# Adapting the Collaborative Strategy 'Students Team Achievement Divisions' in an Information Technology Work Place

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**Abstract.** This paper presents an innovative description and an initial implementation of the "Students Team Achievement Divisions (STAD)" collaboration method (Slavin, 1978), in the form of an online adaptive collaborative design-pattern that has been constructed taking into account adaptation techniques, within the context of an open-source learning design-based environments such as the LAMS system (Dalziel, 2003). This method is described with special reference to the learning of essential aspects of an Information System. The innovative description of the aforementioned collaborative method within the LAMS 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 LAMS system is used. A research study was also conducted aiming the development of an empirical model to allow the implementation of the aforementioned adaptive STAD collaborative method within the context of an IT work place, namely; the Legal Council of the Hellenic State. In fact, the data gathered from this study were used to build the initial learning profile of the user –that is needed for the implementation of Phase 2 of the previously mentioned adaptive STAD collaborative method- so that to be able to provide him/her personalized training, monitoring, scaffolding and evaluation.

## 1 Introduction

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 (Roberts, 2005), motivate active involvement in their learning (Scardamalia & Bereiter, 1996), trigger their cognitive processes (Dillenbourg, 1999), enhance their diversity in terms of the learning concepts in question (Johnson & Johnson, 1999) and develop a sense of community and belonging online (Haythornthwaite, Kazmer, Robins & Shoemaker, 2000). Computer-supported collaborative learning has been recognized as an emerging paradigm of educational technology (Koschmann, 1996).

To encourage teams to achieve effective collaboration, some structuring may be useful (Diggelen & Overdijk, 2009). 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 (McAndrew, Goodyear & Dalziel, 2006). 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 (Koper & Tattersall, 2005). 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 to explicitly indicate the flow of collaboration activities using specific collaboration structures. To this end, LAMS (Dalziel, 2003), is a well-known open source e-learning system that could effectively support the idea of 'learning design'. Recently, a number of collaboration design patterns have been constructed within LAMS (Kordaki and Siempos, 2009; 2010; Kordaki, Siempos & Daradoumis, 2011).

Modern constructivist learning theories suggest that learning is an active, constructive and subjective activity (Jonassen, 1999). 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 (Brusilovsky, 1996). 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 first one 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 transform the "Students Team Achievement Divisions" (STAD) collaborative method (Slavin, 1978) into an adaptive collaborative design pattern within the context of LAMS (Kordaki and Grigoriadou, 2010) to construct a sequence of learning activities for the learning of essential issues in Information Systems (IS) aiming at: (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. An initial proposal of the aforementioned sequence of online, adaptive and collaborative learning activities for the learning of IS using the STAD method within LAMS has been made in an IT work place, namely the Legal Council of the Hellenic State. Such an empirical research study has not yet been reported.

In the context of an IT work place, learners-employees may learn better and more effectively through an exploratory learning methodology and through collaboration in small groups, exchanging their personal experiences, helping each other, and learning/obtaining new knowledge together through experimentation, exploration, discovery, problem solving and critical thinking. To achieve effective collaboration we need to employ the STAD collaborative learning strategy with adaptive capabilities in order to provide learners with personalized training, monitoring, scaffolding and evaluation. Our ultimate aim is to develop a research methodology and an empirical model that will allow the implementation of an adaptive and intuitive learning system that will be based on the STAD collaborative learning strategy and which will be used to provide personalized training to learners-employees who are users of an IS and wish to obtain more knowledge about particular aspects of it.

The essential features of LAMS are briefly presented in the following section of this paper, followed by a brief description of the STAD collaboration method. Then, a sequence of online, adaptive, collaborative learning activities using STAD-within-LAMS with special reference to the aforementioned issues of learning about IS is presented. Next, a research study is reported which addresses the way the 2nd phase of the STAD method should be implemented within a work place. Subsequently, the design of this sequence and of the results emerged from the aforementioned empirical study are discussed. Finally, conclusions and future research plans are drawn.

## 2  Background

### 2.1  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 (Cameron, 2007). 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 (Cameron, 2006). In addition, LAMS provides teachers with the chance to overview the entire sequence of learning activities on the computer screen and make appropriate revisions (Cameron, 2007). 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 (Skinner, 1968) 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 (Kordaki and Siempos, 2009; 2010), 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 (2003) 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[1]. 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.

## 2.2   *Student – Teams – Achievement - Divisions (STAD)*

STAD (Slavin, 1978) 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.

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[1] http://wiki.lamsfoundation.org/%20display/lamsdocs/Home

The design of an adaptive STAD method, as it is proposed by our approach, is described in detail in Section 3.

## 2.3 Adaptation

A four-stage process has been proposed for the design of an adaptive system (Brusilovsky, 2003): (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; Witkin, Moore, Goodenough & Cox, 1977), some view learners as holistic-analytic and verbalizers-imagers (Riding & Cheema, 1991), while others sort learners into activists, pragmatists, reflectors and theorists (Honey & Mumford, 1992). These individual characteristics are usually explored through the completion of a questionnaire immediately after their entrance into the e-learning system.

A system can be adapted in various ways to support learners in their learning, namely: (a) adaptive presentation, and adaptive navigation techniques (Kay & Kummerfeld, 1997; De Bra & Calvi, 1998) - 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 curriculum sequencing, where sequences of educational materials are formed and proposed to the learner by the system according to her/his individual characteristics (Brusilovsky & Pesin, 1994), (c) problem solving support - here, two, 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 (Brusilovsky, 1996), 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 (Brusilovsky, 1999).

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. On the contrary, 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, we will describe all the phases of the STAD method in detail, how some of these phases can include adaptivity aspects and how they have been designed within the LAMS system.

## 3   Design of an Adaptive STAD Online Learning Activity in LAMS

The design of the online STAD learning activity consists of the following phases: 1) Introduction to the learning activity, 2) Personal assessment 3) Adaptive group Formation, 4) Adaptive individual learning and team collaboration, 5) Adaptive group report preparation, 6) Group report presentation, 7) Team assessment, 8) Adaptive individual assessment, and  9) Praise for best group reports. The implementation of these phases within the context of LAMS is diagrammatically represented - as a 'design pattern' - in Fig. 1. The proposed activity can be used in environments of synchronous and asynchronous collaborative learning. The aim of this section is not to describe the details of each phase which is a long and under construction endeveour. Instead, we provide a brief description of each phase and describe phase 2 in detail, which constitutes an important step to achieve the adaptivity of the STAD method.

### 3.1   Phase 1: Introduction to the Learning Activity

The main aim of this educational activity is the encouragement of learners through their interaction within a 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.
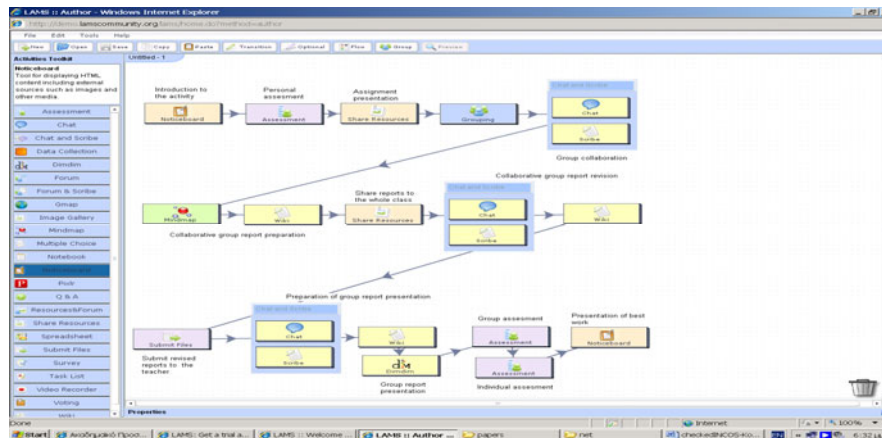
**Fig. 1** Implementation of the adaptive STAD as a design pattern within LAMS

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.

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.

## 3.2   Phase 2: Personal Assessment

The proposed design utilizes the 'Assessment' tool for the investigation of students' main learning styles and their basic preferences (in terms of areas of life about which they like to collect information on IS). Our work in this chapter focuses on implementing an approach that is able to determine students' preferences, and most importantly, to explore a variety of learning styles and assign to each student his/her primary and secondary learning styles that best characterize them. This approach is described in detail in Section 4.

   We pay a particular attention to an effective and accurate identification of students' learning styles, since this is both an important prerequisite to build a robust student learning profile and a criterion to assign students to working groups. Certainly, another important aspect of the student learning profile and group formation is student's preferences, though in this chapter we deal only with some basic preferences, since it constitutes a separate long issue.

   The construction of a rich and well-structured student profile is crucial for achieving adequate adaptations in several phases of the application of the STAD method, so other aspects that our approach wants to incorporate in the student profile are student's specific preferences of the subject matter, student's knowledge and experience, student's interests and abilities, and other aspects that concern everyday working tasks, socialization habits and health issues. All these issues constitute interesting research topics and are currently being investigated by our work.

## 3.3   Phase 3: Adaptive Group Formation

Students have to be grouped in such a way so that they form heterogeneous groups of 5-6 members which are best adapted to the students' needs and goals. To achieve the best adaptation to these prerequisites, we use a variant of the *collaboration support* adaptive method to instruct the system to consider two basic criteria: assign students to a group with the same primary learning styles but with different preferences as these are depicted in each student learning profile constructed in the previous phase. As such, on the one hand, students feel comfortable in a group that all its members have a similar way of learning so the feeling is that they will collaborate and learn better. On the other hand, the fact that the group respects their personal preferences, this satisfies their personal needs and goals as well, since work and learning will focus on these particular needs while the diversity of preferences enhances discussion, interactivity, willingness to learn from one another, all in all it promotes collaboration!

The formation of such groups is 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.

### 3.4  Phase 4: Adaptive Individual Learning and Group Collaboration

When each group is formed, its members should visit the specific areas of life mentioned in Phase 1 'Introduction to the learning activity', where IS are used, to collect specific data. The system can advise the students of each group on the selection of a specific area by using the data of the student profile referring to their particular preferences and primary learning styles (Papadimitriou, Grigoriadou & Gyftodimos, 2008).

As such, each group member sets a specific goal to accomplish and the system instructs him/her how to carry it through in the most adequate and personalized way. To do so, the system is based on specific aspects of the student's learning profile - such as the student's specific preferences of the subject matter, student's knowledge and experience, student's interests and abilities, and other aspects that concern everyday working tasks, socialization habits and health issues - in order to design the learning path which is most adapted to the student's learning profile.

In other words, using these aspects, the system applies a variant of the *interactive problem solving support* adaptive method to direct, supervise and monitor student's work and learning in the area of his/her preference and to provide appropriate feedback during the learning path process. In particular, the system can recommend the student in which topics should focus his/her study, what material to search (providing also material that the system itself has available), which tasks should carry out and how, which skills and competencies needs to work out or develop in order to succeed in his/her workplace, which socialization habits needs to change, and finally which health issues needs to take into account.

Then, when students come back to their group they should join their forces to achieve the goal of the proposed learning activity through participation in group work. To this end, students in each group should first share the information they collected and the knowledge acquired on the specific area of life they visited during their personal work. The system is assisting students to form small subgroups of two or three members by identifying common points in their profile, so that they perform a focused work on specific topics of the activity. Doing so, collaborative work and learning can be adapted using the *adaptive curriculum sequencing* technique, according to which the system can propose adequate sequences of complementary educational materials and tasks to each subgroup of learners.

Finally, all members get together in their group and exchange their expertise and experiences through a debate (using a forum or a chat room) which is monitored by a coordinator member assigned by the group itself, aiming at completing the proposed learning activity. Tools like a Mind or Concept Mapping tool may be used to identify key ideas and organize appropriate data categories.

### *3.5   Phase 5: Adaptive Collaborative Group Report Preparation*

In this phase, students have to work together in their group to prepare a report by using a wiki tool. Then, they have to send this report to other review groups to receive appropriate comments. The selection of the adequate review groups to send the report is guided by the system that uses a variant of the *collaboration support* adaptive method to support the selection of appropriate groups for collaboration and communication, according to the groups' working profile. Doing so, it is more probable that the selected groups can provide suitable and constructive comments to the report. Subsequently, each group should assess the quality of the evaluation comments of the review groups on their own report and can decide whether to take these comments into account and to reply to the review groups accordingly (Gouli, Gogoulou & Grigoriadou, 2008). Finally, groups should submit their corrected reports to their supervisors.

### *3.6   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 that 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 a videoconferencing tool.

### *3.7   Phase 7: Team Assessment*

During the online presentation, the supervisor can initiate a 'question and answer' session to encourage students to assess the work and the presentation of each team. Each successful answer is annotated in the group's working profile, which finally provides a means to classify groups according to their performance.

### *3.8   Phase 8: Adaptive Individual Assessment*

In this phase, each student should be given an adaptive quiz that aims at assessing the student individually and thus conclude the learning activity. The quiz is adapted according to two main criteria: the student's learning profile which has been updated during the whole learning process and the performance success of the student's group that was built up in the previous phase. Thus, the supervisor can use the "assessment" tool in combination with branching techniques - based on tool output branching capabilities of LAMS - to design suitable questions for

students of different levels of knowledge, different learning goals, etc. The question types can be of multiple choice, true-false and open types.

Questions are generated one-by-one, so that the creation of the next question depends on the success of the previous answer. As such, in case of successful answers, the system keeps on presenting more questions until all the topics are covered, whereas in case of a failure the system provides the student various kinds of help.

### 3.9 Phase 9: Praise for Best Group Reports

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

## 4 Implementing the 2nd Phase of the Adaptive Collaborative Method STAD: Determining Learners-Employees' Learning Styles within the Context of an IT Work Place

### 4.1 Aims of the Approach

All the phases that constitute an adaptive STAD method have been described in the previous section. This section focuses on the implementation of the 2nd phase of STAD. This is an important step in our effort to build a complete student learning profile that is crucial for achieving suitable adaptations for the full implementation of STAD. As such, we initially need to extract knowledge about two main issues that concern the learner-employee profile: first, the learner-employees' main and secondary learning styles, and second the learners' preferences as regards the Information System (IS) of a specific working environment that the learner would prefer to experience and learn about. The aim of the current study focuses more in identifying and classifying employees' learning styles in an IS-based working environment, though some basic employee's preferences and interests are also explored.

This work took place in the central department of the Legal Council of the Hellenic State (LCHS). Employees belong to several departmental sections and are all users of the IS. To find the employees' learning styles, preferences and interests regarding IS aspects, we designed two specific questionnaires, both of them with closed-type questions, following a five-point Likert scale. Both questionnaires were given to the employees and those that were answered back were then evaluated and commented subsequently. The following sections describe the methodology and results obtained for the case of learning styles. More specifically, Section 4.2 provides the context where our research work took place, and explicitly sets the research objectives pursued. Next Section describes the methodology employed and the user aspects that were considered and evaluated. Section 4.4 presents the results of the survey, using adequate graphs and tables, as well as the explanation and interpretation of these results in detail. Then, in Section 4.5 we draw the final conclusions.

   Both learning styles and preferences were used as the criteria to construct the learning teams. Each learning team consists of 5-6 members who have the same learning styles but different preferences. These results constitute the input data to build a complete learner profile module, which forms an important component of our adaptive, collaborative learning/training model. The final Section outlines the work done and makes reference to on-going and further work.

## 4.2   The Framework of the Legal Council of the Hellenic State

The Legal Council of the Hellenic State (LCHS) is a single supreme authority of the State and directly attached to the Minister of Economy and Finance. The duties of the Legal Council of the Hellenic State are the following:

- The legal advocacy of the interests of the Hellenic State and its legal support generally
- The support of the Greek Republic to the European Court of Human Rights and the European Court of Justice
- The support of the Administration Services on the Community law
- The guidance of the administration services with legal opinions
- The recognition of the claims against the government, the compromise of the disputes with the government and the adjustment of the debts of the debtor to the state
- To issue legal opinions for the guidance of the public administration
- The advocacy of the civil servants in criminal courts
- The advocacy of the public administration to the courts
- The processing of the legislation which are assigned to the Legal Council of the Hellenic State

The departments which participated in this work were the following: the personnel department, the accounting department, the secretariats, the registration department, the department of scanning and document processing, and the IT department. They are depicted in Table 1.

**Table 1** Description of the departments of LCHS participated in the research experiment

| ID | DEPARTMENT'S DESCRIPTION | EMPLOYEES | E-Q | E-Q/ EMPLOYEES % |
|---|---|---|---|---|
| 1 | The Personnel Department | 14 | 12 | 85.71 |
| 2 | The Accounting Department | 12 | 9 | 75.00 |
| 3 | The Secretariats | 22 | 17 | 77.27 |
| 4 | The registration department | 3 | 2 | 66.67 |
| 5 | The department of scanning & document processing | 13 | 12 | 92.31 |
| 6 | The IT department | 3 | 2 | 66.67 |
|  | **AMOUNTS** | 67 | 54 | **80.6** |

The above table presents the following Fields/Results: The department id and description are presented in the first two columns. The third column contains the number of the employees which are in the department, while the fourth column "E-Q" contains the valid processed questionnaires. Finally the last column estimates the percentage between "E-Q" / "EMPLOYEES".

## 4.3  Research Tools and Methodology

To build a well-grounded methodology for identifying valid user learning styles and preferences and further build a solid user profile, we were based on existing research concerning learning styles and preferences (Riding & Cheema, 1991; Honey & Mumford, 1992; Witkin, Moore, Goodenough & Cox, 1977; Liu & Ginther, 1999; Wyss, 2002). We identified seven most referenced and used learning styles, as they described below.

On the one hand, to extract information about possible learning styles that characterize the employees of an IS and, on the other hand, to find out their particular preferences about an IS and identify their interests about which components and uses of an IS they would like to learn about, a specific questionnaire survey was designed, including two different questionnaires. Both of them included closed-type questions using a five-point Likert scale. The final aim was to achieve an initial learner profile which can be used to implement the rest phases of the STAD method in an adaptive manner.

In sum, the two questionnaires evaluated the following 10 user aspects, as follows:

1. Some **personal characteristics** like their gender, education, age, etc.
2. The user learning style as a *field independent - field dependent* person
3. The user learning style as an *Imager* person
4. The user learning style as a *Verbalizer* person
5. The user learning style as an *Activist/Pragmatist* person
6. The user learning style as a *Reflector* person
7. The user learning style as a *Holistic/Analytic* person
8. The user learning style as a *Theorist* person
9. **User preferences** about the IS of a particular organization he/she would prefer to visit and the specific aspects of this IS that he/she wants to explore further.
10. **User interests** about particular components and uses of the IS that he would like to learn, improve and apply in his/her own working environment.

The learning styles that were considered are briefly described below:

1. **Field independent - field dependent:** The Field Independent learner excels in classroom learning that involves analysis, attention to details, and mastering of exercises, drills, and other focused activities. The Field Dependent learner, by contrast, seems to achieve a higher degree of success in everyday language situations beyond the constraints of the

classroom; he/she deals with tasks requiring interpersonal communication skills (Witkin, Moore, Goodenough & Cox, 1977; Wyss, 2002).

2. **Imager:** The user learns more when he carefully observes charts, graphs, timelines, films and presentations (Riding & Cheema, 1991).

3. **Verbalizer:** Verbalizers learn better with text-based methods of instruction and they prefer to process information by verbal-logical means (Riding & Cheema, 1991; Liu & Ginther, 1999)

4. **Activist / Pragmatist:** They involve themselves fully and without bias in new experiences and their philosophy can be summarized as 'I'll try anything once' (Honey & Mumford, 1992).

5. **Reflector:** These students prefer to think before acting (Honey & Mumford, 1992).

6. **Holistic / Analytic:** They prefer logical approaches and they want to learn when the material is a step by step during the learning progress (Honey & Mumford, 1992).

7. **Theorist:** Theorists learn best when they are put in complex situations where they have to use their skills and knowledge (Honey & Mumford, 1992).

Based on the above descriptions, the questions used for the investigation of the employees' learning styles are listed below while the questionnaires investigating the learners-employees' preferences regarding IS will be presented along with the results emerged from the empirical study in the next section.

**Table 2** Questionnaire used for the investigation of LCHS learners-employees learning styles

| Questionnaire used for the investigation of employees' learning styles | |
| --- | --- |
| **s/n** | **Questions** |
| | 1.    **Field independent-field dependent** |
| 1.1.1. | I face some problem of concentration in an environment with noise and confusion. |
| 1.1.2. | I like to analyze the structures of a problem. |
| 1.1.3. | I feel that I have to understand every single word of what I read or hear. |
| 1.1.4. | I believe that the comprehension of a program is more effective in the labour environment. |
| 1.1.5. | I prefer to work alone despite with other persons. |
| 1.1.6. | The reception of feedback in my labour environment by other persons really does not have repercussions in my learning. |
| | 2.    **Imager** |
| 1.2.1. | Regularly I ask persons with regard to their basic admissions. |
| 1.2.2. | I am charmed more by original, non-conventional ideas rather than practical ideas. |
| 1.2.3. | I tend to be fascinated by technical analysis, planning and prevention (eg network analysis, flow diagrams, branching programs, contingency planning). |
| 1.2.4. | I like being able to correlate current operations with a big picture long term. |
| 1.2.5. | I find stifling the formal process of the definition of the specific objectives and drawings. |
| 1.2.6. | I always feel boredom from methodical and detailed work. |

**Table 2** (*continued*)

| | 3. Verbalizer |
|---|---|
| 1.3.1. | I like to learn an application by studying mainly the user manual and afterwards to apply it. |
| 1.3.2. | I consider that i need to understand the logic of the job-process in a department and afterwards to involve in its information system. |
| 1.3.3. | In discussions I like to be communicative and persuasive with my interlocutors. |
| 1.3.4. | I like to draw diagrams in my answers. |
| | 4. Activist / Pragmatist |
| 1.4.1. | I prefer to have a lot of information sources – as many data to study as better. |
| 1.4.2. | I suggest in meetings practical and realistic ideas. |
| 1.4.3. | I tend to discuss certain things with people rather than taking part in vague discussions. |
| 1.4.4. | I prefer people who approach things realistically rather than theoretically. |
| 1.4.5. | I tend to reject irrational, spontaneous ideas as impractical. |
| | 5. Reflector |
| 1.5.1. | I watch carefully every detail and afterwards i reach to a conclusion. |
| 1.5.2. | I don't produce ideas spontaneously. |
| 1.5.3. | I am careful to don't make hasty conclusions. |
| 1.5.4. | I believe that decisions based on detailed analysis of all information is safer than those based on intuition. |
| 1.5.5. | I prefer to stand back from a situation and to study all perspectives. |
| | 6. Holistic / Analytic |
| 1.6.1. | When I hear about a new idea or approach I immediately begin to study the practical part of the application. |
| 1.6.2. | I am careful for the interpretation of available data and i get used to avoid hasty conclusions |
| 1.6.3. | I prefer to come to a decision carefully considering several alternatives. |
| 1.6.4. | I believe that the problems are faced with rational, reasonable thoughts. |
| 1.6.5. | It is best to think carefully before we act. |
| 1.6.6. | I tend to be tough with people when they find difficult to adopt a sensible approach. |
| | 7. Theorist |
| 1.7.1. | I am a passionate for the exploration of the basic assumptions, principles and theories where these are behind things and events. |
| 1.7.2. | I like the meetings to follow a methodical flow, a particular program, etc. |
| 1.7.3. | I avoid subjective and ambiguous issues. |

The aforementioned questionnaires were given in civil servants to the LCHS, which work exclusively to departments of information technology. They were sent to 67 employees of this public organization, which they agreed to participate in this study. 54 valid questionnaires were sent back, thus returning a response rate of 80.6%. It is much longer than 20%, which is the average of such studies, as it emerges from earlier research.

Here it is worth noting that a meeting was scheduled with a sample of 5 respondents thus ensuring that all participants comprehended all the questions adequately. A five point Likert scale was used in order to select the answers of the respondents. The structuring of the questionnaire and the wording of the questions was finalized after testing the content validity. On average, it took 20-25 minutes for each respondent to answer the questions of the questionnaire.

The tools that were used for the completion of this research and the export of various conclusions were SPSS version 13.00 and Excel version 2007.

## 4.4  Presentation-Annotation of the Aggregate Results of the Survey

### 4.4.1  Comments on Aggregate Results Related to the Employees' Learning Styles

Each questionnaire was separately processed so that to detect the learning style of each person. The survey indicated that employees may have two or three possible learning styles. The aim was to find the primary and secondary (second and third learning style) of all the participating employees in the Legal Council of the Hellenic State. The results are described in the following Table 3:

**Table 3** Primary and secondary learning styles of the employees of the IT department of the LCHS

|   |   | Primary learning style % | Second learning style % | Third learning style % |
|---|---|---|---|---|
| 1 | Field independent-field dependent | 1,85 | 1,85 | 7,41 |
| 2 | Imager | 0,00 | 1,85 | 5,56 |
| 3 | Verbalizer | 24,07 | 22,22 | 7,41 |
| 4 | Activist / Pragmatist | 33,33 | 31,48 | 11,11 |
| 5 | Reflector | 3,70 | 11,11 | 25,93 |
| 6 | Holistic / Analytic | 27,78 | 22,22 | 9,26 |
| 7 | Theorist | 9,26 | 9,26 | 9,26 |

*Primary and secondary learning styles*: The results according to the percentages of the primary and secondary learning styles show that 33.33% of the users (primary learning style) and 31.48% of the users (secondary learning style) are *Activist / Pragmatist*. These results are very important for the organization of the learning/working groups and the Legal Council of the Hellenic State itself, as concerns the way learning and work could be focused more efficiently. In other words, the learning activities that will be planned to be performed by the learners/employees should be adapted to the way Activist/Pragmatist users learn better. Such users may learn better from activities, like:

- New experiences and challenges from which to learn
- Excitement, change and variety
- Techniques that can be directly applicable to their own work
- Techniques for doing things with obvious practical advantages

And what *Activist / Pragmatist* users don't like:

- to have a passive role (lectures, instructions, reading)
- to be observers
- to be required to assimilate, analyse and interpret lots of 'messy' data

Other learning styles that have high ratio are Verbalizer and Holistic/Analytic. Consequently, we summarize the results as follows:

*Employees' primary learning styles:* As regards the employees' primary learning styles, the results are: Activist/Pragmatist (33.33%), Holistic/Analytic (27.78%), and Verbalizer (24.07%). SUM=85.18%.

*Employees' secondary learning styles*: As regards the employees' secondary learning styles, the results are: Activist/Pragmatist (31.48%), Holistic/Analytic (22.22%), and Verbalizer (22.22%): SUM=75.92%.

*Employees' third learning styles***:** The results according to the percentages of the third learning style show that 25.93% of the users are Reflectors. These results are also very important for the organization of the learning/working groups and the Legal Council of the Hellenic State itself, since one has to focus on what Reflector users learn best from activities, like:

• are allowed or encouraged to watch / think / ponder on activities
• can carry out careful, detailed research
• can reach a decision without pressure and tight deadlines.

And what *Reflector* users don't like:

• feel 'forced' into the limelight
• must act without time for planning
• given insufficient data on which to base a conclusion

It is also significant to know that 41 persons out of 54 have at least 3 learning styles, being the rate 75.93, whereas 13 persons out of 54 have 2 learning styles, with a rate of 24.07.

### 4.4.2 Comments on Aggregate Results Related to the Employees Preferences

The percentage on what kind of information system the employees would prefer to visit is as follows:

• Ecological organization (1.85%)
• Financial Organization (12.96%),
• Health Care Organization (11.11%)
• IS Development Company (16.67%)
• Private Company (16.67%)
• Public Organization (12.96%)
• Tourist Agency (1.85%)
• University Lab Specializing in IS (25.93%).

Here, one can observe that the choice with the highest ratio is the "University Lab Specializing in IS". That is, most of the employees (25.93%) prefer to visit a "University Lab Specializing in IS" and learn some aspects about their system and

their tasks. The variety of these aspects, which constitute the employees' interests, is investigated further through the second questionnaire.

### 4.4.3  Employees' Interests about Specific Topics of an IS

Here, it is important to examine the percentages of the proposed questions that were evaluated by the employees with the grades "Agree" and "Strongly Agree" as well as 'Disagree' and "Strongly Disagree'. In Table 4, these percentages present the employees' desires as regards what they would like/not like to mostly learn about an IS.

**Table 4** Employees' interests of the IT department of the LCHS about specific topics of IS

| Employees of the IT department of the LCHS and their interest about specific topics of IS | | |
|---|---|---|
| Code | Questions | "Agree" & "Strongly Agree" % |
| Q2.2.1 | I would like to know what kind of service needs are covered | 94.44 |
| Q2.2.2 | I would like to know how the IS faces up any possible application problems and how it resolves them | 72.22 |
| Q2.2.3 | I'm interested to know the requirements of the IS | 62.96 |
| Q2.2.4 | I would like to know the cost of the IS in relation to its potential | 59.26 |
| Q2.2.5 | I'm interested to know the benefits gained by using the current IS | 96.29 |
| Q2.2.6 | I want to be informed about the infrastructure of the IS, especially about computer hardware, network, Internet   and Servers | 68.52 |
| Q2.2.7 | I would like to learn about the frequency that new software releases are installed | 38.88 |
| Q2.2.8 | I would like to learn how information validity is provided by the IS | 79.63 |
| Q2.2.9 | I would like to be informed about the level of maintenance and support as regards  the applications and networks used | 51.85 |
| Q2.2.10 | I would like to know there is a provision for IS prevention from natural disasters | 66.66 |
| Q2.2.11 | I would like to know the users' opinion about possible / necessary future improvements | 74.07 |
| Q2.2.12 | I would like to learn about the usability of the IS | 90.74 |
| Q2.2.13 | I would like to be informed whether there is interoperability of services / applications with other workplaces | 72.22 |
| Q2.2.14 | I would like to find out if e-Gov services are provided such as G2C or G2B or G2G | 57.41 |

It is significant to comment the questions that have a ratio up to 70%. We observe that the personnel would mostly like to learn about the following aspects of the preferred IS which they want to visit:

- The kind of service needs which are covered
- The way that an IS faces up application problems and how it resolves them.

- The information validity that is provided by an IS
- Future improvements for an IS
- The usability of an IS

There are also questions which have a low interest ratio, fewer than 60%. The aspects that they refer to are the following:

- The cost of the IS in relation to its potential.
- The frequency that new software releases are installed
- The maintenance and support level that concern the networks and the applications used in the IS.
- The provision of services like G2C or G2B or G2G

## 5  Summary and Future Work

This paper proposed an innovative approach to provide adaptivity to the STAD collaborative method, through specific adaptation techniques which are applied in some of the STAD phases, within the context of online learning-design based learning. In fact, we described an adaptive online collaborative design pattern of the STAD method that has been formed within LAMS, a well-known open source learning-design based system.

The innovative description of the adaptive STAD collaborative method is based on the fact that: (a) the activity takes place in an 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 adaptive collaborative learning activity. The design of the aforementioned pattern has been implemented and illustrated through a specific adaptive collaborative STAD- learning activity that concerns the training of public organization employees in essential issues of Information Systems (IS).To this end, the construction of the users' learning profile which can be used as an important component to provide the adaptivity of the STAD learning activity was viewed as significant. In fact, three aspects of student learning profile were examined here: students' learning styles, preferences and interests. To extract and classify this information, two questionnaires were given to the employees of the IT department of the Legal Council of the Hellenic State, aiming at determining their primary and secondary learning styles, their preferences for a specific IS of a real world organization they would like to visit, as well as the issues of the IS they would be interested to investigate and acquire more knowledge about.

The analysis of the data showed that the most dominant primary and secondary learning styles of these employees are 'Activist'/'Pragmatist', 'Holistic'/ 'Analytic', and 'Verbalizer' while their third learning style is 'Reflector'. Most learners-employees also preferred to visit a University Lab specialized in IS to gain extra knowledge about IS. Finally, the issues of IS that were addressed as most important for most learners-employees are related to: (a) the kind of service needs which are covered, (b) the way that an IS faces up application problems and

how it resolves them, (c) the information validity that is provided by an IS, (d) future improvements of IS, and (e) usability of IS.

The results of this study can be used for adaptive team formation, whereas a complete employees' profile can be used to support the rest of the STAD phases, especially adaptive individual learning and team collaboration, group report preparation, group report presentation, team assessment, and adaptive individual assessment. In the adaptive team formation, each learning team consists of 5-6 members who have the same learning styles but different preferences. Future work is still under progress for the complete implementation of all phases of the adaptive STAD design pattern as well as for its evaluation in a real world situation.

## References

1. Brusilovsky, P., Pesin, L.: An intelligent learning environment for CDS/ISIS users. In: Levonen, J.J., Tukianinen, M.T. (eds.) Proc. of the Interdisciplinary Workshop on Complex Learning in Computer Environments (CLCE 1994), Joensuu, Finland, May 16-19, pp. 29–33 (1994)
2. Brusilovsky, P.: Methods and techniques of adaptive hypermedia. User Modeling and User-Adapted Interaction 6(2-3), 87–129 (1996)
3. Brusilovsky, P.: Adaptive and Intelligent Technologies for Web-based Education. Künstliche Intelligenz (4), 19–25 (1999),
   `http://www2.sis.pitt.edu/~peterb/papers/KIreview.html`
4. Brusilovsky, P.: Developing adaptive educational hypermedia systems: from design models to authoring tools. In: Murray, T., Blessing, S., Ainsworth, S. (eds.) Authoring Tools for Advanced Technology Learning Environment, pp. 377–409. Kluwer Academic Publishers, Dordrecht (2003)
5. Cameron, L.: Using LAMS to facilitate an effective program of ICT instruction. In: Proceedings of the 2007 European LAMS Conference: Designing the Future of Learning, pp. 39–49 (2007)
6. Cameron, L.: Picture this: My Lesson. How LAMS is being used with pre-service teachers to develop effective classroom activities. In: Proceedings of the 1st International LAMS Conference 2006: Designing the Future of Learning, Sydney, pp. 25–34 (2006)
7. Dalziel, J.: Implementing Learning Design: The Learning Activity Management System (LAMS). In: Proceedings of ASCILITE Interact, Integrate, Impact, Adelaide, December 7-10, pp. 593–596 (2003)
8. De Bra, P., Calvi, L.: AHA! An open Adaptive Hypermedia Architecture. The New Review of Hypermedia and Multimedia, 115–139 (1998)
9. Diggelen, W.V., Overdijk, M.: Grounded design: Design patterns as the link between theory and practice. Computers in Human Behavior (2009), doi:10.1016/j.chb.2009.01.005
10. Dillenbourg, P.: Collaborative learning: Cognitive and computational approaches. Pergamon, Oxford (1999)
11. Gouli, E., Gogoulou, A., Grigoriadou, M.: Supporting Self-, Peer- and Collaborative-Assessment in E-Learning: the case of the PECASSE environment. Journal of Interactive Learning Research 19(4), 615–647 (2008)

12. Haythornthwaite, C., Kazmer, M.M., Robins, J., Shoemaker, S.: Community development among distance learners: temporal and technological dimensions. Journal of Computer-Mediated Communication 6(1) (2000), `http://www.ascusc.org/jcmc/vol6/issue1/haythornthwaite.html`

13. Honey, P., Mumford, A.: The manual of learning styles. Peter Honey, Maidenhead (1992), `http://www.studyskills.soton.ac.uk/studytips/learn_styles.html`

14. Johnson, D.W., Johnson, R.T.: Learning together and alone: Cooperative, competitive, and individualistic learning, 3rd edn. Allyn and Bacon, Boston (1999)

15. Jonassen, D.H.: Designing constructivist learning environments. Instructional Design Theories and Models 2, 215–239 (1999)

16. Kay, J., Kummerfeld, B.: User Models for Customized Hypertext. In: Nicholas, C., Mayfield, J. (eds.) Intelligent Hypertext. LNCS, vol. 1326, pp. 47–69. Springer, Heidelberg (1997)

17. Koper, R., Tattersall, C.: Learning Design: A handbook on modeling and delivering networked education and training. Springer, Berlin (2005)

18. Kordaki, M., Siempos, H.: Encouraging collaboration within learning design-based open source e-learning systems. In: Dron, J., Bastiaens, T., Xin, C. (eds.) Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare & Higher Education (E-Learn 2009), Vancouver, Canada, USA, October, 26-30, pp. 1716–1723. AACE, Chesapeake (2009)

19. Kordaki, M., Siempos, H.: The JiGSAW Collaborative Method within the online computer science classroom. In: 2nd International Conference on Computer Supported Education, Valencia, Spain, April 7-10, pp. 65–74 (2010)

20. Kordaki, M., Grigoriadou, M.: A Collaborative and Adaptive Design Pattern for the 'Students Team Achievement Divisions' Method: An implementation within Learning Design-Based e-learning Systems. In: IWASCL-2010 WORKSHOP (Held in Conjunction with the 2nd International Conference on Intelligent Networking And Collaborative Systems), Thessaloniki, Greece, November 24-26 (2010)

21. Kordaki, M., Siempos, H., Daradoumis, T.: Collaborative learning design within open source e-learning systems: lessons learned from an empirical study. In: Magoulas, G. (ed.) E-Infrastructures and Technologies for Lifelong Learning: Next Generation Environments. IDEA-Group Publishing (2011)

22. Koschmann, T.: CSCL: Theory and practice of an emerging paradigm. LEA, Mahwah (1996)

23. Liu, Y., Ginther, D.: Cognitive styles and distance education. The Journal of Distance Learning Administration 2(3), Article 005 (1999), `http://www.westga.edu/~distance/ojdla/fall23/liu23.html` (retrieved May 5, 2011)

24. McAndrew, P., Goodyear, P., Dalziel, J.: Patterns designs and activities: unifying descriptions of learning structures. International Journal of Learning Technology 2(2-3), 216–242 (2006)

25. Papadimitriou, A., Grigoriadou, M., Gyftodimos, G.: Adaptive Group Formation and Interactive Problem Solving Support in the Adaptive Educational Hypermedia System MATHEMA. In: Proceedings of the, World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED-MEDIA 2008), Vienna, Austria, June 30-July 4, pp. 2182–2191 (2008)

26. Riding, R., Cheema, I.: Cognitive styles - an overview and integration. Educational Psychology 11(3-4), 193–215 (1991)

27. Roberts, T.S.: Computer-supported collaborative learning in higher education: An introduction. In: Roberts, T.S. (ed.) Computer-Supported Collaborative Learning in Higher Education, pp. 1–18. Idea Group Publishing, Hershey (2005)
28. Scardamalia, M., Bereiter, C.: support for knowledge-building communities. In: Koschmann, T. (ed.) CSCL: Theory and Practice of an Emerging Paradigm, pp. 249–268. Erlbaum, Mahwah (1996)
29. Skinner, B.F.: The Technology of Teaching. Appleton, NY (1968)
30. Slavin, R.E.: Student teams and achievement divisions. Journal of Research and Development in Education 12, 39–49 (1978)
31. Witkin, H.A., Moore, C.A., Goodenough, D.R., Cox, P.W.: Field-dependent and field-independent cognitive styles and their educational implications. Review of Educational Research 47(1), 1–64 (1977)
32. Wyss, R.: Field Independent/Dependent Learning Styles and L2 Acquisition. The weekly column (2002), `http://www.eltnewsletter.com/back/June2002/art1022002.html` (accessed on May 5, 2010)