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Towards a model of self-regulated e-learning and personalization of resources

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Abstract. E-learning systems, also called virtual learning environments, are systems that promote education and training activities using modern information and communication technologies. Therefore, e-learning is the application of modern multimedia technologies and the Internet to improve the quality of learning by making resources and services more accessible, as well as exchanges and collaboration at a distance that can help learners in their studies and that can also help teachers to predict the weaknesses, strengths and level of understanding of learners. Preparing and providing the quality e-learning system and rich learning experience are major challenges. The lack of interaction, feedback, helping the learner to self-regulate, assessing the degree of knowledge and adapting teaching methods and resources to the real needs of the learners which imply a lack of motivation and a high dropout rate, diminish the richness of the learning experience. Hence, we propose in this article a robust model of adaptive e-learning environments to optimize learning for each learner, taking into account the heterogeneity of profiles so that students succeed in their learning experiences.

Keywords: E-learning, Personalization, Self-regulated learning, Learner learning experience, Learner success.

1 Introduction

Today, online learning has outgrown the traditional classroom environment. Due to the spread of the coronavirus pandemic, LMS (Learning Management System) has experienced unprecedented growth should continue to develop and evolve in the coming years. Most students feel less stress as a result of online learning and feel more comfortable emotionally [1].

Unfortunately, distance education poses pedagogical issues that reduce the richness of the learning experience. Prepare and provide a quality system and a rich learning experience are major challenges. The separation of the physical and temporal of the tutor and the learner, and between the learners themselves, can lead to a feeling of

isolation and a lack of discussion and interaction and feedback that generally concerns the learners' communication mechanisms with their teachers and peers. These gaps can reduce the richness of the learning experience. Whereas, peer teaching contributes to improving student success [2]. For the learner, distance education requires good organization and pursuit of goals so that he/she succeeds in his/her training. Dropout rates from online courses are high due to the inability to self-regulate [3], this may be due in part to the fact that students underestimate the effort involved and fail to properly plan their work to be successful in online courses. Distance education poses another issue, which consists of evaluating the student's degree of assimilation of the material taught. This evaluation is essential if we want to accompany the learner and ensure concrete progress, it allows students to determine which parts of the course they need to study and it allows instructors to know what course content needs to be adjusted.

In addition, e-learning environments do not always present the resources most suited to the real needs of learners such as the language of teaching, what they want to learn, the need to work with peers or individually, the type of questions, and type of learning objects (e.g. video, image, text, etc.). Not all of these needs are automatically detected, which implies a lack of motivation among learners and a high dropout rate that can reduce their success rate in these e-learning systems. Thus, all students learn best when teachers adapt the teaching methods, resources, and learning environment that suit their interests, needs, strengths, and level of knowledge. But even for the best teachers, it is difficult to fully understand each learner's profile and adapt the program accordingly and help them to self-regulate. This is why technology could be of great use; therefore using it adds new possibilities for tracking learners' activity and providing them with more immediate feedback on their progress. Hence, the conclusion that one of the main axes is the personalization of learning that must be taken into account if we want to see student outcomes improve.

To resolve these issues, we judged that it is essential to include personalization, evaluation, feedback, help the learner to self-regulate, etc. while adapting them to the learner's profile (knowledge, preferences, abilities, objectives, etc.) due to their importance. In this article, we propose a model of e-learning environments, personalizing the pedagogical resources so that students succeed in their learning experiences. Rather than imposing a unique program on all learners independently of their respective abilities and needs, personalized learning allows the development of individualized learning that they will motivate them to follow.

The article is structured as follows: The following section reviews the literature on key theories and models presenting several factors that can contribute to the use, engagement, satisfaction, and success of learners in the e-learning system. Our proposed model is presented in Section 3. Subsequently, the proposed approach is described in detail in section 4. Then, we will end our article with a conclusion and a presentation of our future research work.

2 Related Work

A large number of studies over the recent decades have attempted to identify the success factors of e-learning that need to be managed to increase the effectiveness of e-

learning systems.

According to [4], the e-learning success model adequately explains and predicts the interdependence of six critical success factors for e-learning systems including course design quality, instructor involvement, student motivation, student-student dialogue, student-instructor dialogue, and self-regulated learning. Several researchers have been interested in aspects of the learner and how they can influence the learning process. Some have looked at personal characteristics such as learning styles [5] or motivation such [6] and claimed that these have an important influence on the success or failure of learners. According to [7] the effectiveness of learner-controlled online learning depends on individual cognitive characteristics and related to motivation such as learning styles, cognitive abilities, attribution of success, and self-regulation abilities.

Motivation is essential to learning and what really makes students learn is their conscious engagement in these learning activities, because "engagement leads to outcomes such as success" and "motivation underlies engagement", engagement and motivation are not the same [8]. Motivation can be transformed into engagement with an appropriate design of support. According to [9] intrinsic value and self-efficacy are motivation variables, whereas effort and metacognitive regulations are regulation variables, and cognitive and emotional engagements are engagement variables. Supporting students' effort regulation is a unique way to improve the motivation and engagement that influences their success and it is the metacognitive and effort regulation that learners put into the process of their learning that transforms motivation into engagement [9].

The word "self-regulation" refers to a student's ability to regulate his or her thoughts and actions [10]. For example, students can reflect more about how they learn and what strategies they will need to succeed in their university studies. To achieve specific learning and performance goals, a self-regulated learner employs motivational, metacognitive, and behavioral processes (for example, help-seeking, goal setting, self-evaluation, and metacognitive monitoring) [11], [12]. Self-regulation processes considered motivating allow a learner to initiate and maintain targeted activities focused on objectives while ignoring distractions and setbacks [13].

A self-regulated learner actively engages these processes by using strategies in what [10] have called Self-Regulated Learning Strategies (SRLS) [10], [14]. Examples of SRLS include tutoring, keeping a study journal, and emailing the instructor. Additionally, not all self-regulated learners use the same strategies. Thus, empirical research has shown that implementing various strategies in online courses can promote SRLS in students and that structuring the e-learning environment to promote self-regulated learning is a central element to fostering the successful use of SRLS by students [15], [16]. Researchers have suggested that SRLS are of greater importance in e-learning environments due to their more autonomous nature [17]. Thus, providing self-regulated learning strategies to online instructors to promote the use by students of these strategies in online courses aim to improve the academic performance of their students [18].

According to [19] learner success in an e-learning system can be explained by self-

regulation and learners' intention to continue using educational platforms, they also show that learners' intention to continue using these educational platforms can be explained by learner satisfaction, and self-regulation can be explained by personal effort and course flexibility, and although the following factors: perceived usefulness, social interactions, system quality, course and information quality, course flexibility, and diversity of assessments can improve learner satisfaction with educational platforms. According to [20], parents (family causal factors), teachers (school causal factors), and students (personal causal factors) can influence final performance. The combination of these factors influencing academic performance, however, varies from one academic environment to another, from one group of students to another, and even from one cultural setting to another.

Other factors play a role in online learning satisfaction and success that were all related to learner characteristics and course design characteristics of e-learning environments [21]. On the one hand, learner characteristics including self-regulation skills, time management, online learning style, knowledge, one that demonstrates better emotional intelligence (i.e. a better knowledge of his/her needs, self-regulation of feelings), self-motivation, self-discipline, organization, planning, and self-assessment. On the other hand, professors/instructors need to know the course design characteristics of online learning environments that promote student success and satisfaction, including time management, course alignment, and organization, integration of content with technology to facilitate engagement, instructor facilitation, instructor's comments, prompt feedback which is a primary factor in online satisfaction, and the size of the course which should not be large. Successful online learning also requires interaction between the learner, the instructor, the learners, and the technology.

The virtual learning environment effectiveness model of [22] posits that two antecedents (design dimension and human dimension) determine the effectiveness of e-learning systems. The human dimension concerns two human entities (the students and the instructor) and their different attributes; and the design dimension includes learning management systems (LMS), self-regulated learning (SRL) and learner control, the quality of course design, and the interaction between human entities.

Learning analytics provides opportunities for students to reflect on learning and develop metacognitive skills. So in order to be successful in self-regulation, it is necessary for students to understand their own cognitive process. To this end, linking visualizations to learning goals can help learners and instructors assess whether the goal has been achieved [23].

Interactions with the learning community members that includes learners and instructors, social presence, positive support, engagement, critical thinking, and overall assessment results have a positive impact on the concept of knowledge and skills acquired during the online learner's learning path that represents the backbone of the online learner experience [24]. In addition, forums play an important role in collaborative student learning, also allow students to interact. Students who participate most actively in the discussion forum are those who succeed in the course [25]. Course structure, class size, feedback, prior digital communication knowledge, interface characteristics, content area experience, student roles and pedagogical tasks, differences in

student demographics and abilities, etc. are factors that can influence student participation in these online discussion forums [26]. Other research results affirm that all students learn best when the instruction, resources, and learning environment are well-matched with their strengths, interests, needs, and their level of knowledge [27], [28]. Hence, the conclusion that personalization of learning is one of the main axes that must be taken into account if we want to see student outcomes improve.

Another aspect to take into account is the evaluation of learning. Students' learning depends on how they are evaluated and with what instruments [29]. Thus, the teacher assesses the student to identify the evolution through different levels of learning. On the one hand, depending on the level reached, the instructor proposes actions and material to improve the performance of the students [30] evaluations, videos, tests, conferences, among others. Each student, on the other hand, learns at his/her own pace. This requires personalizing the mechanisms used according to each student. Information and communication technologies can help the teacher discover who is learning and who is not motivated. They can suggest actions like when, who, and how to evaluate or what activities can be realized.

3 Proposed Model

In this section, we will describe our proposed robust model of e-learning environments that offer the personalization of learning to the specific skills and needs of each learner in order to improve the learning experience of the students, whose goal is to increase their success rate as well as reducing their dropout rate in these e-learning systems. Fig 1 shows our proposed model. It is then a matter of personalizing the learning objects, adapt teaching methods, helping the learner to use self-regulated learning strategies, as well as the feedback and evaluations provided by the teacher, that they will be personalized according to the learner's profile. In an e-learning system, they can be applied as components, also linking the visualizations to the learning goals in order to help learners and teachers to evaluate if the objective has been achieved. This is a useful practice for teachers and especially for learners since it allows the learner to be accompanied at any time and any place and tests his/her knowledge and skills. Hence the system requires a dynamic combination between the learner's demands (his/her interests, preferences, level of knowledge) and the possibilities of personalization.

The **Learner's** need is to learn. Our objective is to help him/her learn, to become autonomous, to be satisfied, and to succeed in his/her learning. In the e-learning system, the learner visualizes the learning objects provided by the teacher which are personalized according to his/her profile by the e-learning system, he/she has to evaluate his/her knowledge and level of understanding. Also, the learner has to be able to define his/her objectives, to make decisions in his/her program, to apply the right learning strategies which are cognitive strategies where the learner can take notes, summarize, create mental associations, use images and audio documents, use the mother tongue; metacognitive strategies are there to reinforce memorization and reflect on the learning process by setting goals, reflecting on him/her way of working, having a

personal learning journal, self-evaluation; socio-affective strategies bring the learner closer to his/her emotions and feelings by cooperating with peers, encouraging each other, opening up to others.

The role of the **Teacher** is crucial. He/she has to design educational sequences, evaluate the level of the learners, use the educational material provided... E-learning doesn't consist of simply letting learners navigate through a set of resources; it is a matter for the teacher accompanying them in their learning process through the design of educational activities integrated into a coherent scenario. The teacher's and the e-learning system's roles are therefore also to guide the learners to identify the best strategies, to help them learn and understand also to helping them to self-regulate.

The sub-components of the "**Learner profile**" component are as follows: history of his/her navigation (his/her learning established on the basis of his/her last interactions with the learning environment); his/her performance (this sub-component updates information about the learner through the results of the suggested evaluations); his/her preferences (based on his/her interaction with the learning environment, we determine the language of teaching, types of learning objects and preferred types of questions).

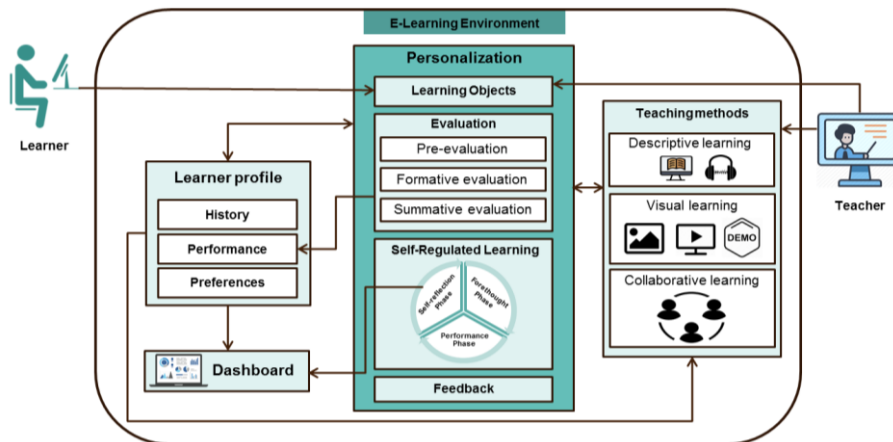


Fig. 1. Our Proposed Model of E-Learning System for Successful Education.

The "**Evaluation**" component aims to provide the learner with a personalized evaluation based on the information provided in his/her profile (e.g. preferences, type of questions, results obtained in the evaluations). It plays an essential role in how students learn, how they are motivated to study, and how teachers instruct. While teachers, students, and the online learning environment work to achieve the learning outcomes, evaluation plays a critical role in providing useful information to guide teaching, help students achieve the next steps, and verify progress and accomplishments. Evaluation serves a variety of goals:

- Evaluation in the service of learning: evaluation informs teachers and the online learning environment about what students understand and allows them to know what learning objects to adjust and to plan and guide teaching while providing use-

ful feedback to students.

- Evaluation as learning: evaluation allows learners to become aware of how they learn, to adjust and progress their learning by assuming increased responsibility for it.
- Evaluation of learning: the information gathered from the evaluation allows students, teachers, and the online learning environment to be informed about the learning outcomes achieved at a specific time in order to highlight successes, plan interventions, and keep promoting success.

The evaluation should be planned according to these goals. Evaluation in the service of learning, evaluation as learning, and evaluation of learning each have a role to play in supporting and enhancing students learning. In addition, the effective evaluation does not apply the same evaluation strategy to all learners because their knowledge is different. Some students should be evaluated on the entire learning content to evaluate their overall knowledge; others only need to assess their current knowledge in a few learning steps, which allows them to access the parts of the course that are most appropriate for their level of knowledge. The aim is to orient the learner to the most appropriate resources for his or her needs through a personalized evaluation. Based on the results of the test, a personalized learning itinerary will be provided. The three most popular types of evaluation are as follows:

- Pre-evaluation: Before they start learning, it is essential to know what type of students it is addressed, situating their level of knowledge and preferences. A personalized program can then be created based on the data collected.
- Formative evaluation: used during the first attempt at learning. By keeping track of students' progress and obtaining feedback to identify obstacles and individual difficulties to the diversity of students to provide individualized help and to adapt "**Teaching methods**". Basically, three teaching methods enhance the student learning experience: descriptive learning (reading, hearing), visual learning (pictures, videos, and demonstration), and collaborative learning (participatory).
- Summative evaluation: aims to evaluate if the most important knowledge has been acquired when the training is completed, in order to adjust the rest of his/her instructing according to the level achieved.

Also, providing learners with personalized "**Feedback**" on their performance is an effective strategy for promoting learning, with congratulatory messages (e.g., if the learner has successfully achieved his or her goal, a message appears saying "Well done, I'm proud of you") and advisory messages (e.g., if the learner receives a low grade, a message appears saying "Anyone can make mistakes, take extra time next time. ").

We then focus on promoting students' use of "**Self-Regulated Learning Strategies**" in an e-learning environment and on personalizing them according to their profile. The model of [11] was the most frequently accepted and we will use it. As shown in Fig 2 of [11], who postulated that SRL occurs in three cyclical phases: forethought, performance, and self-reflection [11], [31]. Each phase of self-regulated learning consists of processes that self-regulated learners engage in (Fig 3 describes the fishbone diagrams of each process), and each phase influences the processes of the next phase, and the third, in turn, influences the first again. The fishbone diagram is a diagram that graphically represents the causes leading to an effect, and can also be called a cause and effect diagram [32].

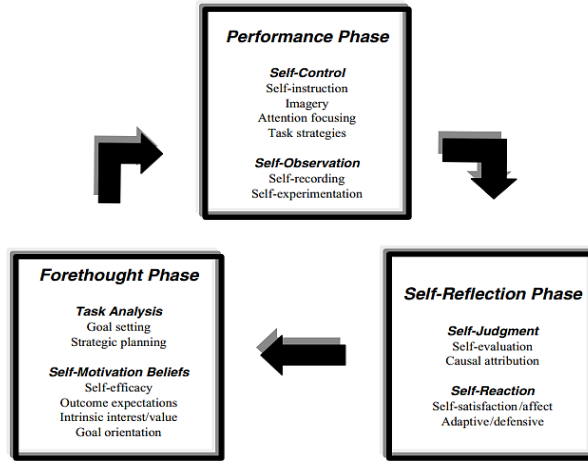


Fig. 2. Phases and sub processes of self-regulation [33].

The Forethought Phase of self-regulated learning describes the processes by which learners start to launch plans to complete a task or attain a goal (see Fig 3 (a)). The Performance Phase describes the processes learners employ to accomplish a task or goal (see Fig 3 (b)). In the Self-reflection Phase, learners reflect on their progress toward the task or goal, or the results if they have completed the task (see Fig 3 (c)).

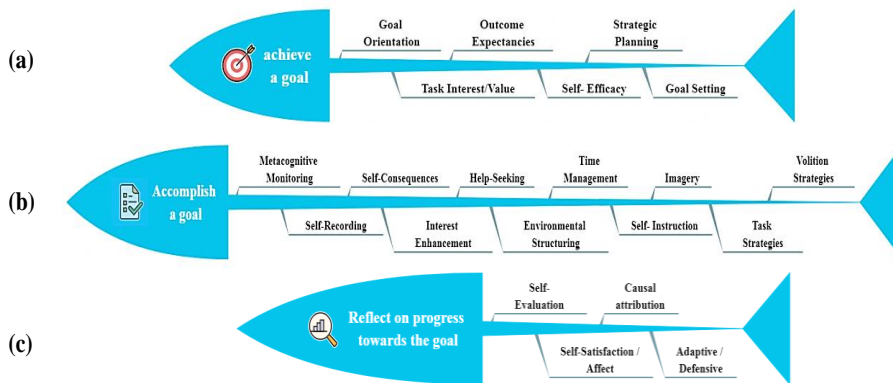


Fig. 3. Fishbone diagrams of the Forethought Phase (a), Performance Phase (b), and Self-Reflection Phase (c) processes [33].

Since students do not necessarily develop SRLS when taking online courses, even though these SRLS are of greater importance in online learning environments due to their more autonomous nature, instructors should consider implementing these strategies to help learners promote positive SRLS [18], but for instructors, it is difficult to fully understand each learner's profile to help them use these strategies and to

personalize these SRLS according to each learner's profile. Therefore, we propose to provide e-learning systems with specific strategies to encourage and help students to use these effective SRLS, which will be personalized to their profiles. Some students know how to launch plans, but some for example do not know how to manage their time. Also, for example, some students want help (Help-Seeking) while others want help to guide their learning. It is therefore the role of our proposition, to offer personalized self-regulation strategies to e-learning systems, to help them self-regulate.

Therefore, to succeed in self-regulation, students must understand their cognitive process [23]. Using goal-oriented visualizations of activity tracking is an interesting experience in analyzing student-centered learning through visualizations [34]. In this case, we add a "Dashboard" component to the e-learning system to allow students to reflect on their activity and compare it with their peers through dashboards. For this aim, the collected information such as their learning performance will be displayed in visualization to help them in their future decisions on task or goal completion.

In the next section, a description of the proposed approach is shown in the form of a sequence diagram that shows the scenario behind the background of our model.

4 Scenario of the proposed model

In this section, we will describe the context of our research using the personalized learning environment scenario.

Once identified, the teacher adds learning objects, evaluations, and feedback. One identified as well, the learner navigates and consults educational resources. These traces of the learner's interaction with the learning system are used by the adapter component to better define the learner's preferences (teaching language, types of learning objects, types of questions, etc.). The adapter's function is to personalize the learning resources according to the learner's profile and to consult the traces, results, and profiles of other learners in order to propose the best configuration to each new learner. The adapter will also help the learner to self-regulate.

The learner must define his/her goal, if he does not do so the system asks him/her to define it. For example, Yasmine is a student in computer engineering who would like to learn the C language, the system sends Yasmine's objective, the resources (learning objects, evaluations), and the feedback provided by the teacher to the adapter to form a pre-evaluation on the chosen objective. After Yasmine answers the corresponding questions and according to the results obtained (the questions that were not answered correctly), the adapter depends on it to generate personalized feedback to Yasmine, teaching methods adapted to her needs, and a program personalized to her profile (preferences, performance).

She starts learning and to achieve her goal she starts using self-regulation strategies, so the adapter will help her to use them aiming to improve her academic performance. For example, she decides to ask for help every week on the parts she did not understand well, and unfortunately at the end of the semester, Yasmine does not receive a good grade in the course. So she attributes the cause (i.e., causal attribution) to the strategy used (i.e., seeking help did not help her achieve her goal). In the course that follows, Yasmine will decide not to pursue this strategy.

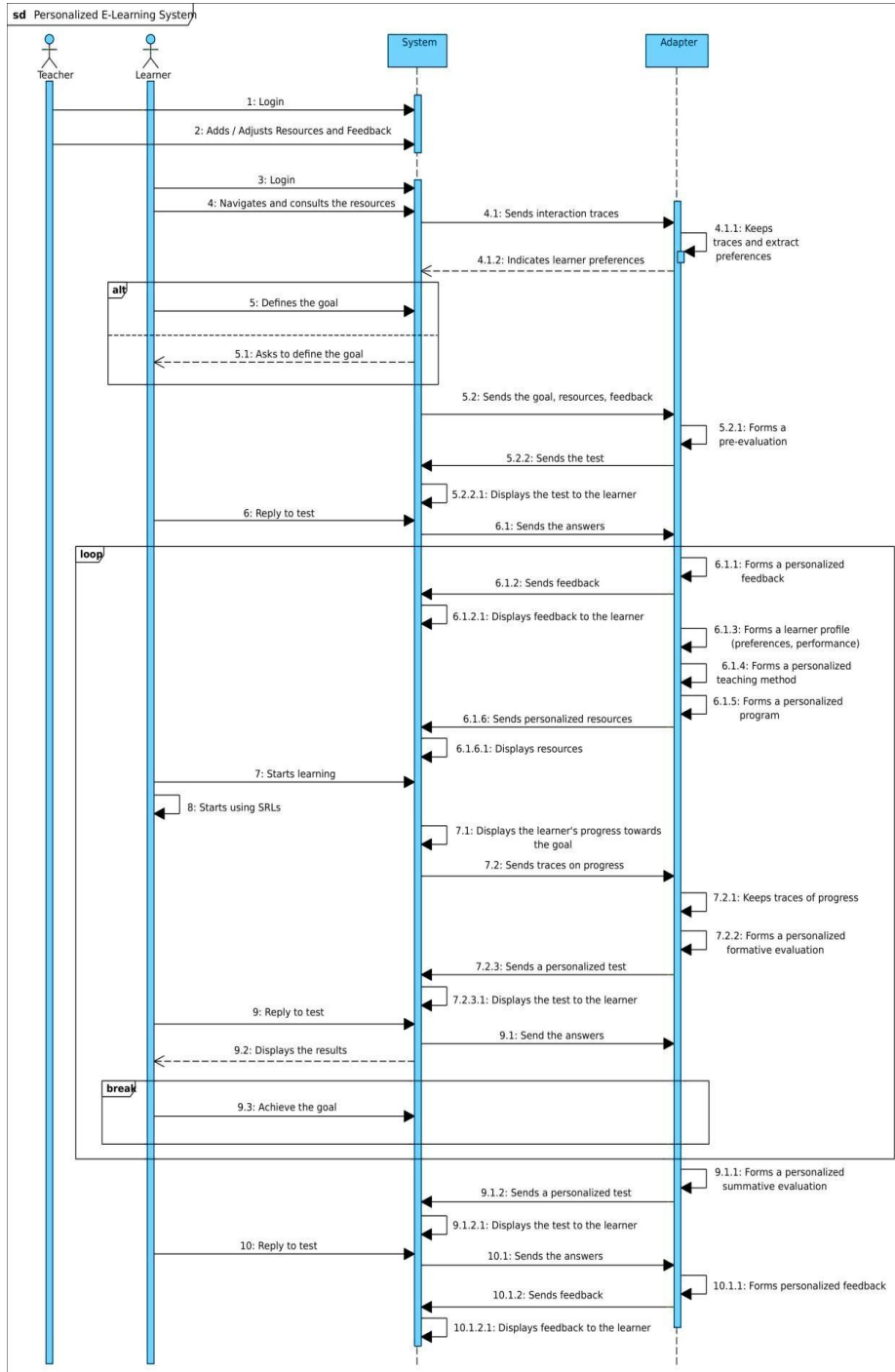


Fig. 4. Personalized E-Learning system sequence diagram.

In order to successfully self-regulate, the system displays the collected information, e.g. her learning performance, in a goal-oriented visualization so that Yasmine can track her progress towards her goal. Thus, to ensure that Yasmine understands the important concepts of the C language, questions will be researched by the adapter and presented to constitute personalized formative evaluations on this lesson, estimating her level of knowledge at each stage of the learning. The adapter should save Yasmine's progress and tracks in order to use them for future evaluation activities and form personalized feedback according to her profile until she achieves her goal.

Finally, the adapter forms a personalized summative evaluation to Yasmine to affirm that she has succeeded in achieving her goal, that she has understood the important language C concepts, and give her personalized feedback, e.g. motivational messages, advice, etc. For example, if she succeeded with a good grade the adapter sends a message saying "Congratulations, it was hard but you did it", this is a motivational message. Figure 4 illustrates a sequence diagram, which shows this scenario behind the background of this personalized e-learning system.

5 Conclusion and Future Work

In this article we have proposed a new model of online learning environment, helping the learner to self-regulate and make his/her learning in the e-learning system more accessible, easier, more personalized, more credible, and more desirable which ultimately leads him/her to better success. Thus, we presented the main factors that influence learners' success in their learning experiences that we included them in the model in order to improve the learning experience and presented a description of the proposed approach in the form of a sequence diagram that shows the scenario behind the background of our model. For future studies, we will experimentally validate this proposed model. Additionally, we suggest further study regarding learner-controlled online learning, how, what, when, and where to learn, which may lead to self-regulation skills and may be a factor in dropout rates of e-learning courses.

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