Collaborative Tutoring System Adaptive for Tutor's Learning Styles based on Felder Silverman Model

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Abstract: In the past decade, in the context of CSCL various personalization techniques have been proposed for developing adaptive and collaborative e-learning systems, these later are specifically designed to assist and support learners in their learning process. It is not only learners but also the tutors who experience difficulties in the learning process. In particular, new recruits may not have enough experience to help their learners. In this research paper, we investigate these ideas to propose a Computer-Supported Collaborative Coaching System with Four-Dimensional Personalization Criteria based on Felder Silverman model called CSCCS @ FDPC-FS. This system aims to create a virtual space based on the exchange of information and experiences between experienced tutors in higher education institutions (coaches) to help new recruits coaches who have difficulties and try to encourage, motivate, and provide them with needed experiences to help them break out of isolation and use their solid information to guide their learners. This system offers two strategies, to help new recruits coaches: either the first strategy offers to the tutor to acquire the experience with a learning strategy of the basic notions of the tutoring process, this first strategy (learning) combining and adapting teaching strategies, learning styles, and electronic media according to Felder-Silverman's learning style model. And the second strategy offers to the tutors the possibility to collaborate with other experienced colleagues, to gain the experience and the know-how. The collaboration strategy offers a classification algorithm for forming coaches' groups, the forming groups algorithm base on two new proposes profiles: collaborator and group profile.

1 INTRODUCTION

In the context of CSCL, the majority of CSCL systems neglect the aspect of group formation by grouping the learners randomly (Alfonseca et al., 2006). Recently, many researches use many criteria for grouping learners: we can cite among these criteria: their profiles, personal information (age, gender, class, etc.) (Analoui et al., 2013.), behaviors, and knowledge, learning styles (Grigoriadou et al., 2006), etc. Other works group learners using their abilities and their thinking styles.

Many techniques were used to group learners, Artificial intelligence and Bio-inspired techniques are among the most common techniques. In the context of bio-inspired techniques, Montazer and Rezaei (2012) have introduced an optimization approach in the e-learning field to improve the grouping methods. Abnar and his colleagues (Abnar et al., 2012) form learning groups by an iterative process based on a genetic algorithm. Other researchers discovered (Ghorbani et Montazer, 2012) that grouping learners by PSO (Particle Swarm Optimization) technique based on their cognitive styles improved the accuracy of grouping. In another approach, Zedadra et al.(2016) presented a new approach of learners grouping in collaborative learning systems. This grouping process is based on traces left by learners. The proposed approach consists of two main algorithms: (1) the circular grouping algorithm and (2) the dynamic grouping algorithm (used to update groups). The authors' proposed approach used the same behavior of penguins' colony. So, we found many works about

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grouping learners and learners collaboration. But, collaboration among learners is not enough to solve some problems like some learners find it difficult to communicate and share experiences within the group (Rojano-Cáceres et al.,2017). As a result, the monitoring functionality is required in these environments. Tutoring is a key element of any distance learning system, which has been applied in several fields. In the educational field, this task has become indispensable, especially in higher education institutions.

The primary objective of tutoring is to support the learners throughout the learning so that it fully reaches the educational objectives set by the educational institution.

Furthermore, it aims at supporting all the activities of learners and assisting them to find learning difficulties and problems. In other words, distance tutoring or e-tutoring is referred to all the activities that support learners in their learning process (Kopp et al., 2012; AbuEloun and Abu Naser,2017; Benjamin D. Nye et al.,2018).

Learning style is a learner characteristic indicating how a learner learns and likes to learn (Keefe, 1991). For example, some learners prefer graphical representations and remember best what they see, others prefer audio materials and remember best what they hear, while others prefer text and remember best what they read. Some learners like to be presented first with the definitions followed by examples, while others prefer abstract concepts to be first illustrated by a concrete, practical example.

In the few recent years, various personalization techniques have been proposed for developing adaptive e-learning systems, and have revealed the benefit of such an approach. In this respect, according to (Al-Azawei & Lundqvist, 2015) many personalized or adaptive learning systems have been developed focusing on a range of learner's personal information, such as their profiles (e.g., gender, age, knowledge level, and background data), learning portfolios, and preferences. Recently, researchers have largely focused on learning styles due to several reasons. According to literature, learning styles have widely been used to avoid a 'one-size-fits-all' teaching approach (Al-Azawei & Badii, 2014; Felder& Brent, 2005).

There are many studies on the effectiveness of combining multimedia and hypermedia with learning styles in educational systems. They attempt to associate specific e-media characteristics to different categories of learners and propose instruments and methods for assessing learning style. Most of these studies are based on the Felder-Silverman learning style model (FSLSM) (Felder and Silverman, 1988). Examples of such systems include CS383 TANGOW, and PHP Programming Course (Hong & Kinshuk, 2004).

Learning strategies are the strategies used to remember, learn and use information. In this regard, some of the previous studies worth mentioning are for example those of Dunn, who insists on the importance of teaching the learners by using methods that adapt to their conceptual preferences.

However, very few researchers give any idea of the correspondence between electronic media and the appropriate teaching and learning styles and very few studies give an idea of the appropriate combinations of electronic media and learning styles that are more effective than others.

So, as we talk about learners' grouping, and learners' learning styles, tutors, especially new recruits also need to collaborate and learn according to their learning styles (Indira, 2019; Tadjer et al., 2018,2020)

Tutors need to work in groups in some cases for example: when learners' needs do not belong to the tutor's skills, the learner's queries will not be satisfied, so in this case, the tutor must collaborate with others to can help his /her learner. Also in the case of new recruits, they have needed to collaborate to get the experience from their experienced friends (Indira, 2019; Tadjer et al., 2018,2020).

Tutors especially new recruits need to learn about basic tutoring notions with their learning styles to give them the advantage of autonomy by gaining experience and avoiding the problems of disorientation and cognition. The learning according to the tutors' learning style offers to them a navigation adaptation (Drissi & Amirat, 2017).

In the literature, the authors found some recent IT(intelligent Tutoring) platforms we can cite among them: the work presented in AbuEloun and Abu Naser(2017), Another work was presented by Benjamin D. Nye et al (2018). Of course, these works focused on tutoring in its classic concepts, which means the tutoring process between student /tutor without take into count neither the learning according to the tutors' learning style neither the task of collaboration between tutors in their methodologies.

In this paper, we aim to propose a novel Computer-Supported Collaborative Coaching System with Four-Dimensional Personalization Criteria based on the Felder-Silverman model called CSCCS @ FDPC-FS. Our system presents a general framework used to teach new tutors recruits (coaches) the basic concepts about the tutoring

process, in higher education institutions. This proposed system combines with two strategies:

- Learning strategy: uses combining and adapting teaching strategies, learning styles, and electronic media According to Felder-Silverman's learning style model. More specifically, This strategy focuses on the proposal for an adaptive taxonomy that will be used to release the fourth levels of adaptation which are: content level adaptation, link-level adaptation, presentation level adaptation, and collaboration level adaptation of an educational collaborative tutoring system (Drissi & Amirat,2017). While based on the four dimensions of Felder-Silverman's learning style model. This strategy is used when the new tutor recruit (coach) chooses to learn the basic tutoring notions alone.
- Collaboration strategy: uses the concepts of collaboration and joining in different groups of experienced tutors. This second strategy is used when the new tutor (coach) prefers to get help from his/her colleagues with prior.

This paper is organized as follows. In the second section, we give a brief of the Felder-Silverman learning style model. The architecture of a CSCC system is presented in section three. We conclude with a conclusion and future works.

2 FELDER SILVERMAN'S MODEL

In this research, we are focusing on the Felder-Silverman learning style model (FSLSM) because

- the (FSLSM) was widely used, more specifically, in Technology Enhanced Learning (TEL) (Al-Azawei & Badii, 2014; Drissi & Amirat, 2017).

More specifically, according to Carver, Howard, & Lane (1999), the Felder Model is most appropriate for hypermedia courseware. So, in our case we applied this model in our CSCCS @ FDPC-FS, to offer to the new recruit to learn the basic notions of the tutoring process according to his learning style. So, automatically the tutor becomes a learner.

FSLSM contains four dimensions when the learner is characterized by a specific preference for each of these dimensions. Each dimension includes two variables as shown in figure 1. As detailed in (Drissi & Amirat, 2017), the first dimension covers sensing versus intuitive learning. Students who enjoy studying from facts and concrete learning materials are students who foster a sensitive learning style. In contrast, intuitive learners are more motivated by abstract learning, such as theories and their underlying meanings. They can discover possibilities and relationships and tend to be more innovative and creative than sensing learners. The second, visual-verbal dimension differentiates learners who remember best and who learn best through vision (e.g., pictures, diagrams, and flow-charts), and learners who benefit the most from textual representations, whether written or spoken. In the third dimension, the learners are rated between an active and a reflective way of processing information. Active learners tend to be more interested in communication with others and prefer to learn by working in groups. In contrast, reflective learners favour individual work or perhaps prefer to work in small groups together with one good friend. Finally, the fourth dimension characterized learners according to their understanding. Sequential learners have linear learning progression. So, they prefer to learn in small incremental steps. Whereas, global learners use a holistic thinking process and learn in large leaps. Table 1 details the description of Felder-Silverman dimensions.

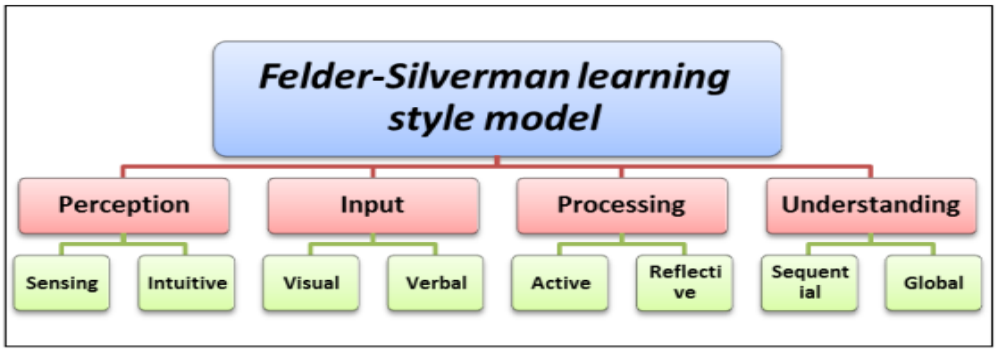

Figure 1: Felder-Silverman learning style model.

Table 1: Description of Felder- Silverman dimensions (Drissi & Amirat, 2017).

Learning Style	Description
Sensing	Prefer concrete facts, data, and relation to the real world around. Rather deal with facts, raw data, and experiments, they are patient with details but do not like complications.
Intuitive	Focus on ideas and possibilities, Prefer abstraction, theories, and models. Rather deal with principles and theories, are easily bored when presented with details, and tend to accept complications.
Sequential	Orderly, step by step, and sequential. Follow a linear reasoning process when solving problems and can work with a specific material once they have comprehended it partially or superficially.
Global	See everything as a whole. Take big intuitive leaps with the information, may have a difficulty when explaining how they got to a certain result, need an integral vision.
Visual	Easy for them to remember what they see: images, diagrams, time tables, films, etc.
Verbal	Remember what they have heard, read, or said.
Active	Motivated, prefer trial-and-error. Enjoy discussion rather than learning independently. "learning by doing" describe how active students learn. Learn by working in groups and handling stuff.
Reflective	Learn better when they can think and reflect on the information presented to them. Learn a good deal from independent work. Work better alone or with one more person at most. "Learning by thinking" could describe Reflective students.

3 ARCHITECTURE OF THE PROPOSED SYSTEM

Our CSCCS @ FDPC-FS system is organized in the form of three basic components: models component, collaboration component, and learning component. These three components interacted to adapt different aspects of the instructional process. Figure 2 illustrates the system architecture.

3.1 The Models Component

This module is divided into three sub-modules:

3.1.1 Tutor Model

In CSCCS @ FDPC-FS proposed, to model our tutor (coach) we will follow two phases:

- Phase 1: In our approach, the tutor (coach) can be modeled first by the typical characteristics that are grouped in a facet identification that contains personal data for example username, password, unique ID, age, sex, e-mail. These data are obtained using a questionnaire that the tutor must complete on their initial login.
- Phase 2: Selection of learning styles of tutors is performed using the Index of Learning Style Questionnaire (ILQ), developed by Felder and Soloman (1997) which is used to categorize the learners into four dimensions (Sensing/Intuitive, sequential/Global, Visual/Verbal, and Active/Reflective). The description of these dimensions is detailed in table 1 previously.

So in this phase, the tutor must complete a questionnaire containing 44 questions (11 items per dimension). Knowing that, each tutor has a personal preference for each dimension. These preferences are expressed with values between +11 to -11 per dimension, with steps +/-2. These measures come from the 11 questions that are posed for each dimension. For example, when answering a question, with an active preference, +1 is added to the value of the active/reflective dimension whereas an answer for a reflective preference decreases the

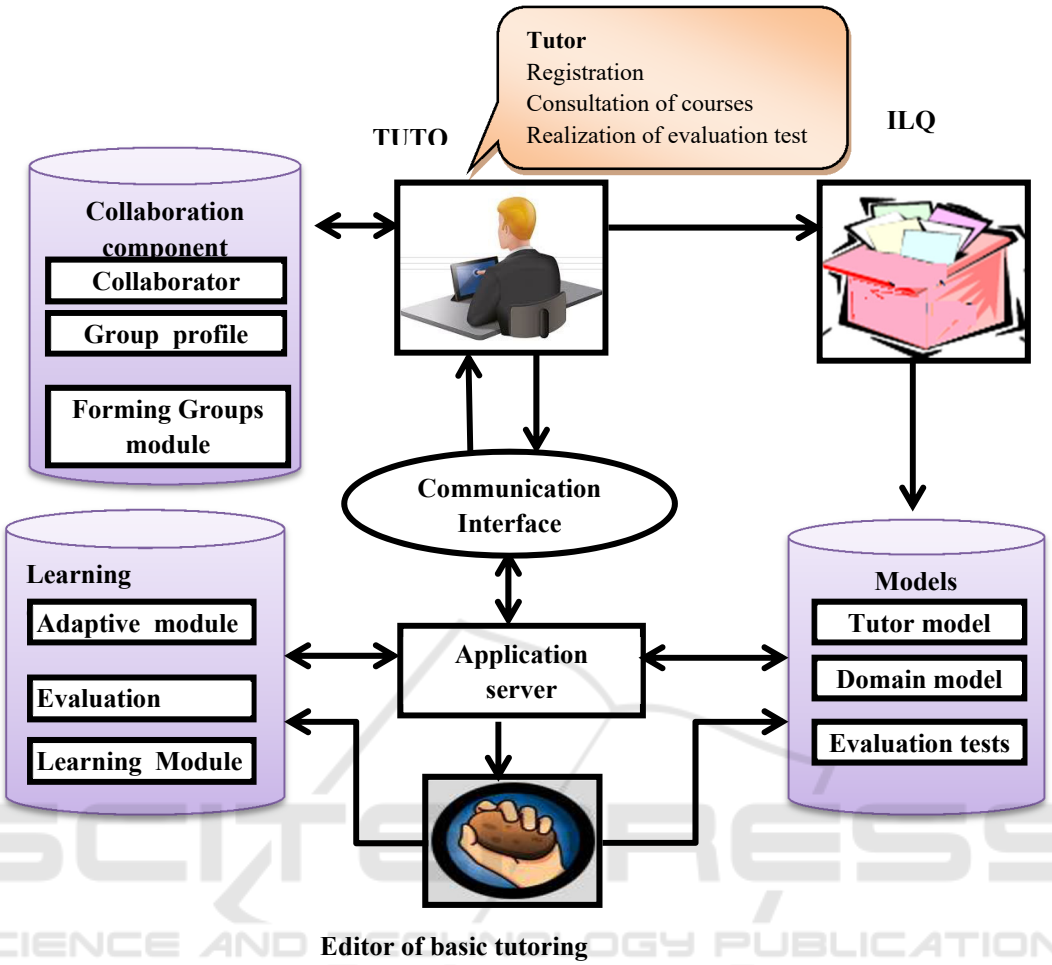

Figure 2: Architecture of the proposed system CSCCS @ FDPC-FS.

value by 1. And for this, each question is answered either with a value of +1 (answer a) or -1 (answer b). while (Answer a) corresponds to the preference for the first pole of each dimension (active, sensing, visual, or sequential), and (answer b) to the second pole of each dimension (reflective, intuitive, verbal, or global).

3.1.2 Domain Model

In this domain model, the tutor (coach) found all the needs of the basic notions of the tutoring process. This domain is represented by three levels: course, chapter and finally learning objects.

3.1.3 Evaluation Test

This module is responsible for offering some tests for the tutors.

3.2 The Learning Component

If the new tutor (coach) prefers to learn alone all the basic notions of the tutoring process, so he/she must choose the learning strategy, this module is divided into three sub-modules:

3.2.1 Adaptive Module

The adaptive module aims to provide a personalized learning resource for tutors (coaches), especially learning content by suggesting personalized learning paths and adaptive layouts when we proposed an adaptive taxonomy that integrates learning strategies, learning styles, and electronic media.

This adaptive taxonomy focuses on a set of resources summarized as navigation tools, Collaboration and communication tools, overview tool, and a set of learning objects.

The learning objects are presented in the form of text, picture sound, and animation. Furthermore, our adaptive taxonomy is adapted to release the fourth levels of adaptation: content level adaptation, link-level adaptation, presentation level adaptation, and collaboration level adaptation of an educational hypermedia course, while based on the four dimensions of Felder-Silverman's learning style model.

3.2.2 Learning Module

The learning module based on the tutors' four dimensions of Felder-Silverman's learning style model to provide tutors (coaches) with personalized learning content by suggesting personalized learning paths and adaptive layouts

3.2.3 Evaluation Module

The evaluation module presents to the new tutors (coaches) a set of evaluation tests to evaluate their knowledge in two levels the pre-test level and the post-test level. This module provides tutors (coaches) with different types of exercises including multiple-choice questions (MCQ) and matching questions.
In CSCCS @ FDPC-FS, evaluation tests were automatically generated using an editor of basic tutoring notions called Hot potatoes that is a software suite that includes five applications to create exercises to upload on the web. In our system, two applications are used: JQuiz editor (multiple-choice questions or MCQs) and JMatch (Editor of matching exercises).

3.3 Collaboration Component

If the new tutor (coach) prefers to learn all the basic notions of the tutoring process, with the help of his /her experienced tutors so, he/she must choose the collaboration strategy.

The methodology proposed for creating the tutors' groups is based on the set of tutor's (coaches) profiles. Tutor's (coach's) profile is a tool to get an idea about him/her, and with whom he /she interact. The tutors'(coach's) profile is composed of information that identifies the ability of the coach in practice. There is a personal profile (name, age, email..etc.), the cognitive profile (diplomas, experience, interest domains…etc.), the behavioural profile (teaching methods, social relationship,.. etc.).

When the coach (tutor) starts working within the system, this latter has no prior information about his collaboration and his groups. However, the system could not give any preferences for him. Therefore, the model of this tutor must have an efficient way of inferring initial information about the tutor. The proposed approach is taken into account by an educational system. In this system, all the necessary information is collected to build the profiles of this actor. For obtaining his group and collaboration profiles and knowledge level, a pre-test is used. The tutor can choose one or more questions according to his skills to do the task. The collaboration component is divided into three sub-modules:

3.3.1 Collaborator Profile

This new profile has five possible values (very passive, little passive, little active, active, highly active). The collaborator profile aims to pre-classify coaches according to their level of collabora tion in the different activities of their colleagues. We must note that we need this profile when a coach has the desire to join a group.

3.3.2 Group Profile

The interest domain of the coach is related to his specialty diploma we try to reduce the number of groups to eight (e-learning - multi-agent system, Artificial vision, image processing, artificial intelligence, networks, information system, internet of things).

3.3.3 Forming Groups Module

So, our idea is we want to classify a new coach (tutor) who registers in the system to join a group of coaches that already exists in the system.
The KNN (K Nearest Neighbors) algorithm makes it possible to determine the k nearest neighbors, and then, for example, to classify a data item in one category or another. The classification process is based on the Euclidean distance between the data (Zhang, 2016).

In our case, we want to classify a new coach (tutor) who registers in the system to join a group of coaches (tutors) that already exists in the system. The classification is made based on the two new profiles proposed: the coach's prior group profile and the coach's collaborator profile. That is to say, for a new coach, the system calculates two coordinates: the group performance and the collaboration value: for the group performance will be calculated from his prior group profile, and for the collaboration value will be calculated from his collaborator profile. Each coach C will be represented by a point

whose first coordinate is the group performance and the second coordinate is the collaboration value, and we determined the number of K closest neighbors of the other coaches registered in our system using the Euclidean distance between the new coach and all other already registered coaches.

4 CONCLUSION AND FUTURE WORKS

In this paper, as the first step of our research project, we have presented the design of a collaborative tutoring system adaptive for tutor's learning styles. The proposed system supports two strategies:

The Collaboration strategy: among human coaches in higher education institutions, we describe the scenarios of the collaboration between coaches by proposing two new profiles (the coach's collaborator profile, the group profile) using for forming coaches' groups these profiles are used by the classification algorithm for forming groups. This strategy gives the new recruit tutor the benefit of gaining experience and the know-how from his more experienced colleagues.

The learning strategy: for combining and adapting teaching strategies, learning styles, and electronic media according to Felder-Silverman's learning style model. More specifically, in this paper, we have proposed an adaptive taxonomy used to release the fourth level of adaptation by using firstly, the «perception dimension» of Felder-Silverman's model to adapt learning content. Secondly, the «understanding dimension» to realize the navigation level adaptation. Thirdly, the «entry Chanel dimension» to realize the presentation level adaptation. And finally, the «processing dimension» to realize the collaboration level adaptation. This strategy gives the new recruit tutor the advantage of autonomy by gaining experience and avoiding problems of disorientation and cognitive overload since it offers a navigation adaptation according to the tutor's learning style.

As future work, we plan to extend the proposed approach by developing a prototype of the Computer-Supported Collaborative Coaching system with Four-Dimensional Personalization Criteria based on Felder Silverman model called CSCCS @ FDPC-FS, also the development of the Classification algorithm for forming coaches' (tutors') groups.

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