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The application of learning styles in both individual and collaborative learning

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Abstract

With the goal of applying learning styles in both individual and collaborative learning, some adaptation mechanisms have been developed. These mechanisms try to improve the process of learning by matching the teaching style with the student's learning style and by grouping students in some specific ways. We use the Felder-Silverman Learning Style Model and its Index of Learning Styles (ILS) questionnaire in order to classify students depending on their preferences on four dimensions (active/reflective, sensing/intuitive, visual/verbal, and sequential/global). The benefits of learning styles can be of interest for adaptive hypermedia learning systems in both individual and collaborative activities, especially if they support automatic grouping of users. From the results obtained by a case study with students of Computer Science in a collaborative task it can be concluded that some dimensions of the learning style model seem to affect the quality of the resulting work. With this aim, new grouping rules have been incorporated in the TANGOW/WOTAN system to be used in the corresponding courses.

1. Introduction

A learning style is defined as characteristic strengths and preferences in the ways people take in and process information [1]. Each student has his/her unique way of learning.

In adaptive educational hypermedia systems, students can be individually guided and their specific needs can be fulfilled during the learning process [2]. Therefore, it is necessary for adaptive systems to store the information about the users that is considered relevant for the adaptation process in the user model.

Among the user features considered in user models, learning styles constitute a valuable tool for improving individual learning [3] [4] [5].

Students learn from their individual interactions with educational resources, but they can also acquire knowledge during the accomplishment of activities in collaboration with others [6]. Grouping students according to both their individual features, such as learning styles, and the synergy that the combination of these features can achieve may constitute a good opportunity to improve the results of the learning process [7] [8].

2. Learning Style Model

Most adaptive learning systems get the conscious student information from the students themselves. Nevertheless, students are not aware of their learning styles and we need a questionnaire to identify them. This information should be integrated among other student characteristics in the user model, a basic component of any adaptive web-based education system.

In order to detect the students learning style, we use the ILS (Index of Learning Styles) questionnaire. It was developed by Felder and Soloman [9] based on the Felder-Silverman classification [10]. The objective of this questionnaire is to establish the dominant learning style of each student. ILS questionnaire is formed by 44 questions with two possible answers, *a* or *b*. These questions are separated into four groups, with eleven questions each. These groups correspond to four of the five categories in the classification of Felder and Silverman (active-reflective, sensing-intuitive, visual-verbal, and sequential-global). Authors do not take into account the inductive-deductive dimension for pedagogical reasons.

The results are explained in sections. The score is obtained subtracting the answers related to one dimension from its contrary. For example, if you have 4 answers indicating sequential preference and 7 indicating global one, your preference is global with a score of 3. If you get a score of 1 or 3 you have a mild

preference but your learning style is well balanced. Differently, if your score is 5 or 7, you have a moderate preference and you will learn more easily in teaching systems that favor that dimension. Finally, if you score 9 or 11, you could have difficulty learning in a system, which does not support that preference. In this way, the final result from the test are four scores (odd numbers between -11 and 11), one for each dimension.

TANGOW/WOTAN (Task-based Adaptive learnER Guidance On the Web) [11] is a system that provides adaptive guidance based on the student profile, the student actions and the teaching strategy. There are two kinds of data in the user model of TANGOW/WOTAN; the static and the dynamic data. The static data comprises the data about the name of the user, password, age, language, previous knowledge, and learning style. The dynamic data is formed by the number of pages visited, time dedicated to each task, number of exercises done, percentage of success in doing the task, and ending of the task.

3. Some empirical data

With the aim of obtaining information about the impact of learning styles on the success of collaborative work, we carried out a case study [12]. The study was carried on with 166 students, grouped in pairs, from a course on Theory of Computation.

From the relation between learning styles and the mark obtained we extracted some conclusions:

i) Learning styles seem to affect the performance of the students when working together

ii) The tendency seems to be that mixed pairs in the active-reflective and the sensing-intuitive dimensions work better. Learn by means of trying things out and doing something is preferred by active learners, while reflective learners progress in their learning process through the thinking before doing things. On the other hand, learning first concrete and practical information oriented toward facts and procedures is preferred by sensing learners, while intuitive learners prefer conceptual and innovative information oriented toward theories and meanings. In collaborative learning is very useful take into account these two different points of view because the final objective is putting in practice some theoretical explanations and students also need a good comprehension of theory.

iii) Heterogeneous groups, when considering Euclidean distance, get better results

iv) The students seem to group themselves randomly, according to no pattern with respect to their learning styles

v) There are far more visual students than verbal ones in Computer Science. There are also more intuitive than sensing students. The other two dimensions seem to have a more symmetrical distribution.

4. Individual and collaborative learning

In TANGOW/WOTAN the course structure is defined in terms of teaching tasks (TTs) and rules, and content is defined as a list of media elements associated to each task. Rules say which tasks are part of other tasks and what the order of decomposition is. Their attributes are name, compound task, subtasks, sequencing, activation conditions, and propagation of parameters. Sequencing can be:

i) AND: all the subtasks must be achieved following a fixed order

ii) ANY: all the subtasks can be achieved in any order

iii) OR: at least one of the subtasks must be achieved

iv) XOR: just one of the subtasks must be achieved

The individual adaptation performed taking into account the information about the student learning style is:

i) Sequential learners should be more directly guided through the learning materials, since global learners should be able to have a look at the course in a global way before studying specific subjects. Therefore, the sequencing of specific rules can be changed from ANY to AND for the former students, and vice versa for the later.

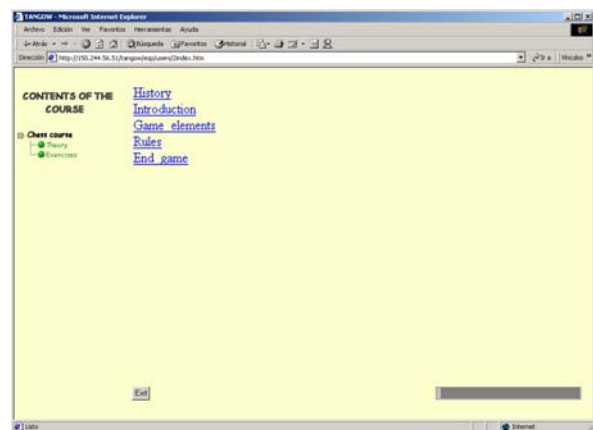


Figure 1. First page of a chess course for global learners

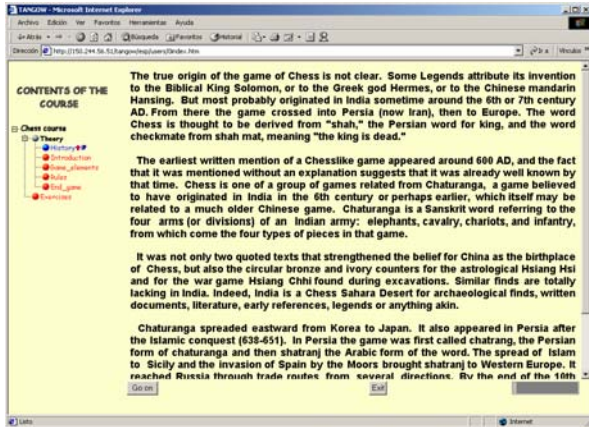


Figure 2. First page of a chess course for sequential learners

ii) Sensing students tend to prefer to observe and interact with examples before studying theoretical concepts or procedures, while intuitive learners usually

prefer the other way round. In this case, when both exposition and exemplification tasks are available for a specific learning unit, sensing learners are presented with the exemplification task first, while the theoretical task will be proposed to the other ones at the beginning.

The automatic grouping is carried out in two phases [13]:

i) Grouping rules determine the group composition regarding the personal features and preferences of the students. Rules by default are provided, and the course designer can define rules with different criteria to form the groups, either specifically for certain collaborative tasks or for the whole course.

ii) For each collaboration task, as soon as it is available to a minimum number of persons belonging to the same group (which is configurable), subgroups are formed and users can initiate the cooperation. During this second grouping phase, their opinions and preferences based on previous collaboration experiences are also considered (i.e., other users they

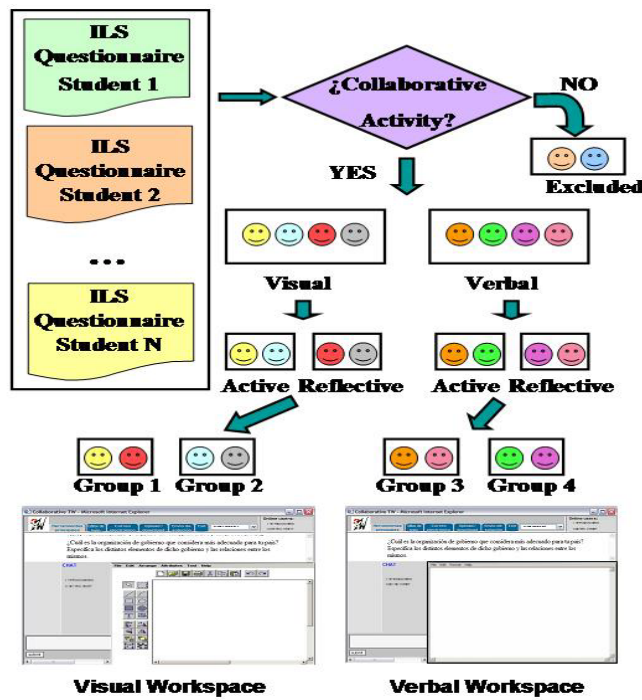


Figure 3. Use of learning styles in collaborative activities

do not wish to interact with again).

In some systems students are grouped according to their learning styles [7] [8]. These papers deal with the combination of students in groups considering some dimensions of Felder-Silverman Model [10]. In [8], groups are formed by combining students according to two learning style dimensions: active/reflective and sequential/global. The members of the same group should have similar values for these two dimensions. In [7], the criteria by default for group formation consist of combining active students with reflective ones in similar percentages, as you can see in figure 3. In that work, students with a moderate or strong tendency to either visual or verbal styles are grouped with similarly rated students, so that the collaboration workspace interfaces can be adapted accordingly. In any case, it is possible for the course responsible to change grouping criteria.

In this work, we propose the distance between the members of the group as a key factor to determine the grouping rules. The final distance is the result of adding the Euclidean distance, the active-reflective distance and the sensing-intuitive distance. For example, if student a has obtained the ILS score (a_1, a_2, a_3, a_4) , and student b (b_1, b_2, b_3, b_4) , the distance between them is:

$$Distance = Euc\ dist + Act-refl\ dist + Sen-int\ dist$$

$$Euc\ dist = \sqrt{(a_1 - b_1)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2 + (a_4 - b_4)^2}$$

$$Act-refl\ dist = \sqrt{(a_1 - b_1)^2}$$

$$Sen-int\ dist = \sqrt{(a_2 - b_2)^2}$$

Results of the case study suggest that pairs of students with distance over the mean obtain significant better results than pairs below the mean. In this sense, the procedure of selecting partners is to select randomly the first member and later, calculate the farthest possible partner to the member/s of the group.

For example, if we have six students with this scores:

Student1 (-3, 3, 1, 11)
 Student2 (-11, -1, 1, 5)
 Student3 (3, 3, 3, 5)
 Student4 (1, 7, 9, 1)
 Student5 (-1, -9, 1, -5)
 Student6 (-11, 5, -3, 3)

We can build a table with the distances between all of them:

Table 1. Distances between students

	Std1	Std2	Std3	Std4	Std5	Std6
Std1		22,77	14,72	22	34,1	22,17
Std2			32,7	36,97	34,25	13,48
Std3				14,48	32,25	31,49
Std4					36,97	31,2
Std5						43,39
Std6						

Mean distance is 28,2 and our system will choose the distribution of groups that has the maximum number of them over the mean. Therefore, if teacher decided to group students in pairs, student 1 only could have as partner to student 5 with a distance of 34,1, student 2 has a distance of 36,97 with student 4, and finally, student 3 and student 6 have a distance of 31,49.

On the other hand, if teacher decided to group students in collections of 3, our system will put together students 1, 5, and 6, because student 6 has a distance of 43,39 with student 5 and a distance of 22,17 with student 1, that is a total of 65,56 (the biggest one). And students 2, 3, and 4, will form the other one.

5. Conclusions

This information can be used with adaptation purposes in educational hypermedia and collaborative systems. The TANGOW/WOTAN system will be used as an example of the application of this information, since it supports the creation and delivery of adaptive web-based hypermedia, collaborative learning and dynamic group formation.

It must be mentioned that there will probably be no "absolute best rules" for a course. Variations may occur from one course edition to another and the students may be pretty different each time. This may make difficult to compare their results with that obtained when using different grouping rules. Yet the aim here is to evaluate whether it is really possible to find "a good set of rules" for each course and to use it for grouping students.

The set of good rules for grouping students according to their learning style and previous actions could be different for distinct disciplines (even for different subjects related to the same discipline). Therefore, the need of analyzing new data and inferring the rules for grouping is clearly there, and the

possibility of doing it automatically is an important step forward.

6. Acknowledgements

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