META-SIMULATING. DESIGNING E-LEARNING SIMULATIONS FOR INSTRUCTIONAL DESIGNERS

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ABSTRACT

Today e-learning increasingly requires, even at an International level, highly competent professionals of learning design. For this reason, the role of traditional academic institutions becomes fundamental in conveying those abilities, knowledge and skills which can be immediately put to use in an e-learning working context. This request of instructional designer training is responded by the innovative formula of the IeLM Master Degree organized by La Sapienza University of Rome and Nova Southeastern University of Miami. The IeLM Master aims at the acquisition of both theoretical knowledge and practical skills for the design of distance courses. With the purpose of ensuring the passage from the acquisition of theoretical notions to complex long-lasting behavioral schemes, the IeLM Master has introduced the activity discussed in the present paper: the design of an e-learning simulation meant for future instructional designers by the members of the 2007-2008 Master’s edition. This educational path was organized in five phases: (1) the definition of the workflow of instructional design; (2) the creation of a matrix of skills; (3) the definition of the calculation model which underlies the simulation; (4) the development of the “perfect story” of the simulation; (5) the writing of the storyboard of the simulation. The main results of this activity have been the possibility for learners to apply the theories and techniques acquired during the learning process and the start of a meta-cognitive reflection on the role of the instructional designer.

KEYWORDS

E-learning simulations, Bayesian networks, instructional design, collaborative learning
1. INTRODUCTION

In the current working context, educational institutions are increasingly engaged in making young professionals ready for the job market as soon as they finish their studies. In Italy this objective has been particularly pursued through masters and postgraduate programs. These learning paths are presented to the potential public as highly formative and capable of offering skills which can be immediately spent in the working context.

In this setting, the IeLM master organized by La Sapienza University of Rome and Nova Southeastern University of Miami (http://www.ielm.it) uses a blended approach to learning. The master is divided into two parts: an Italian face-to-face part which is carried out in class and in laboratory, and an American part, which is carried out online, in English, through synchronous and asynchronous interactions. The modules featured in the IeLM Master deal with both theoretical and practical subjects related to design, development, delivery and evaluation of e-learning educational paths for both public and private sectors as well as online curricular courses for schools, universities and higher education. The lessons include numerous practical assignments, best practice studies and development of pilot programs. Its mission is to train skilled e-learning instructional designers ready not only to actively enter high level working contexts, but also to bring innovation to old generation production processes.

One of the main and most urgent problems taken into consideration in the design of the IeLM Master is the ability of the university system to deal with this task: how can traditional educational systems communicate practical information and encourage the development of skills which can be immediately spent in highly competitive environments like the e-learning one? In this case, in fact, besides a strong theoretical basis for the comprehension of topics and the acquisition of a conscious and reasoned design methodology, it is absolutely necessary to convey complex behavioral schemes classified at the highest levels of Bloom’s taxonomy (levels 5 and 6, which include estimation, creation and evaluation. Bloom, 1956). Planning how to deliver information is therefore fundamental in leading the learner to integrate what he has learned with practical work models.

The IeLM master has adopted a learning methodology in which students are constantly involved in learning activities through class assignments and project works related to each of the presented topics. They are asked to develop their critical spirit toward theoretical topics and to increase their operative skills in applying what has been learned in simulated professional contexts. In most cases the projects are carried out in groups, enabling the learners to develop teamwork skills, share knowledge and mediate diversities.

Assuming that such a learning model is able to translate theoretical knowledge into effective and long-lasting behaviors, how can one be sure that the learners will be able to replicate what they experimented once they are in the workplace? Furthermore, how can one measure, verify and evaluate the actual achievement of these objectives? Which assessment techniques can provide enough information to establish whether the learners will truly be able to apply what they learned?

For all of these reasons, the teaching staff of the IeLM master decided to integrate the learning path with a final ambitious step: all of the students had to design an e-learning simulation aimed at the selection, training and evaluation of instructional designers. The simulation allowed the students to critically reflect on the theoretical aspects discussed during the lessons and on their effective application in working contexts; at the same time, it permitted to generate practical behavioral schemes. According to this vision, the simulation assumed a fundamental educational value. Students were called to measure themselves with deadlines, teamwork and coordination issues as well as many unexpected critical situations. Moreover, they gained a functional understanding of the different information delivery modes and communication tools, such as audio-conference, chats, forums etc.

The motivation and evaluation aspects engaged in these kinds of projects are equally important. Through the simulation students can actively test themselves on a complex project which gives them the perception of their achievements and newly acquired skills. Furthermore, one can compare the assessment results obtained during the rest of the learning path with this wider type of evaluation which is not perceived as a test. This allows students to freely express their abilities, skills and personalities and show their preferences and personal attitudes.
2. DESIGNING E-LEARNING SIMULATIONS FOR INSTRUCTIONAL DESIGNERS

Starting from the previously described aspects, a detailed description of the training program and of its overall structure is now necessary.

The timeframe needed for the development of a well-articulated instructional process, divided into many different steps, required about 6 face-to-face sessions at weekly intervals. Each lesson lasted one day and the interval between them allowed the students to carry out small projects and instructional activities.

The face-to-face meetings had several objectives. The first one was to supply the theoretical basis required to understand the main theories and to assimilate the notions underlying instructional e-learning simulations (Ronsivalle, 2005; Ronsivalle, Loi & Metus, 2006). A second objective was to introduce, activate and motivate the process of collaborative working among students who were allocated in teams according to different assignments. Eventually, tasks and activities were assigned to the students and became the starting point of collaborative discussions and confrontations.

The steps of the collective designing of the simulation for macro-instructional designers matched those of a realistic business environment. For each step, inputs and outputs were defined. The output of each step was the starting point for the following one. These are the five steps of the collective designing process of the simulation: (1) the definition of the working/organizational process which underlies the actual job situation to be represented in the simulation; (2) the creation of a matrix of skills which the instructional designer must possess in order to perform the activities in the process; (3) the definition of a calculation model based on the theory of the complex systems (Bertalanffy, 1968), the Bayesian network (Gill, 2002; Press, 2002); (4) the creation of the perfect story, i.e. a situation evolving in a way that is coherent with the models and with the behavioral patterns shared during the master; (5) the actual writing of the storyboard for each and every step. These five steps will be accurately described in the following sections of the paper.

The articulation of the dynamics of collaboration among the students towards the accomplishment of the assigned activities was crucial to the successful performance of the instructional process. In fact, in order to achieve the learning objectives these dynamics should resemble the actual organizational workflow of the working environment. Therefore, it is fundamental that the students share a common knowledge about the methodology of the workflow organization.

In order to achieve the learning objectives, the instructional process was divided into two separate moments during which the students were grouped in different ways. In the first phase, the learners were divided into separate groups in which a leader was chosen to manage the internal workflow as well as the creation of PowerPoint presentations for the whole class to view every week. In order to maintain the closest possible resemblance to an actual working environment, it was important for group leaders to make the decisions in case of disagreements inside the group. In the second phase, the various groups were merged into a collective structure in which the whole class worked together as a team. In order to achieve this, the outputs created so far were shared and the class negotiated a common version of each one in a collaborative way. Finally, a leader was chosen for the class: he had to manage the work structure, the internal resources and the deadlines of the project.

2.1 The definition of the process

Description of the step

The first step of the design phase was the definition of the organizational context in which the simulated situation and activities of an instructional designer are set. This was a fundamental phase in the description of the components of the simulation and of the abstract variables which are associated with its underlying logical model. In simple terms, the definition of the process can be described as the identification of the phases and actions which are essential to reach the final objective. This is the result of the analysis of all the context and system variables involved (goals and objectives of the simulation, length of the project, technological limitations).

Understanding the dynamics which define the process is fundamental in order to identify the steps which should be included in the simulation and the so-called “perfect story”. Only by starting with the process it is possible to establish the timeline along which each phase is placed, the progress between the various steps
and the decisional moments of the simulation. It is inside the process and through each step that one can also identify the entry information that are necessary for the development of the steps and the outgoing information, consisting in the outcomes of each one. The detailed description of the corresponding actions in each step with their respected input and output is the basis for the construction of the table of skills which define the focus of the simulation. The outcomes of each phase are also necessary to determine which variables will shape the probabilistic net constituting the simulation calculus model.

Identifying the phases of the project allowed, on the one hand, to assess and reflect on the level of skills acquired; on the other hand, it helped the students understand the relationships between the activities performed by an instructional designer and those ones performed by other professionals in the same team. Through the analysis of the process the students could also contextualize the full amount of theories and practical knowledge acquired during their entire learning experience. Therefore, this first phase was not only the initial step of the design of the simulation but also the first occasion for reflection and meta-cognitive discussion on the entire learning path provided by the master.

Methodology

The creation of a process which best exemplifies the activities of instructional design was based on the analysis of the activities carried out during the master, of the acquired knowledge on macro- and micro-design and on the phases included in learning design.

Following an initial phase in which the single groups worked autonomously, the groups interacted with each other and with the instructors in order to achieve one shared synthesis of the components of a learning design process. The result was the description of the learning design process within a complex organization and of the relation between the various elements involved. The structure of the phases which compose the design process was achieved through the parallel identification of the activities, of the professional profiles involved in each phase and of the entry and out-coming information for each phase necessary to the achievement of the final objective. While designing the simulation, the participants could engage in the different phases of the process which constitute the substance of the work of the instructional designer; they also carried out both the roles of instructional designer and content expert in order to identify the sequence of significant activities for the simulation and a context of interactions in which to test the map of skills.

The final phase consisted in identifying the steps in which the macro-designer is directly involved, that is the decision-making moments on which the behaviors acquired by the user would be tested through the simulation.

Output

The final outcome of this first step is the representation of the process through a flow chart which shows the sequence of activities of instructional design from the acceptance of the job order up to the delivery of the prototype to the client. The process has been divided into four separate but interrelated macro-areas (project management, macro-design, micro-design and development).

In order to graphically represent the flowchart some convention on how to indicate the activities, the professional profiles and the main outputs of each phase were agreed upon.

The flow chart was the starting document of the following phases of the learning process.

2.2 The matrix of skills

Description of the step

The goal of this step was to identify the skills to be acquired, strengthened and verified through the simulation. Particularly, the goal was to define in detail the particular combination of knowledge (the mental models of a subject) and abilities (the set of mental functions which enables him to transform knowledge into specific behavioral patterns) to be put into practice in each and every decisional step of the process. The use of a learning simulation is motivated by the need to develop certain skills, that is complex behavioral patterns which the users must be able to put into practice in order to effectively cope with their peculiar working context.

Once the activity flow in which the actor is involved was described, the following key step was to detect that set of resources needed to fulfill the tasks required by his/her professional profile. That is why it was
crucial to fully understand the unique mix of knowledge and skills that instructional designers need in order to perform their job at the highest level. Furthermore, the definition of the matrix of skills was a fundamental element for the development of the Bayesian network, i.e. the calculation model that governs the evolution of the simulation.

Methodology

Intensive brainstorming on the structure of the process allowed the students to identify the knowledge (Johnson-Laird, 1983) and abilities needed by the instructional designer in each previously identified decisional step. Each team autonomously made a proposal, and the best ideas were put together in a shared document.

Output

The output of this work was the matrix of skills, a table in which for each of the nineteen decisional steps of the work flow, two columns listed the knowledge and skills required for the instructional designer to consciously take the correct decisional steps and manage at best all the related issues.

2.3 The creation of the Bayesian network

Description of the step

E-learning simulations are based on the creation of a model capable of reproducing the reality they want to represent. Therefore, they are a system built to reproduce a concrete situation in an optimal environment, protected by the hazards of reality. E-learning simulations must be planned so that they reproduce the logic of a context in which, similarly to real life, one is bound to make decisions without the availability of all the information needed to determine either the success or the failure of the actions performed.

The realism of e-learning simulations (upon which their effectiveness relies) is essentially based on three different factors: (1) the pertinence of the situation narrated, and of the context in which the action/interaction between the user and the system takes place; (2) the verisimilitude of the effects deriving from the user’s decisions as well as, in general, the overall logics of the evolution of the simulation; (3) the coherence of the feedbacks given by the system (both evaluation and orientation feedbacks), compared to the complexity level of the used variables. The first of these key-factors, as seen in the previous chapter, is based on a strict and attentive analysis of the work process, as well as of the organizational and relational dynamics. The latter points, on the contrary, are connected to the simulation architecture and more specifically to the calculation model that makes it evolve on the timeframe.

In the specific example of the simulation described by this paper, given the complexity of the process and the concurrent factors leading to the quality of the output, the choice was made to adopt a calculation model based on the theory of conditional probability (Bayes Law). This specific calculation model can make the evaluation of the system equilibrium state easier: “[…] Bayes Law determines that $P(A | B) = P(A,B)/P(B)$. Stated otherwise, the conditional probability of $A$ given $B$, is equal to the probability that both $A$ and $B$ occur, divided by the a priori probability of the occurrence of $B$.” (Gibbons, 1992)

The basis of the system theory, and particularly the application of Bayes Law to the development of finite-state dynamic systems, lies well beyond the scope of the present paper, and it can be further deepened through the bibliographic suggestions in the last section of these pages. It is sufficient to know that the simulation calculation model consists of a Bayesian network and of a series of rules that regulate the correspondence between the probabilistic relations and the user interactions, which constitute the “events” of which the conditional probability is calculated. The net architecture relies upon the relations among the competences previously detected: the competences will thus be the nodes, simplified and interwoven by common links, within a tree structure centered on the final variable representing the node of verification of the system equilibrium state.

In this respect, the Bayesian network constitutes the heart of the logical representation of the real situation to be depicted. It represents the interpretative model of the complex frame of links and relationships between the user skills and the conditions underlying the design process. The Bayesian networks are graphical models of probability, founded on direct acyclic graphs whose nodes are a set of random variables, and whose arches represent causal needs between the nodes. Through this calculation model, the engine of the simulation can
foresee whether the system maintains its position of stability, or whether, on the contrary, the results of the decisional steps have doomed its equilibrium to collapse. This allows the simulation to have a high rate of similarity to the represented reality (factor 2), and to generate effective and coherent feedbacks (factor 3).

**Methodology**

In order to construct the Bayesian network for the simulation, theoretical references were integrated with some operative skills on the mostly used editing and calculation tools for Bayesian Networks: MSBNX (a Microsoft inc. free tool, available at [http://research.microsoft.com/msbn/](http://research.microsoft.com/msbn/)). Those two aspects were thus the objectives of the face-to-face session on the Bayesian network.

Immediately after the activities of theoretical explanation and collective brainstorming, every student was asked to conceive his/her own network. The resulting products were then summarized by the instructor, through a process of integration and synthesis of the best solutions proposed by the students.

The instructional plus of these phases – the collective construction of the Bayesian network – relies on the possibility to keep up with the critical thinking on these three main factors: the simplification of the matrix of skills; the determination of the logical relations among those skills; and the evaluation of those skills through measurable outcomes. Through the creation of the network, in fact, the skills need to become verifiable through those decisional steps that will be the subject of the “perfect story”. Such process allows the students to reflect on the key skills required of an instructional designer as well as on how the outcomes of the process of constructing the simulation can be interwoven and can prove the acquisition of desired knowledge and skills.

**Output**

The ideal output of the process consists in a Bayesian network which describes all the variables at stake in the instructional designing process. At the same time, the network must easily support the simulation calculation engine.

In the specific context of the IeLM master, the final product of this section of the process was a twenty-node network, in which the left side represented mostly the theoretical variables of the instructional macro-design applied to e-learning products. Among those nodes, it is worth mentioning the concept map, the learning objectives, the content analysis and the course structure. The right side of the map takes into account the required skills of analysis and synthesis that the instructional designer must possess in order to manage the system variables and the government variables. In the central branches of the network, one can find the nodes related to the macro-planning of the evaluation system as well as to the item analysis techniques. The last nodes of the network are the most relevant and the most sensitive ones, the outputs of the process, the so-called “control variables”: the project plan and the prototype. All the higher branches of the tree merge into those two nodes and upon those nodes depends the final state of the variable of system government, which is the index of the conditions of either equilibrium or non-equilibrium of the simulation.
2.4 The perfect story

Description of the step

The “perfect story” is the non-scripted narration of the ideal flow of the simulation, of the logical path that would be carried out in case the user only selected correct choices. In relation to the Bayes network and the calculus model of the simulation, the “perfect story” embodies the evolution of a complex system in constant balance, similar – according to the Game Theory – to the Nash equilibrium.

Writing the perfect story is essential in order to contextualize the different decision-making moments, each represented by a step in our story. This includes: (1) a description of the setting, which aims at introducing the step and presenting its objectives; (2) a central moment of development of the step, in which all of the useful information is provided to the user; (3) a decision-making moment, at the end of the step.

The perfect story can be seen as the conjunctive element between the phases of macro-design (definition of the process, identification of skills and Bayes network) and the micro-design phase (writing the storyboard). The story is the subject of the actual screenwriting of the entire simulation.

Methodology

Starting with this point in the creation of the simulation, the previously created groups were united into one team. A project leader who was placed at the head of the team dealt with assigning the work and managing the available resources. There are two main reasons for this regrouping: on one hand, the possibility of experimenting work organization issues which become more difficult to manage within a wider group and on the other hand the necessity of having enough resources for the lengthy job of writing the storyboard. A third important aspect is the discussion of how to gather the previously created files among the different groups into a single shared document which integrated the best contributions of each one. The negotiation of this transformation can stimulate the creation of very useful soft skills.

From this moment on, wide space was left to personal creative processes in inventing situations and critical aspects which contextualized the different decision-making moments found in the working process. Nonetheless, being the perfect story a result of the work of sixteen different people, it was necessary to define a common base in order to share the criteria which would enable the students to develop independent yet coherent steps. A document which included a set of facts and data to be followed was therefore drafted. This defined in particular the characteristics related to the main character, his working context, the environment,
the characters who take part in the story and the features of the learning path of the simulation. Furthermore, a single template for writing the story was drafted in order to have homogeneous contributions not only in the content aspect but also in the graphical one so that they could be easily integrated into a single document. On this basis of shared knowledge the project leader assigned four or five steps to each group. Within every working unit the respective leaders also distributed the workload among the members. At this point, the students started interacting through audio-conference tools which allowed them to eliminate the physical distance between them and to work together in creating an even product. Once the first draft of the “perfect story” was completed, this underwent a debugging phase: the actions and decisions carried out during this procedure were noted in a specific document with the aim of keeping track of the work progress.

Consequently, in creating the perfect story, the emphasis was placed on the actions and judgments of the user, based on the information, knowledge and skills acquired during the process. This methodology brought about the creation of complex situations and relative decision-making moments.

Output

The perfect story in its final version was made up of an initial setting of context presentation and of nineteen steps, each of them including title, learning objective, setting, information and decision-making moment. The development of the entire step was centered on the decision-making moment, elaborated in a way that would be truly significant to the user and would contain reasoned out information based on the specific objectives of each step. The elaboration of the decision-making moment also took into account the development of the previous steps, in an attempt to link the information and avoid steps which could be solved without the knowledge of previous happenings.

2.5 The storyboard

Description of the step

Once the story of the simulation had been entirely drafted and verified, it was necessary to put the finishing touches to the non-scripted description of the steps to be developed. The “perfect story” was therefore used as a basis for drafting the storyboard, that is the multimedia script of the single steps which compose the simulation. This phase meant the passage from the macro-design to the micro-design phase in which students applied the storyboarding techniques learned during the master. In fact, after the previous knowledge on macro-design was recalled in the earlier phases of the work, the micro-design of the simulation assumed a primary role, both at group and individual levels. For these reasons, the development of the storyboard constituted a crucial passage of the entire design process of the simulation, since the different individual backgrounds contributed to create a shared basis for the final and ready-to-be-developed output.

In this light, the allocation of the steps among the students was kept unvaried, so that everyone could continue to follow the portion of simulation which he/she had already described, in relation to the collectively negotiated global setting. As a consequence, it was possible for the instructors to track precisely the single contributions in the drafting of the storyboard, with considerable advantages. First of all, this approach allowed them to compare, by observing similarities and differences, the previous drafting of the storyboard carried out in groups with the individual work of scripting the single steps of the simulation. Secondly, the specific skills of single students were tested without the risk of pressure generated by a formal evaluation which would have ended up affecting the work itself.

Methodology

The planning and coordination of the necessary activities for the completion of the storyboard drew upon a series of corporation models which the students had previously started to test during earlier group projects developed for the master. Nonetheless, the difficulties connected with the management of a single team, as well as timing constraints, made it hard to establish unambiguous standards for this phase of the work.

Given these critical aspects, the students themselves were left to find the best solutions in order to optimize the available time and resources: the design of the simulation became the ideal context to start up and test the productive logics typical of professional settings. The models of work organization learnt during the master were thus the methodological tools through which the operative phase of storyboard writing was initiated after being planned in detail.
Definition of standards and debugging protocols - The preliminary definition of the micro-design standards and the debugging protocols represents a crucial moment for the development of the storyboard, since the setting of the entire job of writing and revision depends on these two important elements. The micro-design standards contain in fact essential information to make the individual contributions similar to a single model which is obviously characterized by precise attributes, gathered in a textual document which contains the guidelines for storyboard writing and becomes an unambiguous reference for all the members of the team. All of this is the result of a collaborative activity of sharing of information gathered from the implicit and explicit indications and requirements on the simulation. The brainstorming between all of the team members certainly represented a particularly suitable tool, since all of the information useful to start up writing was gathered and discussed until a functional solution was reached. In this sense, the standardization of the storyboarding activity meant the adoption by the students of a productive view which was no longer merely “artisanal”, but fully business-like. In the same way, the development of the debugging protocol is a document which formalized the modalities and peculiarities of the revision interventions on the first scripted draft of the simulation. Planning the debugging phase guaranteed a homogeneous and professional outcome.

Storyboard v1.0 writing - Once all of the standards necessary for writing were established, a first draft of the steps was written. During this phase the main difficulty for each storyboarder consisted in harmonizing his own creativity with the previously decided limitations. The result of this draft was the version 1.0 of the storyboard, later submitted to careful debugging.

Version 1.0 debugging - Given the debugging protocol developed for the storyboard, a small group of students carried out a wider checking activity, which moved from the verification of the scripted dialogues to the errors of document formatting.

Storyboard v2.0 - The process ended with a new and definitive version of the storyboard, the last step toward the development of the simulation.

Output

The storyboard of the simulation contained the script of each of the 21 steps included in the process. Except for the initial and last steps, both lacking a decision-making moment, the structure of the remaining 19 steps included an initial setting, the main scene, planned so that it would provide relevant information to the story and a decision-making moment.

The selected template was made up of four columns: (1) audio text, with all of the dialogues of the simulation; (2) video text, with the information that appears on the screen; (3) frame, with details on the single shots, expressed through filmmaking conventions; (4) development notes, with all the useful indications for the graphical development of the product.

3. RESULTS

The introduction of this new learning methodology in the IeLM master produced optimal results in terms of increase of learning effectiveness.

The evaluation system was designed by integrating different tools: initial and final tests checked the acquisition of knowledge on theoretical contents; class assignments, project works (like the design of the simulation) and interviews checked the acquisition of complex behavioral schemes.

The data were gathered by means of the mathematical model of the following Bayes network. The final score of Syllabus 3 was then calculated after assigning the values to each of its variables.
Figure 2. The Bayes network for the IeLM master evaluation system

As shown in the graph below, Syllabus 3 registered a relevant increase in terms of learning effectiveness.

Figure 3. The effectiveness index increase

The effectiveness index can range from -1 to +1 and is calculated according to the following formula:

\[ \text{Effectiveness Index} = \frac{\text{Added Value}}{\text{Learning Need}} = \frac{\text{Average Final Score} - \text{Average Initial Score}}{\text{Maximum Score} - \text{Average Initial Score}} \]

In the first part of Syllabus 3 (the most theoretical one) the effectiveness index was 0.60. In the second part, after the introduction of the activity of simulation design, the index reached 0.82. The line on the right side shows this positive increase.

4. CONCLUSIONS

The choice of involving the students in the design of a simulation represents an effective solution to the problems stated in the introduction. Moreover, the decision to adopt the selection, training and evaluation of instructional designers (the professional profile object of the master) as main theme increases its learning value. The creation of a simulation is in fact a sufficiently complex process which forces the learners to apply all of the design strategies and techniques previously learned in theory, as well as favoring the integration of different information related to delivery modes and technological communication tools.

From an organizational point of view, it is useful to divide the class into groups, each with leaders coordinated by a single project leader. In this way, it is possible to replicate the dynamics of ramification and hierarchical communication typical of these settings.

The choice of the topic of the simulation forces the student to act out a meta-cognitive process, therefore acquiring a stronger level of consciousness of his/her role and job. Particularly during the target and process analysis phases, the students are called on to reflect on and to rethink their own role and activities, as well as the skills, knowledge and abilities necessary to the context they will become part of.

In order for the group to test the actual work conditions, the project is conducted and led by the instructors in a way that replicates them as much as possible, often emphasizing deadlines, quality of the
outcomes, as well as the relationship with the final recipient and possible unforeseen situations. The work dynamics recreate the critical aspects and hassles of a real working environment, forcing the students to negotiate conditions, tasks and qualitative levels of the work.

Finally the design process allows the students to put into practice what was learnt up until then: techniques, strategies, tools and design documents must be used in the most appropriate way, in order to obtain a professional and effective product. The design process of the simulation also provides an important self-evaluation tool through which learners take into account their progress and newly acquired skills.

The creation of the Bayes network, the comprehension of its logic and functioning allows the learners to gain awareness on the tool which was used to evaluate them. Furthermore, the Bayes network, if well designed, can become a useful assessment tool in case the instructor decides to use it to evaluate the acquired skills. From this same perspective, a further positive element in such a project is the possibility of evaluating the learners’ progress without them perceiving it. The idea of no formal evaluation generates in students a more spontaneous behavior and the practice of skills, motivations and attitudes which hardly emerge when they know they are being judged. This kind of evaluation, appropriately integrated with previously recorded objective measurements, allows the instructor to express a more comprehensive judgment of the learners.

The careful observation of the processes generated within the groups allows the instructor not only to integrate the cases in which data do not provide an objective final evaluation, but also not to limit assessment to a numerical expression and a self-important judgment. Such a reference frame, then, allows the instructor to provide suggestions and useful indications to the learners on how to continue their education in order to deepen and recover.

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