# On Enhancing Blended-Learning Scenarios through Fuzzy Logic-based Modeling of Users' LMS Quality of Interaction
## *The Rare & Contemporary Dance Paradigms*

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Abstract:     The combination of the process of pedagogical planning within the Blended (b-)learning environment with the users' quality of interaction (QoI) with the Learning Management System (LMS), serving as an effective feedback, is explored here. The required QoI (both for teachers and students) is estimated by adopting a fuzzy logic-based modeling approach, namely FuzzyQoI, applied to LMS Moodle data from two academic teaching of dance disciplines, including rare and contemporary dances, respectively. The latter are used as paradigms that comply with the educational scenarios of the i-Treasures project (www.i-treasures.eu), which refers to the intangible cultural heritage. Based on documental analysis, the pedagogical design strategies per semester were transcribed to concept maps and the dynamically (per week) estimated QoIs were presented as feedback to the teachers at the end of the first semester, so they could reflect and update their pedagogical planning, anticipating more enhanced QoI at the second one. The results presented here show the beneficial role of QoI to shift the educational scenarios and strategies towards a more dynamic design, yet taking into consideration the inherent tendencies and attitudes of the users' interaction within the b-learning context.

## 1   INTRODUCTION

Quality of learning experience directly relates with the amount and the quality of interaction (QoI) and the sense of commitment to a community of inquiry and learning. Those could be achieved through the effective integration of technology, while at the same time exploiting the advantages of a traditional course that includes lectures and meetings (Garrison and Kanuka, 2004). Towards this blending, designing, developing and deploying programs that are well organized, using multimedia to engage the learner by employing various intelligences, capturing the experiences and knowledge of the learners, while incorporating and promoting interactivity and training instructors to facilitate online delivery, demand a strategic decision to be made and adequate resources be made available. Blended (b-)learning can address the potential shortcomings of a purely e-learning approach, yet

only in the context of educators taking a strategic approach and planning appropriately (Wall, 2012). This suggests that education providers (e.g., Higher Education Institutions-HEIs) should find the most appropriate blend of conventional and digital learning resources.

Determining learning behavior in electronic media, however, is a complex problem. A difficulty is that these environments are mostly used by students away from the classroom and out of sight of their educators. Without the informal monitoring that occurs in F2F teaching it is difficult for educators to know how their students are using and responding to these environments. In this line, educators have had to explore new ways of obtaining information about the learning patterns of their students. This clearly requires the development of effective methods of determining and evaluating learner's behavior in electronic environments (Hijón and Velázquez, 2010), a role that is undertaken by Learning Management Systems (LMSs).

The user's interaction with a LMS (e.g., Moodle) is actually realized within Online Learning Environments (OLEs), which are characterized by fastness and immediacy, i.e., the ability to quickly access a vast amount of information coupled with a plurality of Web 2.0 tools (Redecker et al., 2009). Apparently, the efficiency of the LMS depends on how effectively the users can access its multi-faceted benefits when interacting with it. According to Wagner (1994), the interaction can be seen as the occurrence of reciprocal events that require the existence of at least two objects and two actions, and when they influence each other. Chatteur et al. (2008), also report that in OLEs is not uncommon for individuals to interact spontaneously, i.e., without being motivated and/or encouraged through interaction strategies and/or activities. In addition, Herrington et al. (2007) argue that the (un)successful learning is intrinsically dependent on the degree of interaction that takes place in a specific educational context. Collins and Berge (1996) highlighted that learners tend to combine the new knowledge acquired by interacting with content, with their prior knowledge on that subject matter. Hence, interaction can be synthesized as an active process, which requires learners to do more than passively absorb information.

The QoI between learner with online content is one of the imperative factors in determining the efficacy of Web-based teaching-learning towards the creation and maintenance of sustainable learning communities (Grant and Thornton, 2007). Interaction with content is an internal dialogue of reflective thought that occurs between learner and the substance. Interaction is often triggered and supported by events in the learning environment-on how the learner interacts with what is to be learned.

A study carried out by McIsaac et al. (1999) explored interactions of doctoral students with an online environment and they concluded that student interactions were goal-focused. In another study (Hijón and Velázquez, 2006) it was shown that the average connections to the LMS was over thirty minutes. Analysis of learner's interactions may also be used to compare learning behaviors of different groups of students (Ramos and Yudko, 2008).

The aforementioned suggest the approach of user's LMS interactions from the perspective that reveals their quality, so the latter could be used to unfold the true nature of the users' attitude when interacting with the LMS within a b-learning environment. So far, works focused on QoI usually employ statistical analysis of LMS data, combined with transcripts of the discussions and exchanges of teacher and learners within the online forums, specifically investigating the dimension, depth and category of exchanges occurred (Ping et al., 2010).

Following an alternative pathway, here, the *FuzzyQoI* model (Dias and Diniz, 2013) is adopted; the latter takes into account the users' (professors' and students') interactions, as expressed through the LMS usage within a b-learning environment, and, by translating the knowledge of the experts in the field to fuzzy constructs, estimates, in a quantitative way, a normalized index of the users' QoI. In this way, the estimated QoI could be used as effective feedback to the teachers, in terms of reconstructing their pedagogical planning and create updated concept maps (Novak and Gowin, 1996) towards more effective educational scenarios within b-learning context. This process is exemplified here with two dance paradigms, i.e., rare and contemporary dance disciplines at a HEI, serving as a bet-set for the realization of b-learning scenarios within the i-Treasures project (www.i-treasures.eu), related with the capture of the Intangible Cultural Heritage (ICH) and learning the rare know-how of living human treasures (FP7-ICT-2011-9-600676-i-Treasures).

## 2 METHODOLOGY

### 2.1 The *FuzzyQoI* Model

In the effort to develop a successful evaluating system of the user's interaction with the LMS through the QoI, intelligent systems may play an important role, i.e., provide a model of the domain expert's evaluating system, with the promise of advanced features and adaptive functionality (Levy and Weld 2000). Based on the latter, a Mamdani-type (Tsoukalas and Uhrig 1996) fuzzy logic-based QoI modelling, namely *FuzzyQoI* scheme, was proposed by Dias and Diniz (2013). The *FuzzyQoI* model constitutes a Fuzzy Inference System (FIS) structure that is able to produce evaluative inferences upon input data. In particular, the latter correspond to the key-parameters and variables (metrics) of LMS Moodle involved within a b-learning environment concerning the user's interaction with the system, whereas the outputted inference forms a quantitative measure of the user's overall QoI (Dias and Diniz, 2013).

The block diagram of the *FuzzyQoI* model is depicted in Figure 1. As it is apparent from the latter, the users (professors/students) interact with the LMS and the available 110 LMS Moodle metrics
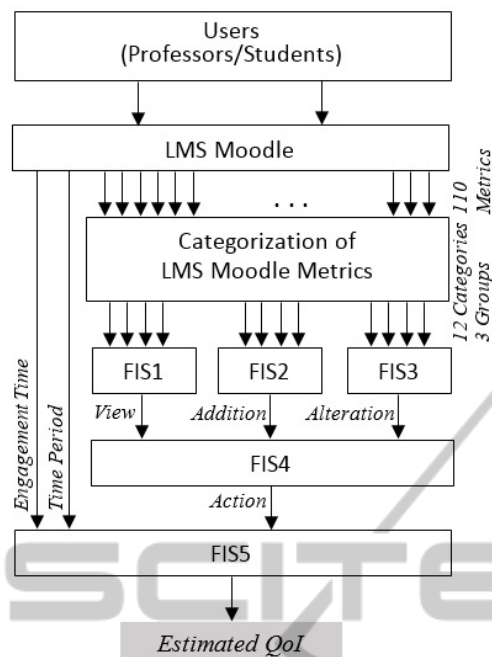
Figure 1: Block-diagram of the *FuzzyQoI* model (Dias and Diniz, 2013).

are corresponded to 12 categories that serve as inputs to the FIS structure. In an effort to efficiently handle the 12 input variables, these are grouped in three groups and a nested sequence of five FISs (FIS1-FIS5) is used to form the proposed *FuzzyQoI* scheme. The first level includes FIS1, FIS2 and FIS3, which output the values of View (V), Addition (AD) and Alteration (AL), respectively. In the second level of inference, V, AD and AL are considered as intermediate variables and are used as inputs to the FIS4, which outputs the value of Action (AC). Finally, in the third level of inference, the AC is considered as intermediate variable and along with Time Period (TP) and Engagement Time (ET) are used as inputs to the FIS5, which outputs the estimated QoI as the final output of the FuzzyQoI scheme (Dias and Diniz, 2013).

For the construction of the knowledge base of the *FuzzyQoI* scheme, an expert in the field of analyzing LMS Moodle data within the context of b-learning was used, for defining the structure of the membership functions used for each FS and the corresponding IF/THEN fuzzy rules.

In particular, a three-level of trapezoid membership functions corresponding to Low, Medium and High values, respectively, are used for the FIS1-FIS4, whereas a five-level of trapezoid membership functions corresponding to Very Low, Low, Medium, High and Very High values were

adopted for the final FIS5, increasing, this way, the resolution in the segmentation of the universe of discourse of the AC, TP and ET inputs and QoI output in the final FIS5. Analytical description of the *FuzzyQoI* model can be found in Dias and Diniz (2013).

## 2.2 C-Maps & Pedagogical Planning

Concept Maps (C-Maps) represent an eclectic range of flexible tools in e/b-learning environments. In C-Maps, in general, concepts are arranged hierarchically, i.e., more general concepts are placed higher on the map and specific concepts are located lower (Novak and Gowin, 1996). C-Maps are largely used in online environments that are able to be presented as learning tools in all stages of the learning process. The use of C-Maps as a way of promoting discussion and negotiation processes through communication tools can be really seen as a valuable learning tool.

Here, the notion of C-Maps is placed within the concept of pedagogical planning, so to facilitate the organization of educational scenarios (Olimpo et al., 2010). The realization of the latter is achieved by adopting the MindMup tool from the i-Treasures Pedagogical Planner (Bottino et al., 2013), which is a scalable cross-browser Web-based application developed in PHP, MySQL and JavaScript. It is conceived with the aim of supporting the design of pedagogical activities/scenarios, namely the descriptions, at different level of granularity, of the playing out of a learning situation or a unit of learning aimed at the acquisition of a precise body of knowledge through the specification of roles and activities. The Pedagogical Planner is essentially a teacher-oriented online tool, yet in the way it is used here, it could serve as a combinatory tool that incorporates both designing and planning of the educational interventions and feedback from the realization of the b-learning delivered instruction. In this way, causal relations between teachers' and students' at the level of their LMS-based QoI could be identified and teachers' metacognitive processes could be fired towards the enhancement of their pedagogical planning and delivery.

The Pedagogical Planner comprises both authoring and display capabilities, with specially designed functions and interface features in both cases. In particular, target population, learning context, content domain, objectives and metrics, along with available tools (such as MindMup), are the core characteristics of the Pedagogical Planner (see Figure 2).
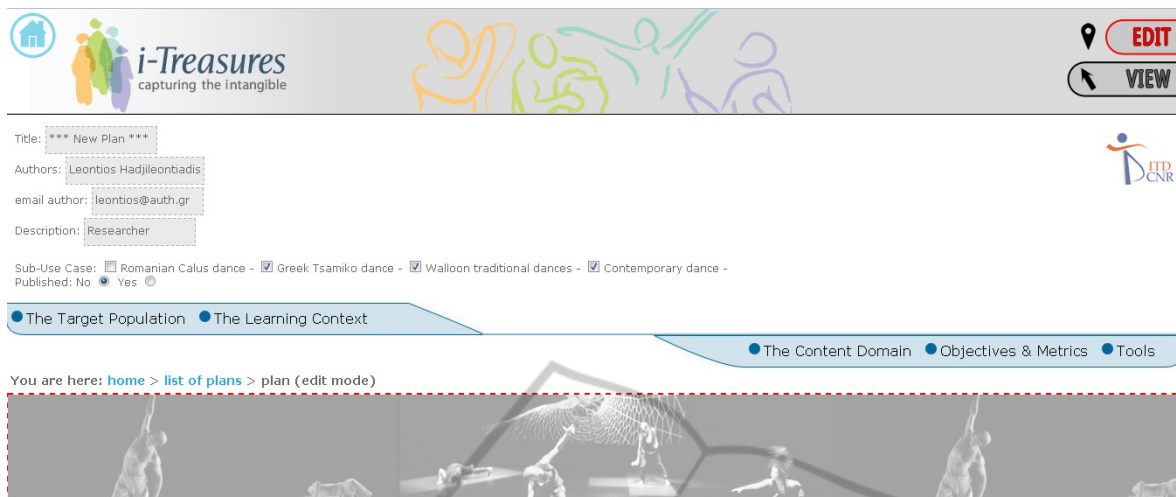
Figure 2: The main page of the Pedagogical Planner within the i-Treasures project (http://i-treasures.itd.cnr.it/).

To exemplify the combination of the *FuzzyQoI* model with the Pedagogical Planner two cases that resemble the use-cases of the i-Treasure project, i.e., the rare and contemporary dances, are used as paradigms and described in the subsequent section.

## 3 THE DANCE PARADIGMS

The data used for the dance paradigms were drawn from the Faculty of Human Kinetics (FHK), University of Lisbon, Portugal, where the corresponding dance disciplines are realized within the b-learning context.

The data were categorized into two types, that is, the ones that relate with documental analysis regarding the pedagogical instruction of the disciplines (e.g., curriculum, teachers' planning strategies, online material) and the others coming from the LMS Moodle platform. The former were used to formulate transcribed C-Maps with the MindMup software (see Section 2.2), whereas the latter were used as input to the *FuzzyQoI* model for the estimation of the QoI for each user (teachers/students) per week. For each paradigm, the data from two teachers (combined teaching) and 10 students were used and analyzed for the duration of two academic semesters (S1: weeks 2-16, S2: weeks 23-38).

### 3.1 Rare Dances Planning

Rare dances at the FHK, actually, belong to the Social Dances discipline, which aims to provide and develop ways to dance, able to contribute to a students' education in a more complete, comprehensive and multifaceted way, through the diversity of approaches and multiplicity of perspectives developed in each dance form.

Moreover, the social dimension and respect of the act of dance are taken into account to enhance the knowledge and extend the application domain with multicultural approaches, revealing the nature and specificity of their contents. For example, dances from Greece (e.g., Tsamiko, Omonia), Belgium (e.g., Schaatsenrijdersdans), Servia (e.g., Savila Se Bela Loza, Vlaški) and other folklore expressions worldwide are approached and examined.

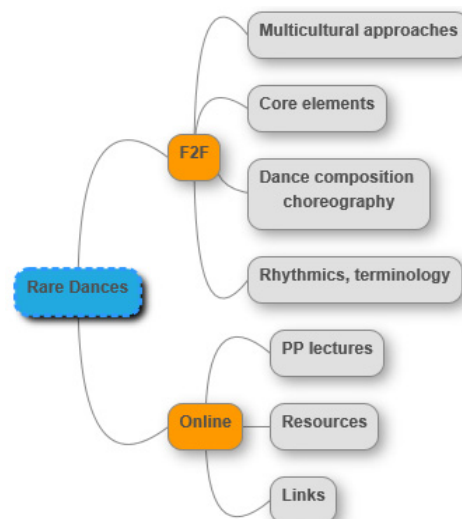The planning of this discipline aims to construct



Figure 3: The MindMup output of the pedagogical planning of the rare dances context followed throughout the S1.

a place of experience and experimentation with different materials, choreographic and contextual, along with specific techniques for analysis, leading to "know-how" and the enlargement and consolidation of formal and expressive repertoire of the students.

To achieve the above goals within the b-learning context, both F2F and online learning activities are constructed. Figure 3 illustrates the pedagogical planning of the S1 in the form of the MindMup output, where the F2F and online components are shown in the form of connected branches.

## 3.2 Contemporary Dances Planning

Contemporary dances at the FHK are included in the Techniques of Theater Dances discipline, which aims to promote the analysis and study of motor vocabulary characteristic of modern and classical dance forms. The pedagogical planning includes practice of standardized modeling steps organized in simple exercises with repetitions and chained in sequence dances increasing complexity. Moreover, training skills of observation in situations of mutual learning, are also considered, being consistent with the principles and quality of dance movements.

Under this discipline, it is intended that students will be able to: know the fundamentals of the techniques of theatrical dance; perform the basic vocabulary of theater dance techniques addressed with correction at the level of bodily vectors and dynamic; play with fluency and accuracy through demonstration sequences danced in technical context; identify, characterize and describe the specific motor skills techniques dance theater addressed; cooperate with colleagues in group tasks; interact with faculty and/or colleagues by actively participating in the tasks; assess their technical performance and that of others and their participation in groups.

As in the case of rare dances, the above goals within the b-learning context are achieved by constructing both F2F and online learning activities, within a corresponding pedagogical planning of the S1, in the form of the MindMup output, depicted in Figure 4.

## 3.3 Estimated QoI Feedback & Pedagogical Planning Updating

The LMS Moodle users' interaction data for S1 and S2 were fed to the FuzzyQoI model that outputted the corresponding estimated QoIs, i.e., $QoI_{S1,S2}^{RD/CD_{P,S}}$,
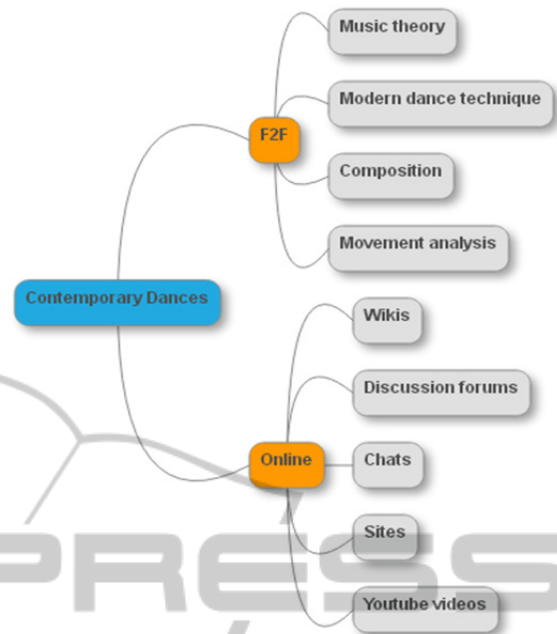


Figure 4: The MindMup output of the pedagogical planning of the contemporary dances context followed throughout the S1.
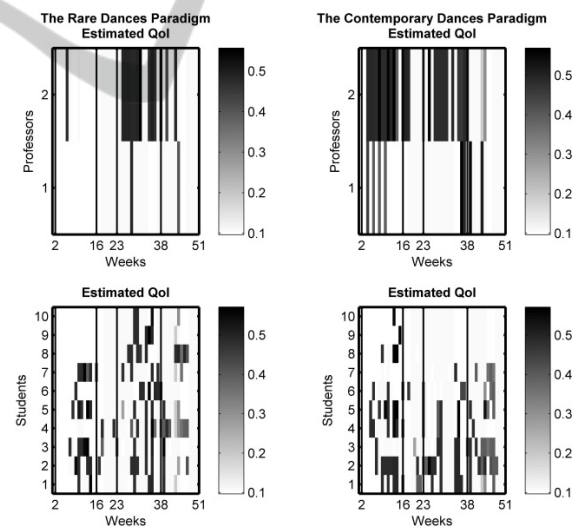


Figure 5: The distribution of the estimated QoI of the rare dances (left column) and contemporary dances (right column) paradigms and corresponding users (professors: top, students: bottom). The S1 and S2 are denoted on the graphs with the vertical solid lines located at weeks 2 and 16 (S1) and weeks 23 and 38 (S2).

where the superscripts RD and CD indicate rare and contemporary dances, respectively, and P and S refer to professors and students, accordingly. The analytically estimated QoIs for both semesters and paradigms are holistically illustrated in Figure 5,

whereas the corresponding mean values are depicted in Figure 6.

Although shown in Figures 5 and 6 in a sequential way, the $QoI_{S1}^{RD/CD_{P,S}}$ values were solely presented to the corresponding teachers as a feedback at the end of S1, so they could reflect on these and readjust/update their pedagogical planning for the S2, accordingly, resulting, hence, in the derived $QoI_{S2}^{RD/CD_{P,S}}$ values shown in Figures 5 and 6. This updating process and its effect upon the pedagogical planning is presented in Figures 7(a) and 7(b) for the cases of rare and contemporary dances, respectively. As it is apparent from Figure 7, and in comparison with Figures 3 and 4, the feedback from the estimated QoI has led to changes in the pedagogical planning, particularly to the online components, in an effort to increase and/or sustain the users' LMS QoI of S2 at higher levels than those of S1.
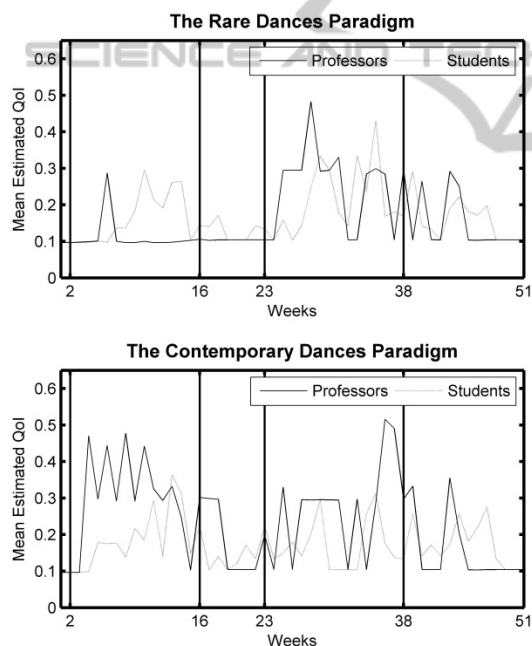


Figure 6: The mean estimated QoI of the rare dances (top panel) and contemporary dances (bottom panel) paradigms and corresponding users (professors: black line, students: gray line). The S1 and S2 are denoted on the graphs with the vertical solid lines located at weeks 2 and 16 (S1) and weeks 23 and 38 (S2).

# 4 DISCUSSION

From the Figure 5 (top panel) it is clear that the two teachers incorporated in each discipline delivery had a dissimilar behavior, regarding their QoI with the LMS. In particular, for the case of rare dances Professor #1-RD exhibited sparse interaction with the LMS, located at the beginning of S2 and after it, where as a significant change is noticed in the QoI of Professor #2-RD, who just initiated the LMS-based process at the beginning of S1 and after the QoI feedback she notably increased her QoI. For the case of contemporary dances, Professor #1-CD showed a quasi-periodic interaction with LMS at the beginning of S1, abandoned at the mid of S1 and almost for the whole duration of S2, exhibiting an increased QoI just before the end of S2. On the contrary, Professor#2-CD, showed almost a constant interaction with the LMS, exhibiting her high QoI values almost across the whole S1 duration and towards the end of S2. Regarding the students' QoI values, they were higher at S2 rather than in S1 for the rare dances case, whereas the opposite effect was noticed for the contemporary dance case.

Focusing at the mean estimated QoI of Figure 6, it is clear that the effect of the professors' QoI feedback was higher in the case of the rare dances (top panel) than the case of contemporary dances (bottom panel). Clearly, in the case of the rare dances, the sole peak of QoI at week 5 for the whole S1 has been extended to more sustained QoI values across S2, peaking also at the ~0.5 after the beginning of S2. This change in professors' QoI probably can be connected with the noticeable change in the students' QoI. In fact, at the S1, a hysteresis-like effect is noticed, as students' QoI starts growing only after professors' peak at week 5, peaks around the mid of S1 and tends to a decay towards the end of S1. On the contrary, the performance is totally different in S2, as the students show a tendency to exhibit synchronized QoIs with the ones of the professors, justifying the updated role of the LMS part in the b-learning activities during S2. In the case of contemporary dances, the hysteresis-like effect is seen between the professors' and students' QoI during S1, where despite the high QoI of the professors, the students QoI exhibits a slow increase towards the end of S1, whereas the updating of the pedagogical planning by the professors for the S2 has contributed mostly to the synchronization between the professors' and students' QoIs. In both cases, the professors acted in a reflective way by adjusting their pedagogical planning for the S2 and exhibited increased QoI (in both cases the QoI peaks are located within the S2).

Turning to pedagogical planning updating process of Figure 7, the shift towards more interactive and appealing online resources (e.g.,
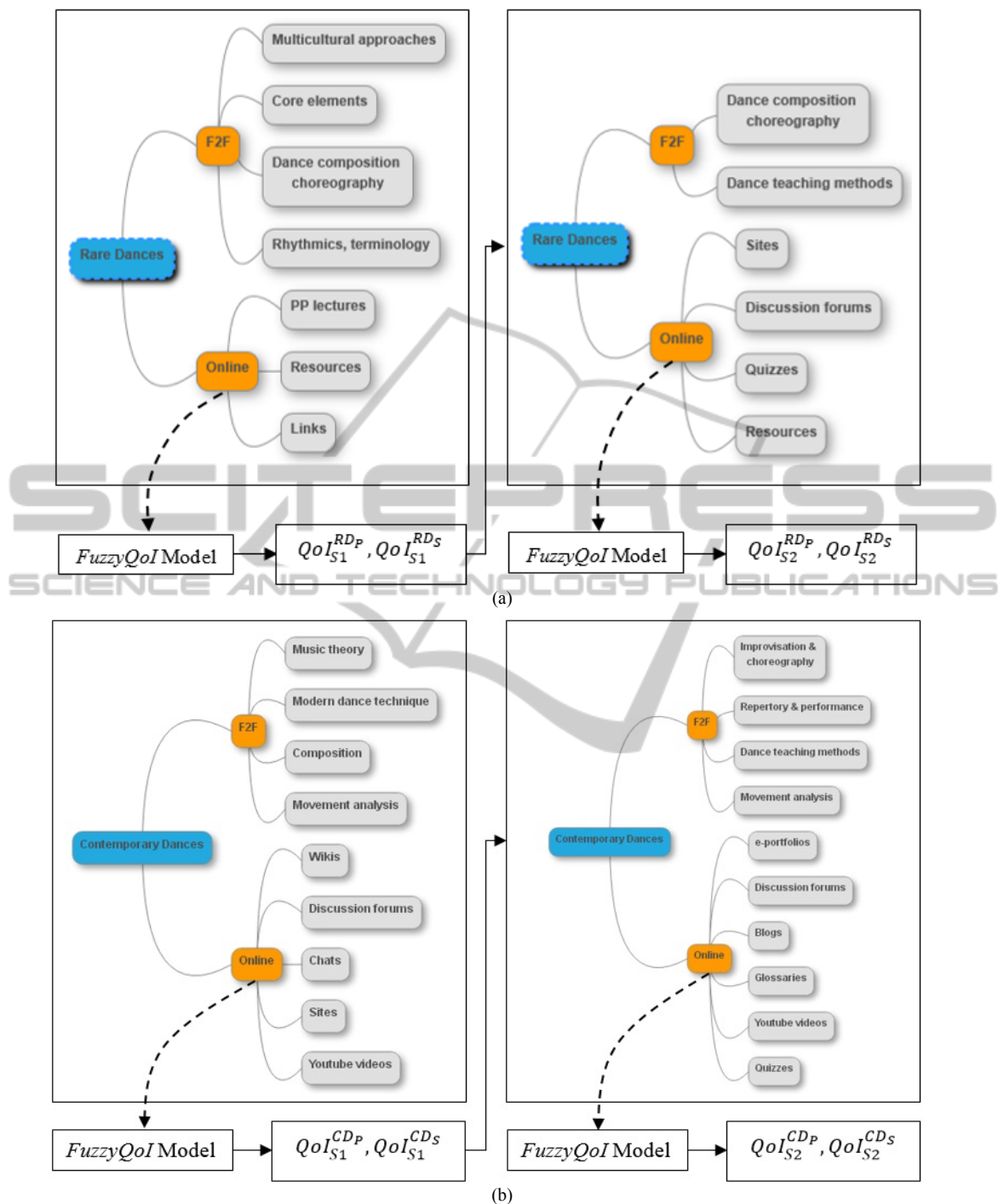
Figure 7: A schematic representation of the way the estimated QoIs by the FuzzyQoI model from the S1 were used as teachers' feedback to update the pedagogical planning of S2, along with the updates of the MindMup outputs from the initial version (followed throughout the S1-left) to the updated one (followed throughout the S2-right), for (a) the rare dances and (b) contemporary dances paradigms.

quizzes, discussion forums, blogs, videos, e-portfolios) has turned the interest to LMS interaction, seeing the latter as a more enhanced source of information, which could accompany the

F2F interaction and complement the effort towards multifaceted way of learning.

From the paradigms presented here it is apparent that the proposed approach could be extended to

various educational scenarios and use-cases (within and outside the i-Treasures project), posing a dynamic character to the role of LMS towards an intelligent LMS (Dias et al., 2014), assisting both teachers and students to enhance the quality of the educational environment.

# 5 CONCLUSIONS

An effort to combine the process of pedagogical planning within the b-learning context with the users' QoI with the LMS as an effective feedback was presented here. A fuzzy logic-based modeling approach, namely *FuzzyQoI*, was adopted to provide reliable estimates of the QoI (both for teachers and students) across two semesters of two academic teaching of dance disciplines, including rare and contemporary dances, respectively. The latter were chosen as paradigms that comply with the educational scenarios of the i-Treasures project referring to the ICH, showing the potentiality to shift towards a more dynamic design of the educational scenarios and strategies, incorporating the inherent tendencies and attitudes of the users within the b-learning context.

# ACKNOWLEDGEMENTS

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