Towards a New Generation of Intelligent Tutoring Systems

https://doi.org/10.3991/ijet.v14i14.10664

Mohammed Beyyoudh (✉), Mohammed Khalidi Idrissi, Samir Bennani
Mohammed V University in Rabat, Morocco
beyyoudh.mohammed@gmail.com

Abstract—In this paper, a new approach of intelligent tutoring systems based on adaptive workflows and serious games is proposed. The objective is to use workflows for learning and evaluation process in the activity-based learning context. We aim to implement a system that allow the coexistence of an intelligent tutor and a human tutor who could control and follow-up the execution of the learning processes and intervene in blocking situations. Serious games will be the pillar of the evaluation process. The purpose is to provide new summative evaluation methods that increase learner's motivation and encourage them to learn.

Keywords—Intelligent tutoring system, serious games, adaptive workflow, evaluation, adaptive learning, learning process.

1 Introduction

Students of today are known of their addiction to technology. They are smart, creative, connected and they live in their world: virtual world. They avoid everything that is traditional including school. For them traditional educating system is outdated and prefer to study using computers.

Today's challenge is how to motivate this generation to study?

Many researches have been conducted in order to answer this question. Several strategies and methods have seen the light to provide systems based on smart tutoring to facilitate education process. We are particularly interested in "serious games" and their integration into intelligent tutoring systems.

Intelligent Tutoring Systems (ITS) objective is to combine educational and computer expertise in order to replace the human tutor with a system able of providing good teaching. It's a system that allows the learner to complete educational activities and to acquire knowledge and skills through an artificial learning process.

Most of researches in ITS do not take into consideration the integration of human tutor in the learning process. In fact, the human tutor has an important role to maintain the learning process and to help learners go further. To respond to this first problematic, our work consists on integrating adaptive workflows in our ITS to permit the adaptation of the content to the student needs and levels and to allow the supervision of the advancement by the human tutor. In addition, we attempt through this paper to re-

spond to a second problematic which consists on increasing the student motivation. In fact, the combination of ITS and learning games will allow the student of these generation to learn based on their preferences and style of learning.

Our work considers the fact that students' goal is to succeed in evaluations. For this reason, we are interested in integrating learning games in the evaluation process. This will boost the motivation to learn in order to complete the game and succeed the evaluation.

Our approach will be the subject of this paper which will be divided into 5 sections: In section 2, we will present serious games and related works and researches. Section 3 will be dedicated to evaluation and its integration into serious games. In section 4, we will present Intelligent Tutoring Systems (ITS) and their components, and we will highlight the integration of serious games in ITS. In the section 5, we will discuss our approach and present our vision of the use of serious games in ITS. Finally, we will draw a conclusion that gives a synthesis and a description of our future work.

2 Serious Games

2.1 Definition

The concept of "Serious games" has been the subject of several researches and studies. Definitions existing are multiple for this concept. Based on the definition given by [1], a serious game refers to using games in learning and education. The authors of the work [2] consider a serious game as the result of applying games to a domain that is not related with entertainment.

Julian Alvarez proposes in [3] the following definition of a serious game: "A computer application that aims to combine with consistency, both serious aspects such as non-exhaustive and non-exclusive, teaching, learning, communication, or the information, with playful springs from the video game, adding this association must be done by implementing a pedagogical scenario".

In fact, Serious games initiative has popularized this concept in 2002. This initiative focusses on the use of games to explore management and leadership problems that the sector public faces. Its objective is to relate productively electronic games to learning games projects in different domain: Health, Education, politics.

Unlike entertainment games, serious games are based on pedagogy to ensure learning while playing. The table 1. Stated in [2] represents the major differences between entertainment games and serious games:

Table 1. Major differences between entertainment games and serious games [2]

	Serious games	Entertainment games
Task vs. enriched experience	Problem solving	Enriched experience
Concentration	Important elements of learning	To have pleasure
Simulation	Assumptions needed for exploitable simulations	Simplified simulation process
Communication	Must reflect natural communication	Often perfect communication

2.2 Characteristics of serious games

Serious games have the same characteristics as a video game. What matters the most is to excite and motivate the player. Charsky has proposed in the work [4] the following characteristic of a serious game:

Competition and goal: The goal of educational games is very often a pedagogical objective. The competition can be added to motivate the player to do all the activities and make the game more fun [5]. In fact, games have developed a lot. Now the game is not just a matter of winning and losing, but of evolving through a pattern that gives the player more control on the goals to be achieved and how to reach them.

Choices: The choice in games refers to the number of options and decisions that the player has access to before and during the game [6]. As Charsky mentioned in [4], there are 3 types of choices:

- **Expressive choices**: Even if these choices do not impact the performances of the player, they can increase his motivation
- **Strategic choices:** Choices that could change the game such as the level of difficulty, next steps
- **Tactic choices:** Choices made by the player to decide how to play the game (asking for help, doing an action rather than another)

Challenges: Malone & Lepper define challenges in [6] as the tasks and activities of a game. In Serious games, challenges are the educational content. The player acquires new skills while playing and completing challenges which lead him to other challenges to learn new skills [7].

Fantasy: Fantasy is used in the game to excite the player.

2.3 Educational benefits

Limits and benefits of serious games are different depending on the game and its context. Pivec & Pivec present four major benefits of serious games [8]:

Learner motivation: Studies done in [9] and [10] on the use of games over the long-term show that Serious Games can boost the motivation of students. In fact, an adapted game gives regular feedback to the student about his actions which maintains his motivation [11].

Learning by trials and errors: Most of serious games rely on learning based on trials and errors. In fact, serious games are considered as an experiment space where the learner exercise their thinking skills. The learner makes assumptions and test them

until finding the right one and win the game. Thus, a good Serious Game offers the learner information to help him build hypothesis by himself [12].

Learning rhythms differences: Serious games consider the learning rhythm of each learner [13]. A learner can progress in the game at his own pace. A learner can repeat a sequence as much as needed until he understands the solution.

Pedagogical interactions between students: Some Serious Games can stimulate educational interactions between students, like some multiplayer games facilitating the establishment of Proximal Development Zones [14].

3 Assessment and Evaluation

3.1 Evaluation Vs Assessment

Assessment is the process of making feedbacks to learners by collecting and interpreting data in order to help them improve their performances [15]. It is a measurement present throughout the learning process to identify areas to improve learning quality. Whereas evaluation is defined as the process of judging the learner's performance. Thus, Evaluation is a summative assessment executed at the end of a learning process to test the learner achievements and to make conclusions about learning quality.

Figure 1 summarizes the key differences and similarities between assessment and evaluation.

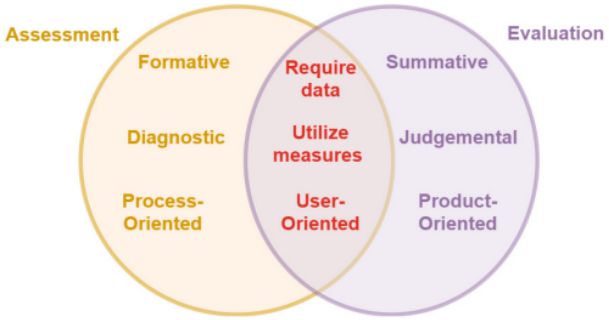

Fig. 1. Assessment Vs Evaluation [16]

3.2 Evaluation and assessment technics in serious games

Many technics of evaluation and assessment exist. In this paper we will classify some technics into two categories: Implicit and Explicit.

The main difference between implicit and explicit technics is the way of collecting and analyzing learner's data. Implicit technics aim to collect and to analyze data in an

indirect way without disrupting the engagement of the learner; whereas explicit technics use a clear and a direct way.

Explicit technics: Consist on evaluating the answers of the learner to a questionnaire at the beginning, during or at the end of a game [17]. For example, the serious game "Stop Disasters" is used to learn how to act in case of emergencies. To evaluate the learners and assess the effectiveness of the game, participants answer a questionnaire both before and after the game [18].

Implicit technics: Consist on evaluating the learner while playing the game. This assessment approach could be developed based on different methods such as the conceptual framework Evidence-Centered Design (ECD) and Bayesian networks [19], Petri Network and ontology [20] or agent technology as proposed by the authors of the work [21] in "SIMFOR" serious game.

3.3 Evaluation and assessment types

Different types of evaluation exist, in our research we are interested in diagnostic evaluation, formative evaluation and summative evaluation [22].

- **Diagnostic evaluation**: Consists on collecting data to identify student strengths, weaknesses and abilities before starting a learning process.
- **Formative evaluation**: Consists on evaluating learners during the learning process in order to improve content and adapt it to learners. Its purpose is to monitor students learning and to obtain feedbacks to identify gaps in teaching.
- **Summative evaluation**: Consists on evaluating a learner at the end of the training to verify whether he assimilated the most important concepts of a notion. This test allows noting the student and deciding whether he has succeeded his learning or not.

3.4 Assessment and evaluation in serious games

Standard assessment methods are often easy to administer and take less time, but there are limitations to these approaches. The concern today is regarding whether the "teaching to the test" practice could decrease a student's interest in learning and lifelong learning [23], [24].

Moreover, standard assessment does not fit for all groups (high or low performing groups). It's not flexible and do not adjust to the assimilation capacity of learners [24].

Recent studies have explored how to overcome standard approaches limitations by using play-based assessment/evaluation. In fact, game-based evaluation provides reliable and detailed information [25], [26].

As explained by Becker and Parker [27], Serious games generally contains effectiveness tests. In fact, players accumulate experience and points as they progress in the game which lead them to learn new topics and progress in the difficulty in next stages. This approach is considered as effective due to the combination of pedagogy and games. It provides immediate feedback to the player [28].

Game based Evaluation is a new method that takes us away from classic tests that usually affect the learner interest and motivation. The implementation of this methods is challenging and needs time and work.

4 Intelligent Tutoring Systems

4.1 Definition

Intelligent tutoring systems (ITS) are computer systems that appeared in the 80s. Based on artificial intelligent technics, those systems evolve rapidly to replace the human tutor in the learning process.

Researches and work in this field are multiple and many approaches have seen the light aiming to implement such a complex system. In fact, ITS regroups many domains: education, artificial intelligence, cognitive sciences, human-computer interaction and software engineering [29].

The objective of these systems is to provide the learner with the necessary materials to promote one-on one learning. ITS proposes to the learner the right pedagogical activity and the right content at the right time taking into account his learning style and knowledge [30].

4.2 ITS components

One of first ITS architectures is the one proposed by Burn and Caps in [31]. It is based on four components: curriculum module, student module, pedagogical module and the interface module.

The student module: This module represents the profile of a learner. It contains his personal data, knowledge, preferences, learning style and the learning state [32].

The pedagogical module: The objective of this module is to provide the right learning strategy for each learner based on his profile. Most of instructional decisions are handled in this module such as the teaching methods, the learning content, the time to study a content etc**.**

The curriculum module: It concerns the teaching field. This module allows the decomposition of the domain to several particular concepts. Two elements describe this module in the work [33].

- **Schema of the domain:** A schematic presentation of the knowledge classes (Concepts).
- **Knowledge base:** Concept instances composing the domain schema

The interface module: this module represents the interactive environment between the user and the ITS.

4.3 ITS and serious games

Different works have tried to integrate learning games in ITS. In his work [34], Komar has implemented an ITS based on two types of games: Crossword and Treasure Hunt. Those games are displayed if the learner choose to learn a concept that has a game as pedagogical content. The objective is that the student learns incidentally while playing.

Begg, Dewhurst & MacLeod [35] describe the changing behavior of players. The games allow learners to access to a new environment and to assume a new identity. They, therefore, explore, experiment and adopt the right vocabulary to succeed the game. As they progress in the game, they explore new leads and learn new topics.

5 Proposed Intelligent Tutoring System

5.1 Adaptive workflows

Most ITS solutions do not permit an adaptive and flexible learning. They neglect the importance of the human tutor who could intervene in blocking situations. In our approach, we consider the assumption that whatever the intelligence of the system, the human intervention is necessary in certain blocking situations that affect the learning and the motivation of the learner. Thus, we have proposed to integrate adaptive workflows in an ITS to allow the combination of the activity approach and human tutor intervention.

In order to implement our proposed system, we have adopted an architecture similar to the one presented in sub-section 4.2 to which we have integrated a model of process generation.

Model of process generation: A workflow is the definition, automation and execution of a business process. We consider an adaptive workflow a workflow that can be adapted as it's executed by integrating new tasks and deleting others. In this paper, we propose the design of a meta- model of the learning process to conclude our research.

Based on the definitions given by the Workflow Management Coalition (WfMC). The authors of works [36] and [37] propose a meta-modeling of the process:

In [36] a meta-model is drawn up according to 4 components:

- **Organizational:** The organizational structure, the actors of the system and their roles
- **Functional:** Functionalities of the system
- **Behavioral:** Tasks and control flows
- **Information:** The information system part allowing the completion of the work

The authors of [37] propose a meta-model that support the use of flexible workflows in an open training context.

Our process generation task is inspired from these works. We have adopted the following definitions and rules to implement the meta-model of process:

- A process can contain one or more sub processes.
- The process and sub-processes can contain one or more tasks or activities
- Tasks and activities are ordered by transitions that are triggered by rules and conditions.
- A task can have one or more subsequent and previous tasks except the first and the last ones of the process.
- A task is fulfilled by the actors of the process. The actor can be a physical person, a group of individuals or a machine (system).
- A task uses one or more resources (documents, form, interface ...). It is the most basic element in a process.

Figure 2 presents our proposed meta-model of the process. It allows to generate workflows that are adapted based on rules and conditions of transitions between activities. It also allows the coexistence of two actors: the system and the human tutor.

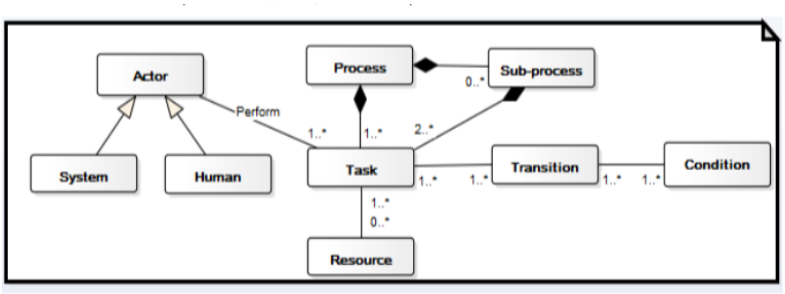

Fig. 2. Adopted meta-model of the process

Learner model: Most of adopted approaches classify the learner into 5 main classes: Personal Data, Characteristics of the learner, Interaction (System & student), State of learning and Knowledge of the learner [38]:

- **Personal data**: Learner's general information from his profile (name, first name, age, email address, gender, origin and nationality etc).
- **Knowledge of the learner:** It describes a learner the knowledge of a learner to offer a personalized learning [39]. It represents the learner's pedagogical background, his level of learning, professional experiences, acquired trainings, domain knowledge, acquired concepts, exam and test scores, etc.
- **Characteristics of the learner:** It contains information about the learner's preferences and learning style. It allows to describe the learner preferences concerning didactic tools and methods to acquire knowledge. Several methods have been developed to identify the psychological tendencies of a learner, especially Learning Style Theory [40], Index of Learning Styles ILS [41], the ISALEM (Inventory of Learning Styles, Multimedia Teaching).
- **Interaction with the system:** The objective of this component is to keep history of the exchange of the student with the system and to trace the operations done throughout the learning process [42]. The system can construct the cognitive state

of the learner from the recorded information which allows to make conclusions on the learner and the proposed content.

- **State of the learner:** It represents the learning plan, the learning history, the program followed etc. Those parameters are used to analyze the learner's situation.

In our proposition, we have adopted a model that contains 4 main classes with parameter-value pairs. In fact, the classes "State of learning and Knowledge of the learner" are regrouped in a single class named Leaner Competence.

Figure 3 presents our proposed learner model, its four components and their context of use in our system.

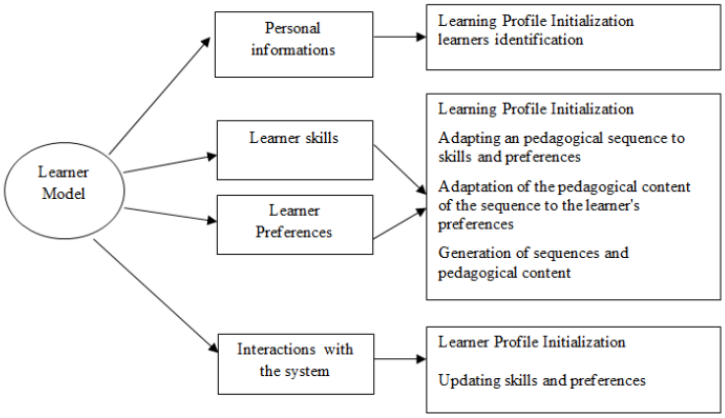

Fig. 3. Proposed learner model

Domain model: The domain modeling and its implementation has been the subject of many researches and works. For example, the MOT method "Modeling by Typed Objects" [43], CommonKADS [44] for modeling methods and Ontology, object-oriented models, semantic networks, neural networks for the formalisms of knowledge representation.

Inspired by the work carried out in [22], we suggest a teaching domain decomposed of six main general concepts: The notions of teaching domain, concepts of the notion, learning objectives, pedagogical sequences, pedagogical activities and resources (pedagogical content).

- Those general concepts are presented in figure 4 using the following rules:
- A learning objective can be decomposed into several sub-objectives.
- A pedagogical objective contains one or more notions
- A notion can be broken down iteratively into several sub-notions.
- A notion is composed of one or multiple concepts.
- A notion could take part in one or more pedagogical sequences
- A pedagogical sequence is composed of multiple pedagogical activities
- An activity can use multiple resources and teaching materials.

These general concepts are linked using different type of links: is associated with, is prerequisite for.

Figure 4 represents an UML modeling of the proposed teaching domain schema:

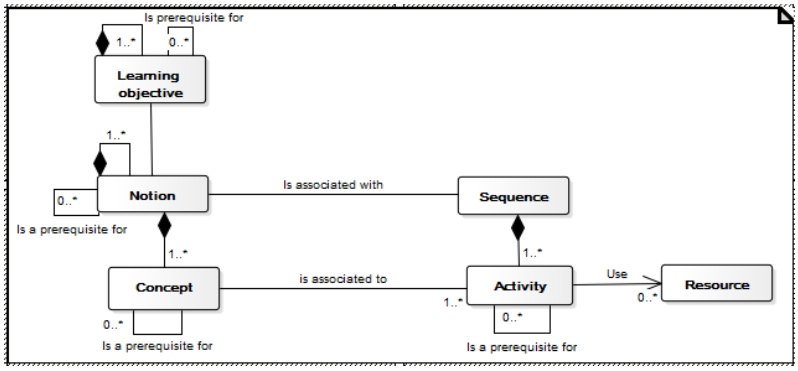

Fig. 4. Adopted Domain model

To present the domain model, several technics have developed. We are interested in the one used in [45] in the INSPIRE system. It's about a technic that is frequently used in ITS. It uses a tree structure to decompose the domain into several layers. This technic consists on connecting the nodes of the layers through arcs that define the execution order and the composition of concepts instances, which allows to adapt the ordering of the concepts. Each element of the model is associated with one or more educational content that represents the resource.

Figure 5 presents layers of our adopted model. It contains six layers according to the domain schema used.

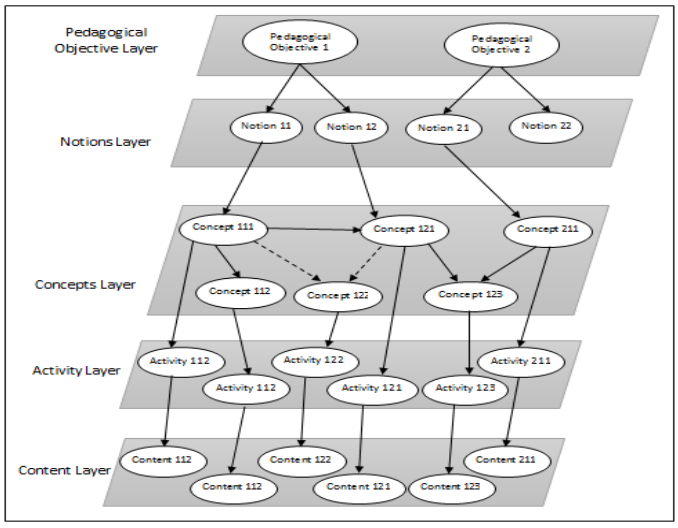

Fig. 5. Domain model layers

Adaptation model: The adaptation strategy in adaptive learning systems can be defined as the set of mechanisms and actions adopted by the system to adjust the learning path to each student considering his or her knowledge and preferences. In [46] two adaptation technics were highlighted: adaptation of the presentation and adaptation of navigation:

- **The adaptation of the presentation:** Consists on adapting the interface based on the characteristics of the student, i.e. the continuous modification of the displayed content to the user according to the evolution of his different cognitive aspects. Several technics have been used for the implementation of this type of adaptation such as "Stretchtext" [47], "progressive access" [48].
- **The adaptation of navigation:** Consists on scheduling the learner pedagogical objectives based on his state of knowledge in a specific domain to orient him in his pedagogical path. Systems using this method recommend a hierarchical structure of the content. There are two types of technics to implement this adaptation model: annotation of the link and scheduling of activities [46].

In our proposition, we consider a pedagogical sequence as ordered pedagogical activities which lead us to deal with a pedagogical sequence as a workflow. In fact, our objective is to provide the learner with the most relevant and optimal pedagogical sequence by following some steps:

- Identification of the acquired concepts from the learner model
- Proposition of notions and concepts to be studied by the interference motor based on the hierarchical presentation of the domain model
- Drawing up the optimal sequence of activities of the identified concepts
- Generation of the learning process
- Transformation of the learning process into executable workflow by the workflow engine
- Adaptation of the workflow when needed by introducing new activities
- To adapt the proposed sequence, the system collects results of partial evaluation achieved during the learning process and uses parameters of the class “interaction with system” of the learner model. While their execution and adaptation, the workflows are displayed in the human tutor interface to survey the advancement and react when the learner is blocked.

A learning process always ends with a summative evaluation that allow to test the degree of assimilation of the notion studied and update the learner model. This subprocess will be discussed in the sub-section 5.2.

5.2 Serious games in the evaluation process

In most works and researches that we have studied, pedagogical games are used to learn not to evaluate students. In this paper, we propose the adoption of pedagogical games in the evaluation process. Our objective is to evaluate learners with serious games in order to make evaluations more fun and less stressful.

Our proposed system uses adaptive pedagogical workflows that always end with a summative evaluation sub-process of a specific notion. This sub-process contains pedagogical activities that allow to evaluate the concepts of a specific notion. Each activity is linked to a specific concept. This sub-process will be realized through a serious game that is based on missions or stages.

Based on the hierarchy of concepts presented in our domain model (Fig. 4) and the game base, the system generates a game with multiple stages. The game type and relations between concepts define if the stages could be achieved in parallel or sequentially.

To achieve a stage, the learner must complete all the tasks assigned. Each task has a score that allows to evaluate the progress of the learner. The completion of a stage/mission means that the learner assimilated the concept while the successful completion of the game means that he assimilated the notion.

The human tutor could survey the execution of this process at the human tutor interface to visualize the learner evolution in the evaluation.

Proposed system architecture: Our proposed system architecture is presented in Figure 6:

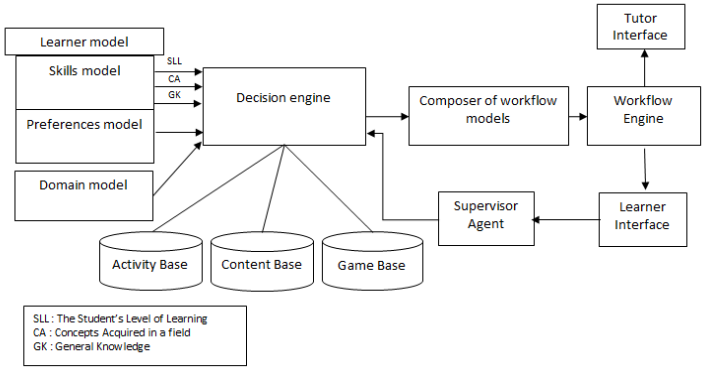

Fig. 6. System Architecture

Based on the learner and domain models, the decision engine generates a learning workflow that is composed of three types of activities:

- **Learning activities**: Activities that allow learn new concepts and new notions.
- **Diagnostic & formative evaluation activities**: To evaluate learners partially before or after learning a concept.
- **Summative evaluation activities**: Activities that compose the evaluation sub-process.

The content of each activity is selected from the content base once the activities are chosen. The game is picked-up from the game base and the stages are defined by the decision engine. Each game is composed of several stages that represent the concepts

of the notion. The number of stages depends on the number of the concepts related to a notion.

The Game base contains different general games that will be designed on stages or missions. Once the game is chosen and the stages are generated, a number of tasks will be related to each stage. To succeed a stage, the learner should get at least the minimum score which is 2/3 of task number*task mark.

To implement this approach, we propose as a first step the implementation of games based on questions that have a precise answer since the diagnostic of the learner's answers could be done easily.

Questions are stocked as evaluation content for each concept. Each question has a correct answer and average time to answer.

When the learner answers a question, the system compares it with the correct one. The learner gets the full mark if his answer is right. Once all the questions of a stage are answered, the total score is calculated to decide if the learner has succeeded the evaluation. If the score is higher than the threshold defined, then the learner has succeeded and passes automatically to the next stage. If he doesn't succeed, then he should restart the stage.

After completing the evaluation, the learner profile will be updated with the evaluation information: concept score, notion score, evaluation time, number of failures.

6 Conclusion

In this paper, we aim to answer two main problematics of designing intelligent tutoring systems:

- Implementation of activity-based approach considering the coexistence of human tutor and system tutor
- Student motivation to learning and evaluations

To resolve these problematics, we have attempted to overstep the conventional methods and introduce new concepts.

Our proposition consists of two concepts. First, we introduced the notion of Adaptive Workflows to adapt the pedagogical sequences and to permit the human tutor intervention. Then, we adopted serious games in the evaluation process to boost the motivation of learners.

This proposed approach faces some limitations regarding the dependencies between the different modules of the ITS:

- The tools of implementation of this architecture are limited and require expanded research
- It's hard to implement the automatic construction of a questionnaire in learning games. Advances intelligence mechanisms are needed for such an approach.

Our suggested approach opens multiple perspectives of research all bearing on the mechanisms of implementation of such a model while keeping the logic of our proposed system that is based on adaptive workflows.

7 References

[1] Zyda, M., "From visual simulation to virtual reality to games," Computer, 38(9), pp. 25-32, 2005. https://doi.org/10.1109/MC.2005.297

[2] Susi, T., Johannesson, M. et Backlund, P., Serious games: An overview, 2007.

[3] Alvarez, J., Djaouti, D., "“An introduction to serious game - definitions and concepts,” in Proceedings of Serious Games & Simulation for Risks Management Workshop.," LARSEN Science, vol. December, 2011. https://doi.org/10.1007/978-1-4471-2161-9_3

[4] Charsky, D., "From edutainment to serious games: A change in the use of game characteristics.," Games and culture, vol. 5, no. 2, 2010. https://doi.org/10.1177/1555412009354727

[5] Alessi, S. M., Trollip, S. R., Multimedia for learning. Methods and development, 2001.

[6] Malone, T. W., Lepper, M. R., "Making learning fun: A taxonomy of intrinsic motivations for learning.," Aptitude, Learning, and Instruction, vol. 3, pp. 223- 253, 1987.

[7] Gee, J. P., What video games have to teach us about learning and literacy, 2003. https://doi.org/10.1145/950566.950595

[8] Pivec, M. Pivec, P., "Literature related to the Games in School Study," European Schoolnet., 2008

[9] Wastiau, P., Kearney C., Van Der Berghe, W., "Quels usages pour les jeux électroniques en classe? “European Schoolnet, 2009.

[10] Wix, A., "Jouer en classe, est-ce bien sérieux? Bilan de l’expérimentation académique sur les usages de jeux sérieux au collège et au lycée," Académie d'Aix-Marseille, 2012.

[11] Whitton, N., "Game Engagement Theory et Adult Learning," Simulation and Gaming, vol. 42, no. 5, pp. 596 -609, 2011. https://doi.org/10.1177/1046878110378587

[12] Sanchez, E., "Usage d'un jeu sérieux dans l'enseignement secondaire. Modélisation comportementale et épistémique de l'apprenant," Revue d'Intelligence Artificielle, vol. 25, no. 2, pp. 203-222, 2011. https://doi.org/10.3166/ria.25.203-222

[13] Kafai, Y. B., Minds in Play: Computer Game Design as A Context for Children's Learning. Routledge, 1994.

[14] Vygotsky, L., "Pensée et Langage," Editions Sociales, 1985.

[15] Bellotti, F., Kapralos, B., Lee, K., Moreno-Ger, P., Berta, R., "Assessment in and of serious games: an overview," Advances in Human-Computer Interaction, 2013. https://doi.org/10.1155/2013/136864

[16] Angelo, T., Cross, K.P, Classroom Assessment Techniques a Handbook for College, San Francisco: Jossey-Bass A Wiley Imprint, 1993.

[17] Haferkamp, N., Kraemer, N.C., Linehan, C., Schembri, M., "Training disaster communication by means of serious games in virtual environments," Entertainment Comput, vol. 2, no. 2, p. 81–88, 2011. https://doi.org/10.1016/j.entcom.2010.12.009

[18] Silva, V.S.R., Dargains, A.R., Felício, S.P.A.S., Souza, P.R.A., Sampaio, F., Motta, C.L.R., Borges, M.R.S., Gomes, J.O., Carvalho, P.V.R., "Stop disasters: serious games with elementary school students in Rio de Janeiro," international Technology, Education and Development Conference, p. 1648–1659, 2014.

[19] Shute, V.J., "tealth assessment in computer-based games to support learning," Comput. Games Instr., vol. 55, no. 2, p. 503–524, 2011.

[20] Pradeepa, T., Jean-Marc, L., Mathieu, M., Amel Y., "How to evaluate competencies ingame-based learning systems automatically?" Proceedings of International Conference on Intelligent Tutoring Systems, p. 168–173, 2012. https://doi.org/10.1007/978-3-642-30950-2_22

[21] Oulhaci, A., Tranvouez, E., Fournier, S., Espinasse, B., "Improving players' assessment in crisis management serious games: the SIMFOR project," Bellamine Ben Saoud, N., Adam, C., Hanachi, C. (eds.) ISCRAM-med, LNBIP, Springer, vol. 233, p. 85–99, 2015. https://doi.org/10.1007/978-3-319-24399-3_8

[22] Faizan, N., Löffler, A., Heininger, R., Utesch, M., Krcmar, H., "Classification of Evaluation Methods for the Effective Assessment of Simulation Games: Results from a Literature Review," International Journal of Engineering Pedagogy, vol. 9, no. 1, 2019. https://doi.org/10.3991/ijep.v9i1.9948

[23] Tribune, C., "Standardized testing will limit students' future," 2010.

[24] Fairtest, "What's Wrong with Standardized Tests?," 22 May 2012. [Online]. Available: www.fairtest.org/facts/whatwron.htm

[25] Short, E. J., Noeder, M., Gorovoy, S., Manos, M. J., Lewis B., "The importance of play in both the assessment and treatment of young children," *An Evidence-Based Approach to Play in Intervention and Prevention: Integrating Developmental and Clinical Science, S. Russ and L. Niec.*

[26] Kaugars, A. S., Russ, S. W., "Assessing preschool children's pretend play: preliminary validation of the affect in play scale-preschool version," *Early Education and Development,* vol. 20, no. 5, p. 733–755, 2009.https://doi.org/10.1080/10409280802545388

[27] Becker, K., Parker, J. R., The Guide to Computer Simulations, Indianapolis: John Wiley & Sons, 2011.

[28] Tan, C. H., Tan, K. C., Tay, A., "Dynamic game difficulty scaling using adaptive behavior-based AI," *IEEE Transactions on Computational Intelligence and AI in Games,* vol. 3, no. 4, p. 289–301, 2011. https://doi.org/10.1109/TCIAIG.2011.2158434

[29] Hieu, B., T., Syed Mustapha, S.M.F.D., "Automated Data-Driven Hint Generation in Intelligent Tutoring Systems for Code-Writing: On the Road of Future Research," International Journal of Emerging Technologies in Learning, vol. 13, no. 9, 2018. https://doi.org/10.3991/ijet.v13i09.8023

[30] Chan, T. W., Roschelle, J., Hsi, S., Kinshuk, Sharples, M., Brown, T., Soloway, E., "One-to-one technology-enhanced learning: An opportunity for global research collaboration.," *Research and Practice in Technology Enhanced Learning,* vol. 1, no. 1, pp. 3-29, 2006. https://doi.org/10.1142/S1793206806000032

[31] Burn, Caps, Intelligent Tutoring Systems, Hillsdale, NJ: Lawrence Erlbaum Associates, 1988.

[32] Derry, J. S., Lajoie, P. S., Computers as Cognitive tools, New Jersey: Lawrence Erlbaum Associates, 1993.

[33] Schreiber, G., Wielinga, B., Breuker, J., KADS: A Principled Approach to Knowledge-Based System Development., London: Academic Press.

[34] Komar P., Development of Intelligent Tutoring System Framework For Game-based Learning, 2012.

[35] Begg, M., Dewhurst, D., Macleod, H., "Game-Informed Learning: Applying Computer Game Processes to Higher Education," *Innovate,* vol. 1, no. 6, 2005.

[36] MAHDAOUI, L., Boukhedouma, S., ALIMAZIGHI, Z., "Modélisation de processus e-Learning par les workflows".

[37] Vantroys, T., & Peter, Y., "Un système de workflows flexible pour la formation ouverte et à distance.," pp. 97-104, 2002.

[38] ZHANG, Y. F., "Modélisation de l'apprenant dans le cadre d'un environnement informatique pour l'apprentissage humain offrant des conseils personnalisés," 2010.

[39] Hnida, M., Khalidi Idrissi, M. , Bennani, S., "A formalism of the competency-based approach in adaptive learning systems," *WSEAS Transactions on Information Science and Applications,* vol. 11, pp. 83-93, 2014.
[40] D.A., Kolb, LSI Learning-Style Inventory, McBer & Company, 1985.
[41] Felder, R.M., Silverman, L.K., "Learning and Teaching Styles in Engineering Education," *Engr. Education,* vol. 78, no. 7, pp. 674-681, 1988.
[42] Jugo, I., Kovacié, B., Slavuj, V., "Increasing the Adaptivity of an Intelligent Tutoring System with Educational Data Mining: A System Overview," *International journal of Emerging Technologies in Learning,* vol. 11, no. 03, 2016. https://doi.org/10.3991/ijet.v11i03.5103
[43] Paquette, G., "La modélisation par objets typés-une méthode de représentation pour les systèmes d'apprentissage et d'aide à la tâche.," *Sciences et techniques éducatives,* vol. 3, no. 1, pp. 9-42, 1996. https://doi.org/10.3406/stice.1996.1279
[44] Schreiber, G., "Knowledge engineering and management: the CommonKADS methodology," *MIT press,* 2000. https://doi.org/10.7551/mitpress/4073.001.0001
[45] Papanikolaou K., Grigoriadou M., Kornilakis H., Magoulas G., "Personalizing theInteraction in a Web-based Educational Hypermedia System: the case of INSPIRE,User Modeling and User-Adapted Interaction".
[46] Piombo, C., Modélisation probabiliste du style d'apprentissage et application à l'adaptation de contenus pédagogiques indexés par une ontologie, 2007.
[47] Brusilovsky, P., "Adaptive hypermedia," *User Modeling ans User-Adapted Interaction,* pp. 87-110, 2001. https://doi.org/10.1023/A:1011143116306
[48] Villanova-Oliver, M., "Adaptabilité dans les systèmes d'information sur le web: Modélisation et mise en oeuvre de l'accès progressif (Doctoral dissertation, Institut National Polytechnique de Grenoble-INPG)," 2002.

8 Authors

Mohammed Beyyoudh is a Ph.D. candidate at the Laboratory of Research in Computer Science and Education, Mohammadia School of Engineers, Mohammed V University of Rabat, Morocco. His research project is about the integration of adaptive workflows and serious games in intelligent tutoring systems. 5 recent publications papers between 2017 and 2019; He is interested in the fields of Artificial Intelligence, Assessment techniques and Educational engineering.

Mohammed Khalidi Idrissi is a full Professor at Mohammadia School of Engineers. Doctorate degree in Computer Science in 1986, PhD in Computer Science in 2009; Former Assistant chief of the Computer Science Department at the Mohammadia School of Engineers (EMI); Pedagogical Tutor of the Computer Science areas at the Mohammadia School of Engineers (EMI) Professor at the Computer Science Department EMI; 34 recent publications papers between 2014 and 2017; Ongoing research interests: Software Engineering, Information System, Modeling, MDA, ontology, SOA, Web services, eLearning content engineering, tutoring, assessment and tracking.

Samir Bennani is a full Professor and Deputy Director of students and academic affairs at Mohammadia School of Engineers. Engineer degree in Computer Science in 1982; PhD in Computer Science in 2005; Professor at the Computer Science Depart-

ment EMI; 34 recent publications papers between 2014 and 2017; Ongoing re-search interests: SI, Modeling in Software Engineering, Information System, eLearning content engineering, tutoring, assessment and tracking.

Article submitted 2019-04-15. Resubmitted 2019-05-28. Final acceptance 2019-06-03. Final version published as submitted by the authors.