As it can be seen from the graph, language interaction used for social communication improved in all axes. Stem sciences recorded less achievement in the specific areas of Engineering contents, which can be explained similarly to the results marked for the implementation of new technological models. By this, it is meant that the period for the innovation — 20206 2021 — was distinguished by change, crisis and meager web accessibility.

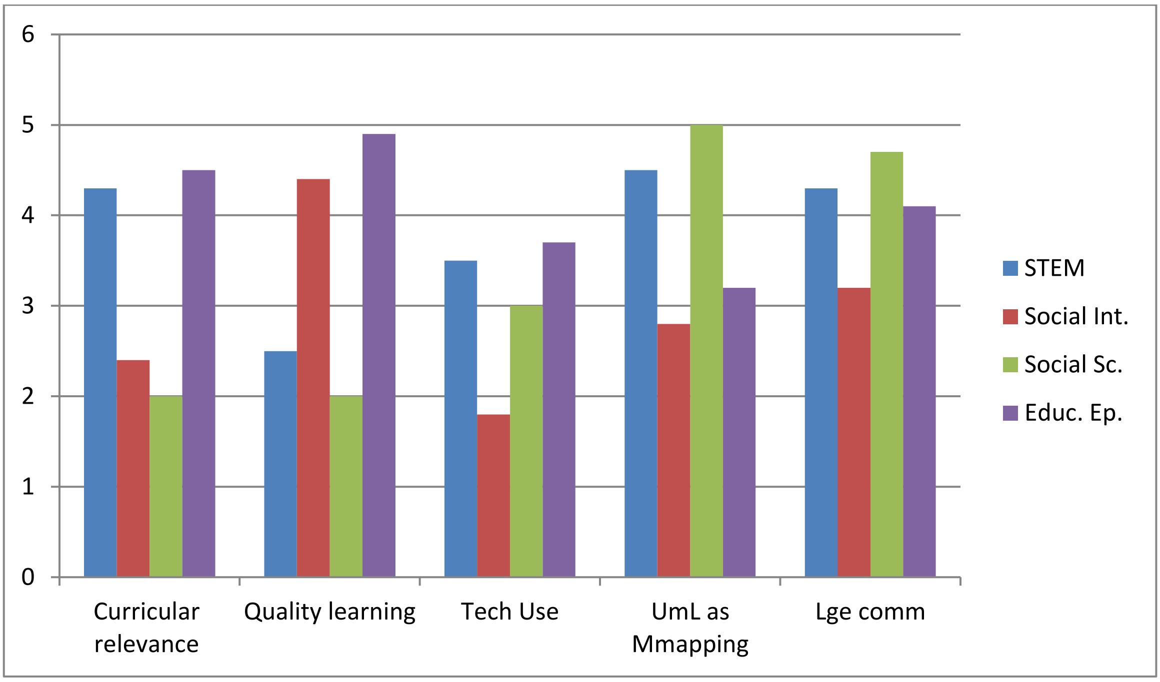

Figure 3 Axes Values

On the other hand, the support of the unified modeling language and mind mapping devices made it easier for students to understand themes and exhibit their own cognitive processes, obtaining under such tools the expected outcomes.

Communicative interaction was not always in direct correlation to Quality Bioengineering devices use. Finally, it must be noticed that social sciences recorded the minor values which is not weird for a career based on exact sciences.

5. Discussion

Among the main conditioning learning factors, the following were found:

- Heterogeneous groups in age, interests, motivations, experience and aspirations were diverse and thus, results had to be categorized in order to understand cause/effect correlations.
- Students' results were not uniform during the biannual period, being the 2020 outcomes minor than the ones obtained a year later, although the tasks developed required the same time and effort.
- The population's main objective was obtaining a passing mark, and so the general interest was reduced. The commitment revolved around tasks completion. The search for knowledge, well-being, self-confidence and esteem was a hard job for teachers throughout the implementation of the innovation.
- Students' anxiety and lack of confidence played an important role when facing failure.
- Susceptibility and insecurity in the face of criticism often under the weight of previous frustrating learning experiences convinced some subjects that they were not able to acquire new knowledge and competence (Battaglia N., Neil C., De Vincenzi M., Martínez M., 2016).
- Contradictory sources of knowledge demanded allotting more time for face to face classes outside the

initial schedule.

In spite of the fact that compensation mechanisms were incorporated in the design to overcome the shortcomings of the experience; a great deal of attention had to be paid off in the training environment.

The following table poses the contrast between educational analytics figures for the first academic term achievement contrasted to the innovation achievements as regards mind mapping, self-assessment, total quality monitoring, skills and knowledge relevance and efficiency in the final evaluation instances.

These assessments were carried out with the complete populations attending classes in the 2020 and 2021 academic years. The Table 1 displays the media values for the trans-disciplinary involved subjects considering the results obtained in the initial and final instances of the evaluation processes. The figures range from 1 to 10, being 6 the passing mark in mind-mapping or UML diagrams, competences self-assessment, total quality portfolio evidence, procedural skills and theoretical knowledge management.

Table 1 Media Values

Trans-disciplinary items	2020 Initial test	2020 Final test	2021 Initial test	2021 Final test
Diagrams	5.3	6.1	5.9	8.4
Competences self-assessment	4.1	5.5	4.9	7.5
Total Quality evidence	4.8	5.2	6.2	6.9
Competences Procedural skills	5.1	5.9	6.8	7.3
Theoretical knowledge	4.3	5.7	6.1	7.1

As it can be observed both groups increased their rates but the minor values are found in the sanitary crisis year when one of the main interference was web accessibility.

6. Conclusion

The design showed a value-added performance and identified highly successful classrooms and teaching, creating innovative opportunities to learn from the trans-disciplinary framework (Sarmiento Laplagne, Cristina Maria, Juan San & Laplagne Cris, 2020; Rodríguez Álvarez N., Toledo Dieppa V. & Sabín Redón Y., 2018). The hypothesis intuitively perceived, before the innovation prototype was designed proved to be right; in spite of the availability of technological devices at teachers' disposal, these were felt as alien before the crisis and were absent in the classroom praxis. Creating an innovative instrument, the prototype implied teaching simplicity and although accessibility was not the best, many teachers were satisfied with the innovation results under a fixed prototype. Thus, the promotion of critical epistemological trans-discipline spaces — such as the ones proposed by Morin (2022) and Nicolescu (2018) could lead different subjects, contents and their administrators to achieve students' competences and aims by means of pilot experiences alike the one depicted in this report. Knowledge commitment and problem solving tasks have to be acknowledged as a general syllabus objective. Sorting out obstacles and seeking for solutions is a major competence that the academy must promote in students to acquire in the face of different health, economic and environmental crises. There were considerable differences among students in terms of how much students actually learnt, though in most cases results were extremely helpful to observe how highly effective teachers had taught. Identification of outstanding or merely poor practices reflected other constructs' factors interference, such as the scarce use of promoting learning gains, for example, promotional marks, unit credits, or others. Providing extra counseling meant an opportunity to give struggling students more opportunities to meet promotion requirements and valuable professional development tools and strategies. It was particularly useful to identify and examine the classrooms success when guiding students who were at risk for poor educational outcomes. Open resources technology approach in the classroom was a step forward away from teacher centered stage classes and let learners take greater responsibility in their own learning path. It was concluded that a technological b-learning approach in the classroom implemented in a trans-disciplinary curricula, under students' centered complex models, aiming at competence achievement through TQ and UML displayed a successful innovation practice (Šorgo A., Bartol T., Dolničar D. & Podgornik B., 2019; Sarmiento Laplagne, Cristina Maria, Juan San & Laplagne Cris, 2020; Vergara Fregoso M., Silva Guerrero J. & Rosas Chávez P., 2020).

References

Battaglia N., Neil C., De Vincenzi M. and Martínez M. (2016). "UAI Case: Integración de un Entorno Académico con una Herramienta CASE en una Plataforma Virtual Colaborativa", in: XI Congreso de Tecnología en Educación y Educación en Tecnología.

Cabero-Almenara J. and C. Llorente-Cejudo (2020). "Covid-19: transformación radical de la digitalización en las instituciones universitarias", *Revista Campus Virtuales*, Vol. 9, No. 2, pp. 25–34.

CONFEDI (2018). Libro Rojo, available online at: https://confedi.org.ar/download/documentos_confedi/LIBRO-ROJO-DE-CONFEDI-Estandares-de-Segunda-Generacion-para-Ingenieria-2018-VFPublicada.

Horkheimer M. (2003). *Teoría crítica*, Primera edición. Traducción de Albizu, E. y Luis, C. Buenos Aires: Amorrortu.

Morin E. (2022). *Lecciones de un siglo de vida*, Colección Estado y Sociedad, Barcelona, Ediciones Paidós Ibérica.

Nicolescu B. (2018). "La evolución trans-disciplinaria del aprendizaje", *Revista Trans-pasando Fronteras, ICESI, No. 4*, available online at: https://www.icesi.edu.co/revistas/index.php/trans-pasando_fronteras/779.

Rodríguez Álvarez N., Toledo Dieppa V. and Sabín Redón Y. (2018). *Ejercicios por niveles de desempeño cognitivo, Educación Superior* (Spanish Edition), Madrid: Editorial América Española.

Sarmiento Laplagne, Cristina Maria, Juan San and Laplagne Cris (2020). "Emerging trends in education and LKT facing society and practice subjects' changes: Emerging trends in education and LKT facing society and practice subjects' changes", available online at: https://www.researchgate.net/publication/346423238.

Šorgo A., Bartol T., Dolničar D. and Podgornik B. (2019). "Attributes of digital natives as predictors of information literacy in higher education", *British Journal of Educational Technology*, Vol. 48, No. 3, pp. 749–767.

Vergara Fregoso, M., Silva Guerrero, J. y Rosas Chávez, P. (2020). La universidad en la sociedad actual: aportaciones y limitaciones. En: *El papel de la universidad en la sociedad actual.* Guatemala: Editorial Serviprensa de la Universidad de Guatemala.

Wedell M. and Malderez A. (2013). *Understanding Language Classroom Contexts: The Starting Point for Change*, London: Bloomsbury.