A Collaborative and Adaptive Design Pattern for the 'Students Team Achievement Divisions' Method:

An implementation within Learning Design-Based e-learning Systems

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***Abstract*—**This paper presents an innovative description of the "Students Team Achievement Divisions" [1] collaboration method, in the form of an online, adaptive collaborative design-pattern that has been constructed taking into account adaptation techniques, within the context of open-source learning design-based environments such as the Learning Activity Management System [2]. This method is described with special reference to the learning of essential issues in Computer Science and especially in the area of Information Systems. These issues include an understanding of: (a) the realization of the importance and the reasons of using Information Systems in big industries and organizations, (b) the familiarization of students with the practical uses of Computer Science and especially of the uses of Information Systems, and (c) realization of the wide impact of Computer Science in the human life and especially in the work place. The innovative description of the aforementioned collaborative method within the Learning Activity Management System is based on the fact that: (a) the tasks assigned to the groups consist of investigation of real world scenarios, and not merely the study of learning material as is usually proposed, (b) adaptive techniques are integrated with the method and (c) for the design of the collaborative learning activity, an intuitive learning design tool such as the Learning Activity Management System is used.

Keywords-STAD; collaboration; design patterns; adaptation; LAMS

I. INTRODUCTION

Computer-supported collaborative learning has been recognized as an emerging paradigm of educational technology [3]. Specifically, research in e-learning shows that involving learners in online collaborative learning activities could provide them with essential challenges to: extend and deepen their learning experiences, try new ideas and improve their learning outcomes [4], motivate active involvement in their learning [5], trigger their cognitive processes [6], enhance their diversity in terms of the learning concepts in question [7] and develop a sense of community and belonging online [8]. Despite the above, many teachers remain unsure of why, when, and how to integrate collaboration into their teaching practices in general, let alone their online classes [9].

However, to encourage teams to achieve effective collaboration, some structuring may be useful [10]. To this end, it is proposed that using computer-supported collaborative design patterns is essential. A pattern is seen as something that will not be reused directly but can support the informed teacher in building up their own range of tasks, tools or materials, drawing on a collected body of experience [11]. Specifically, best pedagogical practices can be reflected in the formation of context-free 'design patterns' which could be shared across learning contexts and subject domains and essentially support online learning.

The concept of specific collaborative patterns could be well integrated into 'learning design'-based e-learning environments. A 'learning design' has been defined as the description of the teaching-learning process that takes place in a unit of learning, e.g. a lesson or any other learning event, such as a specific collaboration structure [12]. An important aspect implied within this definition is that teaching strategies could be conceptually abstracted from context and content, so that excellent instructional models can be shared and reused across educational contexts and subject domains. A 'learning design' represents the sequence of learning activities that need to be performed by teachers and learners within the context of a unit of learning. Within the context of 'learning design', the role of collaborative design patterns is explicitly to indicate the flow of collaboration activities using specific collaboration structures.

However, involving teachers in not only the implementation – by experts - of ready made lesson plans but also the design of their teaching sessions is thought to be essential. The essential role of appropriately-designed tools in supporting teachers in their mindful and appropriate 'learning design' has been acknowledged by many researchers [13-15]. It would appear clear that teachers need high level tools in order to understand learning design and it is likely that specialized tools for a particular pedagogic context would be easier to use [16]. To this end, it is acknowledged that the type of editor usually required by classroom teachers should be similar to the authoring environment provided by the Learning Activity Management

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System (LAMS) [2]. Specifically, LAMS is a well-known open source e-learning system that could effectively support the idea of 'learning design'. Recenly, a number of collaboration design patterns have been constructed within LAMS [17-19].

Modern constructivist learning theories suggest that learning is an active, constructive and subjective activity [20]. In the context of these theories, 'learning design' attempts have to seriously take into account individual learner differences in knowledge, skills, goals and preferences, and each individual learner's needs. Learners could therefore be supported in understanding the learning concepts in question when e-learning is coupled with appropriately-designed adaptation techniques [21]. Specifically, the use of adaptation techniques within e-learning systems can support each individual learner, taking into account some of their individual characteristics, i.e., learning styles, background knowledge including her/his alternative views and misconceptions about the learning concepts in question as well as their experience, goals and preferences. The architecture of adaptive e-learning systems usually consists of the 'learners' model', the 'subject matter model' - or expert model - and the 'learning model'. The latter consists of the aforementioned individual characteristics for each learner, the subject-matter model contains the aspects of the knowledge domain deemed appropriate for students' learning and the learning model consists of the instructional methods –including adaptation strategies- proposed as appropriate for the learning of the subject matter, e.g. the use of specific collaboration strategies.

Taking into account all the above, we have attempted to form the "Students Team Achievement Divisions" (STAD) collaborative method [1] into an adaptive collaborative design pattern within the context of LAMS to construct a sequence of learning activities for the learning of essential issues in Information Systems (IS) aiming: (a) the realization of the importance and the reasons of using IS in big industries and organizations, (b) the familiarization of students with the practical uses of Computer Science (CS) and especially of the uses of IS, and (c) the realization of the wide impact of CS in the human life and especially in the work place. Such a sequence of online, adaptive and collaborative learning activities for the learning of IS using the STAD method within LAMS - has not yet been reported.

The essential features of LAMS are briefly presented in the following section of this paper, followed by a description of the STAD collaboration method. Next, a sequence of online, adaptive, collaborative learning activities using STAD-within-LAMS with special reference to the aforementioned issues of learning about IS is demonstrated. Finally, the design of this sequence is discussed and conclusions and future research plans are drawn.

II. BACKGROUND

A. LAMS

LAMS (Learning Activity Management System; http://www.lamsfoundation. org/) is an open-source tool for designing, managing and delivering online collaborative learning activities. In fact, LAMS is a revolutionary environment that can support easy and intuitive learning design – appropriate for the learning of concepts within any subject domain - especially for professionals with no programming experience and knowledge, as is the case with most teachers at primary and secondary level [22]. Teachers are also provided with the ability to 'Preview' the learning activity sequences through the lens of a learner and make suitable adjustments after reflection. [23]. In addition, LAMS provides teachers with the chance to overview the entire sequence of learning activities on the computer screen and make appropriate revisions [22]. Furthermore, there are also possibilities for improvement of a sequence even while it is running online in real-time. It is also worth noting that, in the context of LAMS, the role of the teacher is not reduced to the role of a traditional behaviorist practitioner [24] who necessarily uses 'learning designs' ready-made by expert designers: in fact, LAMS provides teachers with possibilities to transform ready-made sequences of learning activities according to both their own personal views of learning and their students' individual learning characteristics. Collaboration could also be easily supported by using the possibilities of fine-grained grouping and branching. Within LAMS there are also possibilities for adapting a sequence of learning activities according to students' previous knowledge, their preferences and specific learning styles, by using appropriately-designed questionnaires in combination with suitable grouping and branching. Efficient learning design patterns could also be accessed by teachers using the Activity Planner integrated within LAMS. Various generic 'blank' learning sequences representing efficient collaboration learning strategies are also available from/for members of the LAMS community ([17-19], http://www.lamscommunity.org/lamscentral/). To this end, the community of learners built around LAMS could prove encouraging to teachers and designers of learning activities by providing them with opportunities to exchange experience and knowledge as well as their own sequences of learning activities.

LAMS also offers designers of educational activities specific tools that support grouping and conditional branching. In fact, the grouping can be random or based on either learner's or author's choice. Additionally, students can be directed to different sequences of activities depending on the group they belong to (grouped branching) or based on what the learner has contributed to a specific activity (tool output branching). LAMS can make branching decisions based on criteria such as the number of correct answers in a questionnaire, or the certain words that a learner has or has not typed into a chat, forum or survey activity. In any case, the author of the learning activity can assign students manually to any branch he likes. Nevertheless, Dalziel [2]

has commented on the absence of tools supporting broader ranges of collaborative tasks and, despite the availability of all the tools mentioned above, sequences of learning activities for the STAD collaboration method within LAMS – using adaptation techniques - for the learning of specific IS concepts have not yet reported.

The said sequence of collaborative activities was implemented using specific tools provided by LAMS: http://wiki.lamsfoundation.org/display/lamsdocs/Home. These tools are demonstrated in its interface and are briefly presented below:

The *Assessment tool* allows authors to create a series of questions with a high degree of flexibility in total weighting. The *Chat Activity* runs a synchronous discussion for learners while the *Scribe Activity* is used for collating the chat group's views on questions posed by the teacher. The *Forum Activity* provides an asynchronous discussion environment for learners, with discussion threads initially created by the teacher and the *Scribe Activity* is also used for collating Forum Postings into a written report. The *Mindmap activity* allows teachers and learners to create, edit and view mindmaps in the LAMS environment. The *Multiple Choice activity* allows teachers to create simple automated assessment questions, including multiple choice and true/false questions. The *Noticeboard Activity* provides a simple way to supply learners with information and content. The activity can display text, images, links and other HTML content. The *Question and Answer Activity* allows teachers to pose a question or questions to learners individually and, after they have entered their response, to see the responses of all their peers presented on a single answer screen. The *Share Resources* tool allows teachers to add content to a sequence, such as URL hyperlinks, zipped websites, individual files and even complete learning objects. The *Submit Files Activity* allows learners to submit one or more files to the LAMS server for review by a teacher. The *Survey Tool* presents learners with a number of questions and collects their responses. However, unlike Multiple Choice, there are no right or wrong answers. The *Wiki Tool* allows authors to create content pages that can link to each other and, optionally, allow learners to make collaborative edits to the content provided.

B. Student – Teams – Achievement - Divisions (STAD)

STAD [1] is considered to be one of the basic approaches to introducing learners to cooperative learning. The use of this method is thought of as an effective and efficient way to teach well-defined educational subjects. The teams are heterogeneous, made up of learners of diverse academic achievement, race, and nationality. The rewarding of the best teams motivates the better students in a team to encourage the other members to achieve their mutual goal.

Goals: 1) to motivate students to encourage and help each other, 2) to accelerate student achievement, 3) to facilitate gains in self esteem, liking of class, 4) to improve behaviour.

Process: 1) Personal assessment, 2) Assignment presentations, 3) Team collaboration, 4) Collaborative writing of reports, 5) Team assessment, 6) Praise for best reports.

C. Adaptation

A four-stage process has been proposed for the design of an adaptive system [25]: (i) design of the 'knowledge-base', including a hierarchy of learning goals and specific learning topics, (ii) design of the 'learner's model', including her/his individual learning characteristics and preferences, (iii) design of the 'media space', including various materials and topics which are interconnected with the topics included in the previously mentioned knowledge-base, and (iv) design of the 'adaptation model', including the rules for the selection of appropriate topics - from both the knowledge-base and the media space - taking into account each learner's individual characteristics as they emerge from the relevant 'learner model'.

As regards the construction of the 'learner model', the learner's profile in terms of her/his knowledge-background and experience, goals, preferences and learning style must be investigated. To this end, the learners' background and experience with regard to the knowledge in question is useful to explore, because learners with different backgrounds need different treatment from the system. In fact, the learner's knowledge has to be diagnosed before they can be characterized as novices, intermediate or experts; their goals and preferences should also be examined. The basic learning style of each individual learner also plays a fundamental role in finding ways to support them in their learning. In terms of learners' learning styles, various classifications have been proposed. Some important classifications separate learners as field-dependent (F/D) and field-independent (F/I; [26]), some view learners as holistic-analytic and verbalizers-imagers [27], while others sort learners into activists, pragmatists, reflectors and theorists [28]. These individual characteristics are usually explored through the completion of a questionnaire immediately after their entrance into the e-learning system.

To this end, the system could be adapted in various ways to support learners in their learning, namely: (a) adaptive presentation, and adaptive navigation techniques [29-30] - these techniques are usually proposed for the design of adaptive hypermedia educational materials, where sequences of web pages are created and the adaptation could be implied at both content level and link level, (b) adaptive sequencing curriculum, where sequences of educational materials are formed and proposed to the learner by the system according to her/his individual characteristics [31] (c) problem solving support - here, too, three modes of support have been reported: (i) intelligent solution analysis, where the ideal solution to a problem is compared with the solution provided by the learner and appropriate feedback is given by the system, after the problem-solving process has been completed, (ii) interactive problem solving support - here, the system monitors the learner's problem-solving path and provides appropriate feedback during the problem-solving process, and (iii) example-based problem solving [21], where an appropriate repository of examples is provided by the

system, to support each learner's problem-solving actions, and (d) collaboration support, where the system can use the learners' personal characteristics to support the creation of appropriate groups for collaboration and communication to deal successfully with suitable learning activities [32].

Adaptive techniques are also useful for the design of tests used for the assessment of learners' knowledge throughout the course of a learning experiment. Such tests are generated by the system according to each individual learner's knowledge. For example, when a learner successfully answers a set of questions - appropriate for the assessment of a piece of knowledge - then the system provides questions aiming to assess another, probably more complicated, piece of knowledge. Contrarily, when a learner does not succeed in answering a set of questions, the system provides her/him with easier questions and various kinds of help.

In the next section of this paper, the design of the STAD adaptive online activity within LAMS is presented.

III. DESIGN OF THE STAD ADAPTIVE ONLINE LEARNING ACTIVITY

The design of the adaptive online STAD learning activity consists of the following phases: 1) Introduction to the learning activity, 2) Personal assessment 3) Group Formation, 4) Team collaboration, 5) Group report preparation, 6) Group report presentation, 7) Team assessment, 8) Individual assessment, and 9) Praise for best group reports. The implementation of these phases within the context of LAMS is diagrammatically represented - as an 'adaptive design pattern' - in Figure 1. The proposed activity can be used in environments of synchronous and asynchronous collaborative learning.

Phase 1: Introduction to the learning activity

The main aim of this educational activity is encouragement of learners, through their interaction within an adaptive collaborative learning environment, to explore fundamental issues concerning CS and especially of IS. Additionally, through the learners' efforts to fulfill educational objectives, some secondary skills are developed, e.g. a) the practice of word processing and presentation software, and b) the practice of web searching techniques. The learning activity also aims to highlight the value of collaborative learning as a modern method of teaching. To fulfill the aforementioned learning aims, students have to collect diverse data types by visiting significant areas of life where IS are used, such as: (a) a financial organization, e.g. a bank, (b) a private company, (c) a public organization, (d) a health care organization, e.g. a hospital, e) a university lab specializing in IS, and (f) an IS development company.

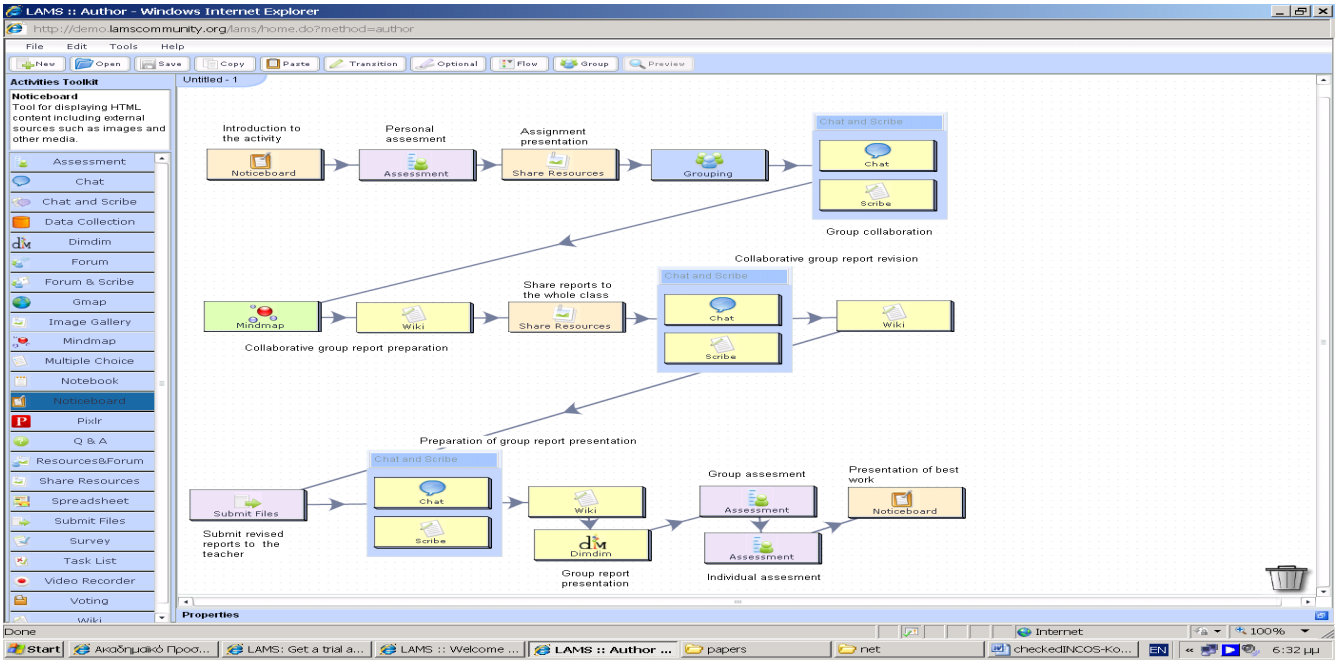

Figure 1. Implementation of the adaptive STAD as a design pattern within LAMS

Here, it is worth noting that the usual process of data collection in school environments is the study of given literature or web searching. In fact, pragmatists can learn through practical activities – e.g. in a financial organization - where they can observe how IS are applied; activists can gain knowledge by being involved in interactive learning activities (e.g. in a private company), reflectors can learn through various IS examples – e.g. reflecting on their experience within a university IS lab - and theorists can absorb knowledge through exploring theoretical materials available in a university CS department. Other appropriate types of content could also be provided for online study.

By visiting the aforementioned real life areas, students should be able to collect data on the following issues regarding each specific IS in use: (a) needs covered and solutions given, (b) specifications, (c) cost, (d) benefits, (e) infrastructure, in terms of types and number of computers as

well as kind of networks used, (f) updates performed, (g) validity, (h) maintenance and support, (I) possible/necessary future improvements, and (j) the hiring and firing needed after the use of the IS at hand.

Students should ask the users of each specific 'IS' about such interesting issues as: (a) their background of knowledge about computers, and (b) how their jobs - in terms of tasks, health and socialization - have been changed due to the evolution of the specific IS in their work place. By visiting a company that develops IS, students should ask questions regarding: (a) stages of the development of an IS, (b) initial specifications, (c) programming languages used, (d) debugging, (e) documentation, (f) operator-training, and (g) support. In this phase of the STAD activity, students are informed - using a Notice board - about the whole context of the activity, including its aims and the specific issues of IS that have to be studied during this activity as well as the various places where they could collect appropriate data. Students should exchange ideas on the whole procedure of the activity using a whole-class Forum/ Chat-room.

Phase 2: Personal assessment

The proposed design utilizes the 'Assessment' tool for the investigation of students' preferences (in terms of areas of life about which they like to collect information on IS) and their main learning styles.

Phase 3: Adaptive group Formation

Students have to be grouped in such a way that each group consists of students of diverse preferences and main learning styles as emerged from their answers to the aforementioned survey. The formation of such groups could be supported by the system, using the grouping tool in combination with the branching tool. In case of dispute, the students who prefer to be in another group could ask the educator to assign them accordingly.

Phase 4: Adaptive Group collaboration

Each group must visit the specific areas of life mentioned in the 'Introduction' to the activity, where IS are used, to collect specific data. The system can advise the students of each group on the selection of these areas by using the data referring to their main learning styles and preferences [33]. Next, every member of each group should pursue a specific sub goal of the proposed learning activity through their participation in the group work. Students in each group should share the information they collected on various areas of life during their personal attempts. Then, they can communicate to exchange ideas about this information (using a forum or a chat room), find key ideas and organize appropriate data categories, using the Mind mapping tool.

Phase 5: Collaborative group report preparation

In this phase, students have to prepare a report by using the wiki tool. Next, they have to send this report to the other groups to receive appropriate comments. Then, they can decide whether to take these comments into account and to reply to these groups accordingly. Each group should assess the quality of the evaluation comments of the other groups on their own report [34]. Finally, groups should submit their corrected reports to their teachers.

Phase 6: Group report presentation

Here, it would be useful to provide students with some recommendations as to how to prepare and deliver a good presentation. Some useful guidelines for the former are: (a) the presentation must begin with the main idea of the subject, (b) only the key points of the subject should be presented, (c) on every slide, only 4-5 key points should be presented, (d) a uniform style of presentation must be followed (unnecessary effects must be avoided since these distract the learner from the key concepts), (e) the duration of each presentation should be around 10 minutes (for synchronous presentation) since there is always the danger the students may get bored. There will be additional time for further discussions. Online presentations could be performed by each group, using a whole-class chat or forum or the dim dim videoconferencing tool.

Phase 7: Team assessment

During the online presentation, the teacher can initiate a 'question and answer' session to encourage students to assess the work and the presentation of each team. Each group has also been assessed about its work as evaluator of the reports of the remainder of groups.

Phase 8: Adaptive individual assessment

In this phase, each student should be set an adaptive quiz - once the learning activity is concluded - for purposes of assessment. The students cannot help each other during the testing process. The educator could use the "assessment" tool in combination with branching techniques - based on tool output branching capabilities of LAMS tools - to design suitable questions for students of different levels of knowledge and of different learning goals. The question types can be of multiple choice, true-false and open types.

Phase 9: Praise for best group reports

In this final phase, the best group work - as assessed by their colleagues and their teacher - will be published with honors.

IV. SUMMARY AND FUTURE WORK

This paper proposed an innovative approach to the STAD collaborative method, taking into account adaptation techniques, within the context of online learning-design based learning. In fact, an adaptive online collaborative design pattern of the STAD method has been formed within LAMS, a well-known open source learning-design based system. The design of this pattern was also presented through a specific collaborative STAD-activity for the learning of essential issues in the area of Information Systems. The innovative description of the STAD collaborative method is based on the fact that: (a) the activity takes place in the online context, (b) the tasks assigned to groups emphasize investigation of real world situations, (c) adaptive techniques are integrated and (d) an

intuitive learning design tool such as LAMS is used for the design of the collaborative learning activity. For the evaluation of the proposed adaptive, online, investigative, collaborative STAD design pattern, further research with real online learners is necessary, and this forms the basis of our future research plans.

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