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Adaptive learning: toward an intentional model for learning process guidance based on learner's motivation

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Abstract

The goal of ITS is to support learning content, activities, and resources, adapted to the specific needs of the individual learner and influenced by learner's motivation. One of the major challenges to the mainstream adoption of adaptive learning is the complexity and time involved in guiding the learning process. To tackle these problems, this research proposes an intentional model that adopts Map formalism to support personalized learning guidance by considering learner's motivation. For that, the intentional model adopts the ARCS model of motivation. The proposed model couples the learner's intention with the learning strategies and provides a multitude of paths between learner intentions. Based on the learner's motivation and the corresponding learning mode or the individual learning style, the ITS can adaptively support the learner to achieve his/her intention through the selected strategy. The first results show that this study's provide implications for both theoretical research and the practical development of ITSs that will help education professionals make full use of ITSs. In the initial tests, the process model has met what was expected, however, more studies with experiments must be carried out.

Keywords: Intelligent tutoring system, Guidance, Motivation, Learning process, Intentional model, ARCS model

Introduction

A lot of research in recent years has concentrated on the adaptation challenge in intelligent tutoring system (ITS). There has been an important academic revolution in intelligent tutoring systems (ITS) by considering the different individual learning needs to generate appropriate learning process. The whole aim of this revolution is the comfort of learners (learning the appropriate content in the appropriate way).

While several definitions have been reported in the literature, most of them focus on the tactical process modeling (Bayounes et al., 2012, 2020, 2022). Various works view learning processes as a set of phases without respecting the different goals to achieve and the various strategies to apply. Moreover, the different learning needs and the learner's motivation are not well considered by various studies in the literature (Paris et al., 2021). For that, the concept of intentional process is adopted to specify the proposed model.

This model considers each intentional process as a set of actions to perform by considering motivational state and situational knowledge. Each intentional process applies in a particular situation to achieve a learning purpose. The intention is adopted to model the learning processes and ensure variability and flexibility for guiding their construction.

Within this context, the paper focuses on strategic and intentional specification of learner's motivation and preferences to solve the problem of learning process guidance by ITS. For that, it proposes a strategic perspective of process modeling by choosing the Map formalism to specify the different intention types to achieve and the various strategies to apply (Rolland, 2007). This formalism will guide the learning progression by supporting the selection of the appropriate educational intentions and the suitable strategies according to the learner's preferences and the learning needs.

The remainder of this paper is organized as follows. In "Related work" section, learner's motivation is introduced by presenting the ARCS Model of motivation. "Material" section provides an overview of the process context to define the intentional model of learning process. This defined model is adopted to specify two examples of learning progression. "Method" section discusses the results of experimentation. Finally, we conclude and outline several topics of potential future work.

Related work

Motivation is the strength that moves behavior, that derives to all activities by the people. Within this context, this definition of motivation recognizes that the learner must have enough activation and clear objectives, energy during the learning process to reach that learning goal.

Motivation concept

Scholars have suggested many definitions of motivation in the literature. Glynn et al. (2011) define motivation as an internal state that arouses, directs, and sustains goal-oriented behavior. It is a psychological concept, and it is used to describe the reason for one's behavior. Renko et al. (2012) explains motivation as the combined effect of a chain of three factors: expectancy, instrumentality, and valence. Expectancy is the personal assessment that exertion of effort will result in performance (Ji et al., 2018). Instrumentality represents the personal thinking of whether that performance will result in reward or punishment (Ji et al., 2018). Valence describes the extent to which that reward or punishment is important to the person (Ji et al., 2018).

For instance, literature identifies two types of motivation: extrinsic motivation and intrinsic motivation (Kovacevic et al., 2013; Osterloh & Frey, 2000; Visgatis & Tada, 2020). Extrinsic motivation is defined as individuals to live up to their needs ultimately by getting supplementary resources, such as money, advancement opportunities and other non-financial resources (Deci, 1976). On the other hand, intrinsic motivation is defined as an action by an employee who is valued for its own sake and appears to be a self-sustaining for him/her (Deci, 1976).

Lindenberg (2001) divided intrinsic motivation with normative (i.e., sense of conformity with personal and social norms) and hedonic (i.e., meeting in self-determined, individual capability and enjoyable activities) (Azman et al., 2013; Kreps, 1997).

In contrast, extrinsic motivation is present when a task is performed for the sake of external rewards or to avoid threatened punishments (Sandrin et al., 2019; Deci & Ryan, 2000; Kuan-Chung & Syh-Jong, 2010). In addition, Deci and Ryan (1985) categorized extrinsic motivation into two components: task-contingent rewards and quality-dependent rewards.

Maehr (1976) stated that motivation is very important in all kinds of education. It is a key factor in learning in case of the face-to face educational contexts (Brophy, 2010) as well as in online learning environments (Hartnett et al., 2011). Traditionally, online learners have been understood as independent, self-directed, and intrinsically motivated (Hrastinski, 2007). Motivation of the learner is complex, multifaceted, and sensitive to situational conditions (Hartnett et al., 2011). In fact, it is referred broadly to what people desire, what they choose to do and what they commit to do (Keller & John, 2010).

The two major objects of motivation are the teachers and the learners. Teacher's motivation is the possibility of an extension and updating of independent work of learners (Zaikin et al., 2016). Learner's motivation is the joint study of the subject under supervision of a teacher live chat, cognition through competition, stress reduction compared to traditional testing, choice possibility, etc. (Moos & Marroquin, 2010; Zaikin et al., 2016).

Destarianto et al. (2018) considers motivation as one of the important factors affecting student involvement in learning activities because this factor comes from within the student itself. Finally, it is important to know the student motivation level before determining and using the true method in the learning process (Destarianto et al., 2018). Motivation refers to a student's willingness, need, desire and compulsion to participate in learning, and to be successful in the learning process (Feng & Tuan, 2005; Isnaini, & Hendy, 2019). The guidance of this process needs innovative learning methods and has to improve student learning motivation (Destarianto et al., 2018; Law et al., 2008; Wen-Hao, 2011).

A considerable number of current studies (Chen et al., 2022; Mirzaei et al., 2022; Rahmat et al., 2021; Roemintoyo et al., 2022) have been claimed that ACRS model of motivational design is the most effective model to overcome the challenge of adaptive learning. John Keller is the founder of the ARCS Model of Motivation, which is based upon the idea that there are four key elements in the learning process which can encourage and sustain learners' motivation (Keller, 1983). This model is particularly important for e-learning, since motivating learners in an online course more difficult than in face-to-face courses. For that, this research adopts ARCS model of motivation to guide the learning process construction in ITS.

ARCS motivation model

Among the various models, the ARCS model has been considered a systematic and easy-to-apply model for designing motivational learning (Keller, 1983). It is one of the models that demonstrate how the motivation of students in academic life is influenced in the teaching–learning process scan and help educators to design a layout that will motivate the students (Demirli & Gürol, 2007).

Keller developed the ARCS motivation model, cognitive psychology, social learning theory and motivation theories to increase the motivation factor in his design and the effectiveness of the learning process (Shellnut, 1996). Khakpour et al. (2016) has

described this model by specifying four aspects: Attention, Relevance, Confidence and Satisfaction. These four aspects are closely related to students' learning motivation in the learning process (Li & Ren, 2018).

The ARCS model provides a basis for designing learning activities that support teachers/tutors in the guidance of learning process. It is used in the current research as the theoretical basis of the whole process model to improve learning interests from four aspects, namely students' overall learning attention, knowledge relevance, learning confidence and effect satisfaction, so as to provide a feasible direction for the improvement of the learning process guidance. The following paragraphs illustrate the different methods of motivation aspects (Keller & John, 2010).

The attention refers to arouse and sustain learner's curiosity and interest by following methods:

- Perceptual arousal: it is devoted to the use of surprise or uncertain situation to create curiosity and wonderment.
- Inquiry arousal: it focuses on the nurture thinking by offering challenging quesions and problems to solve.
- Variability: it incorporates a variety of teaching methods to sustain interest.

The relevance links a learner's needs, interests, and motives by means of the following methods:

- Global Orientation: it discusses how the knowledge will help the learner today as well as in the future.
- Motive Matching: it assesses the learner's needs and reasons for learning and provides choices in their learning methods.
- Familiarity: it focuses on the examples of pervious works that apply to new classroom concepts.

The confidence develops positive expectations for achieving learning success through the following methods:

- Performance Requirements: it provides learning standards and evaluative criteria to establish positive expectations and trusts.
- Success Opportunities: it presents multiple, varied challenges to experience learning success.
- Personal Control: it allows learners to attribute success to personal effort and ability.

The satisfaction provides reinforcements and rewards for learners by means of the following methods:

- Intrinsic Reinforcement: it stimulates an intrinsic enjoyment of the learning experience.
- Extrinsic Rewards: it ensures positive reinforcement and motivational learning.
- Equity: it maintains consistent standards and consequences of learning success.

Material

The proposed model is based on the homogeneity of the expression of learners' needs to reduce the conceptual mismatch between learning paradigms. It enables rethinking of learning process by adopting the intentional and the strategic dimensions. For that, the process description is oriented to the objective that the process can achieve.

I order to define the process model, the section introduces the process context, which is considered to describe the learning progression based on the proposed model.

Process context

The learning process is viewed as an outcome and finality gained by defining the learning product (Bayounes et al., 2013). Finality refers to a major intention to be achieved by a process model (Bayounes et al., 2013, 2014; Saâdi et al., 2020). The different outcomes are verbal information, intellectual skills, motor skills, cognitive strategies, and attitudes (Gagné, 1985). The intellectual skills are mental operations. The motor skills refer to the capacity of the learner to perform a physical movement (Bayounes et al., 2013). The cognitive strategies are internal processes by which the students plan, control and monitor the learning (Bayounes et al., 2013). At the end, attitudes relate to the predisposition that affects an individual decision (Bayounes et al., 2013).

The product model specifies the learning domain. Learning domain includes different topics belonging to a domain explored by the learner. The learner identifies the desired topics to reflect upon (Bayounes et al., 2013). This reflection is used to support the elaboration levels, including knowledge, comprehension, application, analysis, synthesis, and evaluation (Forehand, 2005; Reynolds et al., 2018). The elaboration level is examined by engaging in different assessments to reach the learning outcome (Bayounes et al., 2013). For that, the desired level is satisfied by using different learning objects, namely fact, concept, procedure, and principle (Merrill, 1983).

Learning process model

Model definition

To specify the major learner's intention, the learning process model capitalizes on different definitions of process (Bayounes et al., 2013). It is based on four intention types, namely explore, reflect, engage, and elaborate (Bybee et al., 1989). To reach these intentions, the model proposes various learning strategies (see Fig. 1).

Within this context, the new classification of learning strategies is defined to achieve different intentions (Bayounes et al., 2013). This classification is based on the Oxford learning strategies classification (Samida, 2004) to propose the cognitive, metacognitive, social, and affective strategies. The first class is beneficial to the students because it helps store and recover information (Bayounes et al., 2013; Haller, 2013). The second class helps the learner in regulating the learning process (Bayounes et al., 2013). The third class includes different strategies to be used in communication and control of emotions and learner attitude (Bayounes et al., 2013).

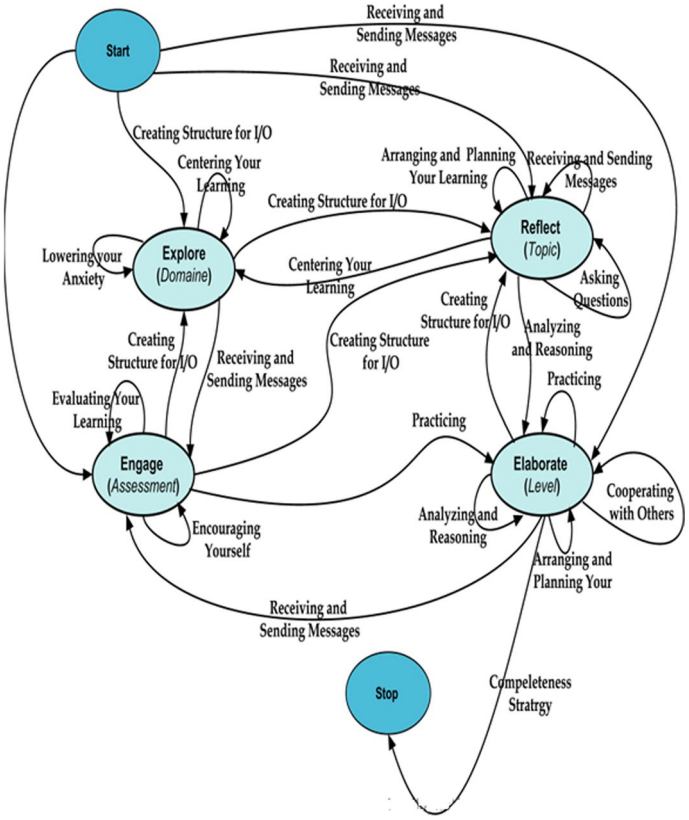

Fig. 1 Learning process model

Exploration arguments

Our process model is based on the adaptation of Map guidelines to learning context by specializing Intention Achievement Guidelines (IAG) into cognitive, metacognitive, social, and affective guideline based on learning strategies (Bayounes et al., 2013). To explore the process model, we have also classified, and refined arguments considered in the choice criteria of an alternative based on the persuasive or logical objective of argument into logical argument, quasi logical argument, and rhetorical argument (Bayounes et al., 2013, 2014; Saâdi et al., 2020). A logical argument (LA) is guided by a clear thinking (Bayounes et al., 2013; Saâdi et al., 2020). A quasi-logical argument (QL) is supported by the experience (Bayounes et al., 2013; Saâdi et al., 2020). A rhetorical argument (RA) depends on the individual preferences (Bayounes et al., 2013; Saâdi et al., 2020). The logical argument is specified by the learning mode. It is based on Norman theory (Rumelhart & Norman, 1978) by defining the three major learning modes, namely accretion, structuring and tuning. The various tactics of learner's motivation are considered to define the quasi-logical argument. These tactics are classified into four main dimensions, namely attention, relevance, confidence, and satisfaction (Keller, 1983). The rhetorical argument is identified by the five dimensions of felder-silverman learning style model (FSLSM), namely perception, input, processing, organization, and modularization (Felder & Silverman, 1988). The first dimension of perception distinguishes between a sensory and an intuition type

of perception. The second dimension identifies the input modes of information. The third dimension of processing covers reflective versus active learning. In the fourth dimension of organization, the learners are characterized according to their way of organization. Finally, the fifth dimension of modularization distinguishes between a global and a sequential mode of understanding. By adopting these arguments, the selection criterion (SC) is defined as SC = QL AND (LA OR RA). The guidelines and argument refinements offer us more flexibility for learning process guidance in ITS.

Learning progression

In this section, a brief description of guidelines examples is given to support the learning progression.

Intention selection guideline (ISG)

After the achievement of the current intention, the ISG guideline guides the progression by selecting the next intention to be accomplished according to the learner's motivation and the learning mode or the learning style. The guideline ISG1 < (Session, With State(Session) = Started), Progress from Start > supports the process progression by recommending the selection of the first intention between exploring the domain, engaging in the assessment, elaborating the predicted level and reflecting on the topic (see Fig. 2). The selection of reflection intention depends on the structuring mode or the auditory learning style. The engaging intention is achieved by the active processing or the tuning mode of learning. However, the extrinsic rewards strategy of learner satisfaction and the sequential style of learning can be used to achieve the elaborating intention. Finally, the accretion or the structuring mode of learning and the presentation of success opportunities to develop learning confidence can be adopted to reach the exploring intention.

Strategy selection guideline (SSG)

The purpose of this guideline is to guide the selection of the suitable strategy to elaborate the desired level according to the learner's motivation and the learning mode or the learning style. In order to satisfy this purpose, we present the guideline having the following Signature SSG3: < (Level, With State(Level) = Not elaborated), Progress to Elaborate (level) > (see Fig. 3). This guideline specifies how to elaborate the level by choosing the practicing strategy or the cooperating with others strategy or the analyzing and reasoning strategy or the arranging and planning of your learning strategy. The selection of the practicing strategy depends of the tuning mode and the extrinsic rewards strategy of learner satisfaction. The arranging and planning strategy is based on the structuring mode or the intuitive perception of learners. The cooperating with others strategy requires an inductive style of learning and the presentation of success opportunities to develop learning confidence. At the end, the personal control of learning and the structuring or the accretion mode are adopted by analyzing and reasoning strategy.

Method

The experimentation was conducted in a tertiary education institution in Tunisia. It took place during January–April 2018. The aim of this experiment is to investigate the performance of the intentional model for learning process guidance based on the learner's

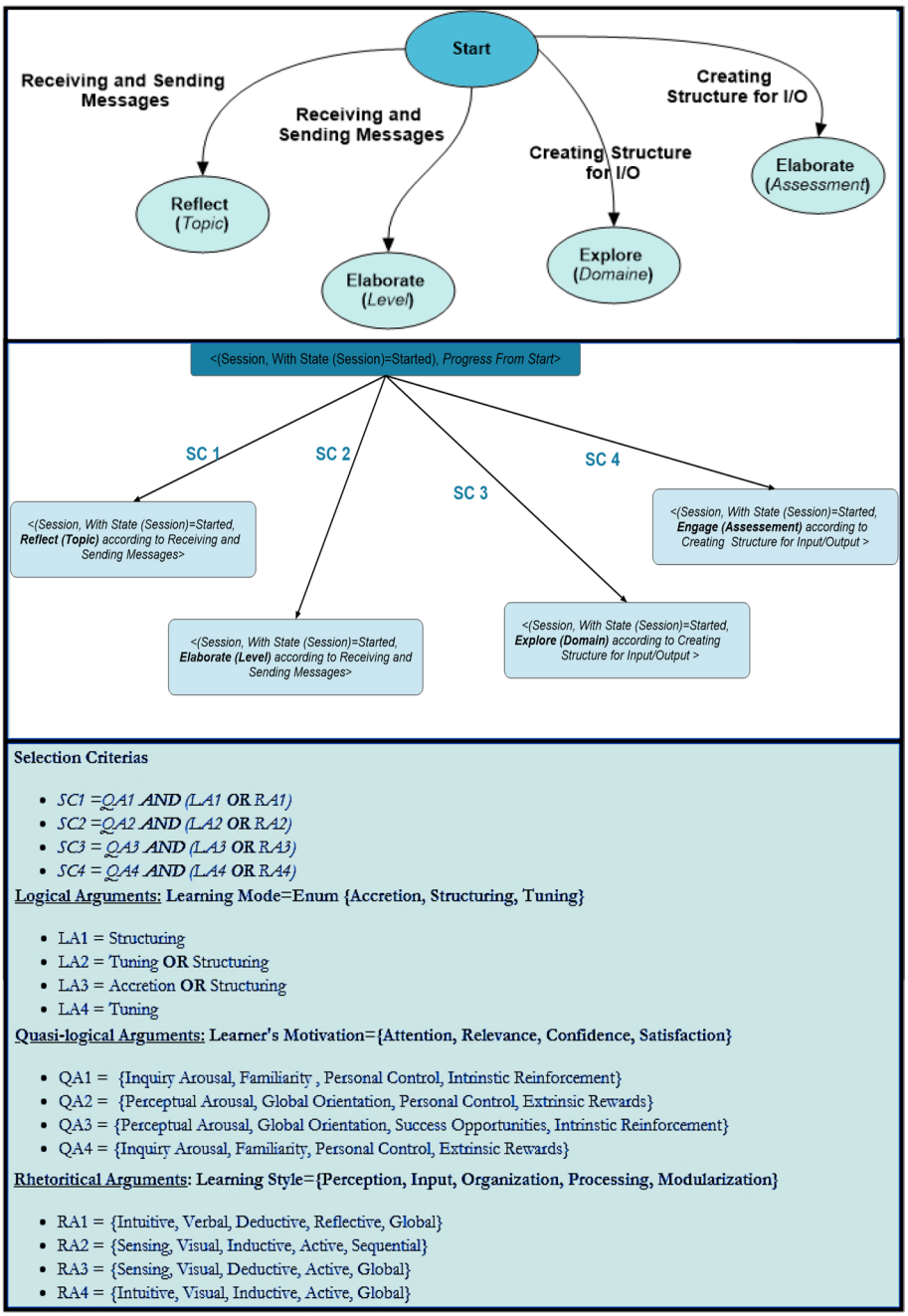

Fig. 2 Example of intention selection guideline

motivation. Before the result analysis, this section identifies the participants and the used instruments to define the experimentation procedure.

Participants

Forty students participated in the experiment. This experimentation involved 20 participants studying in applied license's degree in Business English and 20 participants studying in applied license's degree in Education Sciences. In order to evaluate the usability

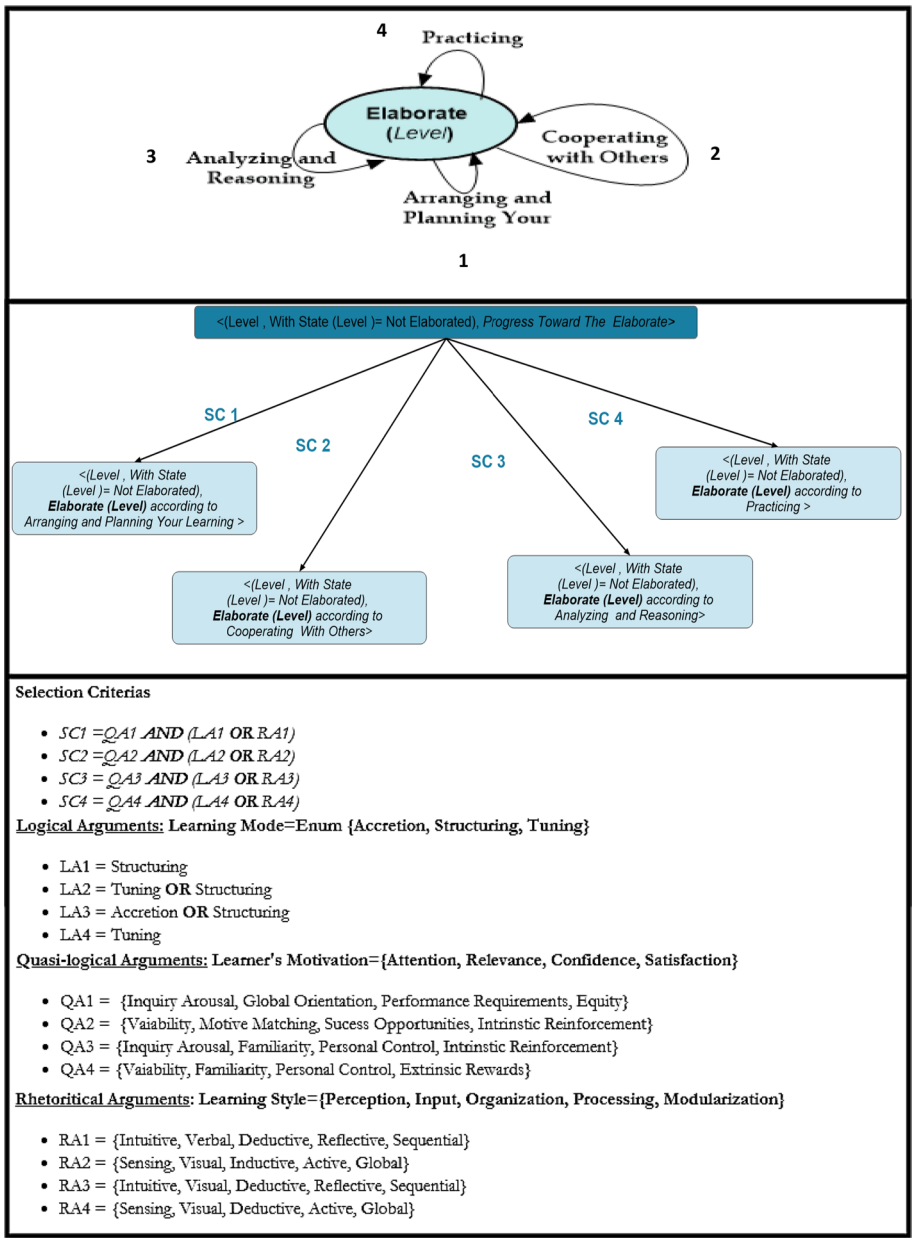

Fig. 3 Example of strategy selection guideline

and effectiveness of the proposed model, the selection of the participants was based on their ability of word processing through their previous experiences of using Microsoft Word to do their work.

However, only 32 students (8 males and 24 female) actually finished the online learning process. Specifically, the other 8 students dropped out of the course at different phases (i.e., some students dropped out of the course in the second week, while others after a couple of weeks). This study analyzed the log data of the students who finished all the learning processes for 6 weeks.

All the students reported that they had never taken a fully online learning experience before. The average age of the students was 20 years old, with 75% being female. The

students were randomly divided into two groups. All students were already familiar with using electronic devices, such as mobile phones and computers, for information searching and communication, but had not previously used any ITS for learning.

Instruments

This experimentation is based on a course about Microsoft Office Specialist certification (MOS) Word 2016 that was taught to undergraduate students in the second semester at High Institute of Applied Studies in the Humanities of Zaghouan, University of Tunis. The online course had five lessons, covering the main concepts of certification. The lesson was composed of commonly used learning activities in word processing and the lecture slides to explore the main concepts. In fact, different courses given at the ISEAHZ are available on the digital environment of the Virtual University of Tunis (http://ent.rnu.tn). When registering in this environment, the students filled out the Index of Learning Styles (ILS) questionnaire (Felder & Silverman, 1988) so that their learning styles could be identified and stored in Moodle. The ILS questionnaire is an often-used instrument and consists of 40 questions, 10 for each dimension. Moreover, the students' learning motivation was measured by adopting the 25-item of science motivation questionnaire II (Choi & Shah., 2015; Glynn et al., 2011). The science motivation questionnaire assesses the factors underlying the leaners' motivation (intrinsic motivation, career motivation, self-determination, self-efficacy and grade motivation) to choose the appropriate tactic to enhance the overall learning attention, the level of knowledge relevance, the state of learning confidence and the effect satisfaction. Finally, the required learning modes were defined by the lesson syllabus.

Procedure

Based on the different learning styles and the various tactics of learner's motivation, a total of 20 learning processes were selected for two lessons of certification course (LA: Create and Manage References, LB: Insert and Format Graphic Elements). For each student, the tutor explains the predefined learning process at the beginning of lesson. After the achievement of different learning activities of the lesson, the learners were asked to assess the usefulness of each section of proposed process on a five-point Likert scale (0: never; 1: rarely, 2: sometimes, 3: often and 4: always). The mean of usefulness for different sections determined the overall usefulness of predefined process.

Results and discussion

After the analysis of learners' answers, the Table 1 summarizes the result of the study. The overall usefulness and the number of sections are presented for the different processes. For each process, the Table 1 presents the number of sections according to their usefulness level. As shown in the Table 1, the overall usefulness of majority of learning processes is "often" (50%). For that, the mean of the overall usefulness is 2.33 and the standard deviation is 0.8. Moreover, 20% of processes have "always" and 30% of processes have "sometimes" usefulness. As a result of this study, it is observed that the usefulness of most of the process sections isn't "rarely". For the different process, the mean of sections number by usefulness level and the standard deviation indicates that the usefulness of 50% sections is "often" or "always". For the first lesson, 31%

Table 1 Usefulness of learning processes

Lesson	Learning process	Number of sections	Overall usefulness	Number of sections "rarely" usefulness	Number of sections "sometimes" usefulness	Number of sections "often" usefulness	Number of sections "always" usefulness
Lesson A	P1	3	(Always: 3.67)	0	0	2	1
	P2	4	(Often: 2.25)	1	1	2	0
	P3	4	(Often: 2.75	1	1	0	2
	P4	3	(Often: 2.67)	1	0	1	1
	P5	5	(Always: 3.40)	0	1	1	3
	P6	5	(Often: 2.80)	1	1	1	2
	P7	4	(Sometimes: 1.25)	1	0	0	1
	P8	3	(Sometimes: 1.33)	2	1	0	0
	P9	3	(Often: 2.00)	1	1	1	0
	P10	5	(Often: 2.80)	1	1	1	2
Lesson B	P11	4	(Often: 2.75)	1	0	2	1
	P12	4	(Always: 3.00)	0	2	0	2
	P13	5	(Always: 3.00)	1	2	1	2
	P14	3	(Often: 2.33)	1	1	0	1
	P15	4	(Sometimes: 1.75)	2	1	1	0
	P16	4	(Sometimes: 1.25)	2	0	1	0
	P17	5	(Often: 2.80)	0	2	2	1
	P18	5	(Sometimes: 1.60)	2	3	0	0
	P19	3	(Often: 2.00)	0	0	2	0
	P20	4	(Sometimes: 1.25)	1	2	0	0
Mean of sections number by usefulness level 1 s				1 (0.95)	1 (0.86)	1 (0.79)	1 (0.95)
Standard deviation of sections number by usefulness level				0.69	0.86	0.79	0.94
Mean of sections by process					4		
Mean (overall usefulness)					(Often: 2.33)		
Standard deviation (overall usefulness)					0.79		

of process sections have "always" usefulness and just 18% of process sections have "sometimes" usefulness. On the other hand, 17% of process sections of the second lesson have "always" usefulness and 32% of process sections have "sometimes" usefulness. For the two lessons, 22% of process sections have "often" usefulness.

On the other hand, some limitations are found which may limit the generalizability of the results. For instance, the sample size of the experiment was limited, due to the experiment context (public university). Also, the learning process of each group was only for two hours of one course (just course of MOS Certification). However, despite these limitations, this study presented insights, including practical examples and recommendations.

In future work, we try to extend the sample size of experiment and we plan to compare the effectiveness of proposed model for three different courses.

Conclusion and future work

The core contribution of this research is to provide an individual learning path by respecting the learner's motivation and the learning preferences. This contribution has attempted an intentional modeling of the learning process to support the adaptive learning by an ITS. However, the proposed model considers the different definitions of the learning process (Bayounes et al., 2013). It is based on a non-deterministic ordering of intentions and strategies (Rolland, 2007), that allows us to model the learning process. Different progressions from one intention to another are guided by strategies (Velez, 2002). Within this context, the proposed model adopts the ARCS motivation model to consider the different aspects of student's learning motivation in learning process. Based on these aspects and the different dimensions of individual learning style or the corresponding learning mode, the model guides an adaptive construction of learning process.

The proposed model is evaluated in different learning situations of the MOS certification course to assess the different model guidelines. The preliminary evaluation shows that the proposed model can enhance learning level by considering different dimensions of individual learning styles and various aspects of learner's motivation. However, there are two major constraints for the application of this model. The first one is the huge task that learners would need to undertake to respond to an explicit questionnaire for the determination of their learning style and the current state of motivation. The second constraint involves the elimination of some pedagogical preferences that makes the proposed guidelines less suitable according to the real learning situation.

Overall, this work can serve researchers in ITS by guiding the most suitable learning process which considers the learner's motivation and the learning needs. Future work lines include two main threads. On the one hand, this model can be a basis for integration of the fuzz logic in order to generate the more suitable guideline according to the current state of learner's motivation and the dynamic learning preferences. On the other hand, we have detected a clear need of providing teacher/tutor with the intentional model for pedagogical process guidance that considers the cognitive traits of learner and the pedagogical preferences of the tutor. In addition, future studies ought to focus on how to integrate these significate research with development of adaptive MOOC.

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Availability of data and materials
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Declarations

Competing interests
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