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Assessment Model for Education in Health, based on Games and Virtual Environments.

Modelo de Avaliação para Formação em Saúde baseada em Jogos e Ambientes Virtuais.

Modelo de Evaluación para la Formación Profesional en Salud basada en Juegos y Ambientes Virtuales

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ABSTRACT: This paper presents a study of decision models in portals of games and virtual environments, and it shows a new decision model that analyzes the performance of students, considering the cognitive, affective and psychomotor domains. From the research, this study reveals that portals of games and virtual environments for health can include assessment processes, to monitor activities for health education. Understanding that the planning of these activities must be oriented by educational objectives, this work considers these objectives in the assessment process in health and presents a decision model based in the Taxonomy of Educational Objectives. This model can be considered as an alternative to performance assessment based on objective measures of performance in the portals of games and virtual environments.
Keywords: Educational Measurement; Decision Support Techniques; Educational Technology.

RESUMO : Este trabalho apresenta um estudo sobre processos de decisão em portais de jogos ou ambientes, e mostra um novo modelo de decisão que analisa o desempenho de estudantes, considerando os domínios cognitivo, afetivo e psicomotor. A partir de uma revisão, o presente trabalho revela que portais de jogos ou ambientes virtuais para a área de saúde podem incorporar processos avaliativos, baseados em modelos de decisão de máquina, que permitem avaliar conjuntamente atividades de apoio à formação de recursos humanos. Compreendendo que o planejamento dessas

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atividades deve ser balizado por objetivos educacionais, o presente trabalho apresenta um modelo de decisão de máquina baseado na Taxonomia dos Objetivos Educacionais. Este modelo de avaliação pode ser considerado como uma alternativa para avaliação de desempenho baseada em medidas objetivas de análise de desempenho nos portais de jogos e ambientes virtuais.
Palavras chave: Avaliação Educacional; Técnicas de Apoio para a Decisão; Tecnologia Educacional.

RESUMEN: Este trabajo se presenta un estudio de los modelos de decisión en los portales de juegos y entornos virtuales, y se nota un nuevo modelo de decisión que analiza el rendimiento de los estudiantes, teniendo en cuenta los dominios cognitivos, afectivos y psicomotores. A partir de la investigación, este estudio revela que los portales de juegos y entornos virtuales para la salud pueden incluir los procesos de evaluación, para supervisar las actividades de educación para la salud. Entendiendo que la planificación de estas actividades debe estar orientada por objetivos educativos, este trabajo considera que estos objetivos en el proceso de evaluación en salud y presenta un modelo de decisión basado en la taxonomía de objetivos educativos. Este modelo puede ser considerado como una alternativa a la evaluación del desempeño basado en mediciones objetivas de desempeño en los portales de juegos y entornos virtuales.
Palabras clave: Evaluación Educacional; Técnicas de Apoyo para la Decisión; Tecnología Educacional.

INTRODUCTION

Health training involves studies, interdisciplinary and practical actions in different contexts. The advancement of technologies and means of communication and interaction with the world suggests changes in the academic world, as well as to guide the learning process, to promote the training of human resources and to encourage practical application. In this line, the games and virtual environments (sometimes called simulations) allow you to include in the training process, additional means to the methods traditionally used to teach, learn and practice skills[1].

The games and environments in the scope of teaching and learning brings advantages to the practice of students and professionals of health, motivating their implementation in the field. They, for example, can provide the experimentation of different professional life situations, with a variation of the level of risk and types of materials available. In addition, they can make use of decision-making processes that automate different tasks like assessment of user decisions, management of the degree of difficulty of the game or simulation, control of opponents (virtual characters), among others[2]. In General, surveys of the area confirm the importance of these resources (sets/environments) as a means of complementing the means of construction of knowledge, as in Nunes et al.[3] and Taekman et al.[1].

The games and virtual environments can be gathered through portals and platforms, which are instruments that can help centralize the search and access to the games and to the environments in a given context. This fact arouses some inquiries. What services the gaming portals or platforms have to offer to their audience? How are the decision-making processes used in these portals? How

can a decision-making model assist in the performance monitoring of users in gaming portals and environments? Thus, the article aims to show how to use machine-decision processes in analyzing information, services offered, as well as introduce a new assessment model, based on the decision-making process, to assist the monitoring of game portals and user environments.

METHODOLOGICAL COURSE

In order to introduce a new assessment model for the analysis of student performance on game portals and virtual environments, this work initially shows a review about the services offered by the portals. Accordingly, the review seeks to explore and identify the services and how to use the decision-making process in portals and platforms. There was a shortage in the availability of scientific papers that address the use of platforms and portals as resources to curriculum integration tools, and found materials available on the web, not necessarily in publishing databases, which is why the review of these portals was not systematic.

Whereas the planning and analysis of activities with educational purposes must be marked out, respectively, by the definition and verification of the educational objectives of the experiment, this work considers it important to direct the analysis of educational objectives in the decision process that comprises an assessment. So, after the review, the article shows and discusses the use of the taxonomy of educational objectives as a means of standardization of information in the decision-making process.

Finally, based on the review on the use of decision-making processes in portals, as well as on the importance of verification of the achievement of educational objectives in decision-making procedures, the work presents a new assessment model based on taxonomy of educational objectives to analyze the performance of students within portals and gaming platforms and environments for training in health.

Decision-making in gaming portals and environments

Decision-making processes are present in activities that require different alternatives with need for further analysis. It can be observed that more and more computer applications are developed with the possibility of assisting in decision-making processes through the Artificial Intelligence (AI) in so-called machine decision models. The AI is an area of computer science that points varied techniques and resources that enable the development of programs able to make a decision in a similar manner as humans[4].

In the context of the Serious Games (SGs) and Virtual Environments (VAs), AI can act in different ways, such as in the assessment of the user's decisions, management of game difficulty or simulation, and control opponents (virtual characters), among others. In the area of health, the

use of AI to identify the level of knowledge of the user (player assessment) and, through this knowledge, make decisions for advances in application (behavior of the game or simulation)[2].

Some game portals and VAs also use the decision-making process to assist in activities. These instruments can provide a means of monitoring of users to identify performance levels with the aid of AI. As well as in games and VAs, AI in portals assists the assessment process of users with possibility of decision-making to define change in their environment.

In this line of portals, the *Portal of Instructional Games, Online* (Pingo) offers educational games with customizable content and has a repository with topics covering various disciplines of basic education, allowing Brazilian school teachers to customize its contents. Access to the environment is free and specific for each user profile: game developer, teacher and student. Using the portal, teachers can select games through the repository, adapt the content to your work context and make them available individually for their classes. The students, in turn, have access to customized games, being monitored by the environment that performs data logging in each game (time spent, score, errors and successes), which can be viewed by the teacher or by the student[5]. The portal performs the student performance analysis of each teacher and assists the teacher in managing their class.

Also with a focus on children, the portal *Attractive Educational Virtual Portal* (AVEP) offers 2D games (mathematics, logic languages, among others), but has restricted access for testing done with the Slovak Republic and Czech schools. It offers the possibility of inserting new games and features a student-tracking service based on data obtained by the instrument. From the data recorded, the portal performs an automatic analysis by means of AI, which allows the teacher to monitor student performance and complementary tasks[6].

In the line of platforms for mobile devices the *mobile Game Based Learning*[7] (mGBL) can be cited, a platform that allows one to centralize the exposure and access to educational materials. It has three modules: authoring, distribution and monitoring. The authoring module allows teachers to build games from templates. The distribution module ensures the availability of the platform on different networks. Monitoring module uses AI techniques to control the game and evaluate the learning success[7].

Bamidis et al.[8] report the development of a portal for the treatments, which gathers different cognitive exercises to prevent the decline of memory, along with physical activities, including games, to promote enhanced assistance to the elderly. Through the application, therapists can design custom training programs, view the progress of the sessions, as well as add new games and exercises in the system. The portal has three types of users: elders, family members and therapists. The elderly has access to their treatment program and can perform the exercises. Family members can access the system to monitor the progress of the treatment of their elderly. Therapists can already construct the script treatment, adjust the intensity and duration of training, and monitor the

performance of their patients from the results provided by the AI.

All these portals and platforms seek to somehow bring together games and simulations as educational strategies to facilitate the operation and organization of the use of these resources with user groups. Through them, the search and selection of resources (and VA games) can be facilitated, assisting the planning of activities. From the papers presented there are some types of services, such as:

- Storage: unit responsible for the registration of information and research of the games and simulations in the instrument;

- Adjust or Increase: service responsible for allowing the insertion, adapting or creating new games and simulations through the portal;

- Projection of activities: service that enables mediators to establishment of activities, which includes the selection of games or simulations for apprentices/patients;

- Monitoring: service responsible for the performance record of the apprentices/patients with possible reporting.

As the focus of the current work is the process of decision, we highlight here the monitoring service, which involves the use of decision-making processes of the machine, i.e., AI, to assist in the performance verification of the user. This service can provide performance information in two ways: (i) give information about user performance by game or simulation, or (ii) confer performance information analyzing aspects of various games or simulations for conjugate assessment (General) and may be useful in the management of activities.

It is worth noting that not all gaming portals or virtual environments have monitoring service or services involving machine-making processes[9,10]. In this context, there is the portal *Games and Simulation for Healthcare Library and Database* that provides a list of games and environments to meet the health educators needs, researchers, professionals and patients who want to know games and simulations to be used as a strategy for education and patient care. The portal offers an inventory with games and simulations that permits only the viewing of details of each application and the address to access[10].

This work highlights the importance of decision making of machine monitoring portal users to promote performance analysis in the training activities process in health. The Table 1 shows the monitoring forms observed in portals presented in this work.

Table 1-presence of the monitoring service in the evaluated platforms/portals.

Platform/Portal	User Monitoring	
	Performance verification by game or simulation	Performance verification set in the games or simulations
Pingo	Yes	No
AVEP	Yes	-
mGBL	Yes	No
Treatment platform	Yes	-

Source: elaborated by the author.

In Table 1, the null value ("-") is the lack of explicit information about the analyzed characteristics. Thus, it is noted that the presented portals provide the user monitoring service for game or simulation; may be this monitoring offered by its own resources or provided by the portals. It is observed that the user performance analysis considering aspects together in the games or simulations to provide more general assessment is not yet contemplated these portals, which suggests the possibility of inclusion and adaptation of this service is an area of potential research.

In the surveys, portals games and VAs for professional training in health that use the monitoring service were not found. However, the inclusion of the decision-making processes of these health portals allow machine to monitor and evaluate the performance of users (students), assisting in the process of forming professional mediators based on the use of games and virtual environments. The inclusion of this and other services on game portals and VAs contributes to the use of these instruments in supporting training and the design of the portals are used only for storage.

Taxonomy of educational objectives for the standardization of information in decision-making

The use of decision-making processes in order to provide monitoring and assessment services in portals, requires that the information used for analysis in different games and environments have a same pattern. In the case of game portals and VAs for training in health, performance analysis of students can be made from the investigation of information relating to the achievement of educational objectives[11].

As confirmed by Anderson et al.[12], the teaching result takes place from the goals, therefore, these should be considered both in the planning and assessment. By nature, the objectives are short-term and should be attainable at the completion of an educational session or, generally, within a period that includes a series of educational sessions (sequence of activities). The objectives may be viewed as statements that tell the student what is expected under a cognitive, psychomotor and affective perspective, being before the goal, which is the highest result[11].

For game portals and VAs, user performance analysis can consider the objectives distributed

among the different applications that need to have a unified statement. It is therefore important to use subsidies that allow the classification of those goals within a portal consisting of different games and simulations as a way to standardize the communication language. This fact makes it possible to carry out decision-making analyses and application from verification of the objectives covered in different applications within the same portal.

According to Fernandez et al.[13], there are subsidies that support the didactic-pedagogical planning, structuring, organization, the definition of objectives and the choice of means of assessment. The taxonomy of educational objectives, also known as Bloom's taxonomy, is one of those subsidies which have as purpose the aid in the statement and identification of educational objectives. According to Fernandez et al.[13], many are the benefits in the use of Bloom's Taxonomy in the educational field. Among them stands out the supply base to develop means of assessing and applying differentiated strategies to promote, evaluate and encourage the performance of students in levels of knowledge acquisition. With this, it becomes possible to categorize the educational objectives clearly and significant, showing an educational goal similar to different people and in different contexts, enabling inferences about the types of behaviors expected from students.

Bloom's taxonomy (or taxonomy of educational objectives) provides a convenient system for description and ordering of test items, examination techniques and assessment tools. It also allows comparing and studying educational programs, noting the similarity of goals and learning experiences. This taxonomy of learning types is differentiated into three domains: cognitive, affective and psychomotor. For Bloom et al.[14] the sum of these three areas results in the person's integral development.

The cognitive domain involves learning and includes a new knowledge, intellectual skill, understanding, reflection and attitude about an issue or fact. It was reworked by a group of experts supervised by Krathwohl, one of the authors of the first formulation. This reformulation has kept the basic idea of the cognitive domain and divided into two dimensions: size of the cognitive process and dimension of knowledge. However, only the cognitive process dimension became more known and applied in the academic context. This dimension relates to the process, that is, "how" something will be achieved, represented to the crescent organization of cognitive complexity. It was divided into six hierarchical categories: remember, understand, apply, analyze, evaluate and create.

The affective domain is related to feelings, attitudes, emotional-order reactions and empathy. It can be demonstrated by behaviors and attitudes of consciousness/awareness, interest, attention, restlessness/concern, responsibility, ability to listen and respond in interactions with others, as well as ability to demonstrate these behavioral characteristics or appropriate values for each type of test and field of study[15]. It is divided into five hierarchical categories: receiving, responding, valuing, organization and characterization by a value or set of values.

Already the psychomotor domain involves skills that combine muscle actions and cognition.

Therefore, this domain related physical and cognitive processes skills, dealing with skills related to handling tools or objects. Bloom and her team have developed a taxonomy for the psychomotor area. As a result, there are different contributions coming from work in this third area, for example, the psychomotor domain proposed by Dave[16], quite widespread, simple and suitable for most adult formations in the area of health[11]. Dave's Psychomotor Domain suggests that the accuracy should be stressed before that the speed at which a skill is gained[17]. It is divided into five categories, namely: imitation, manipulation, precision, articulation and naturalization.

According to Conklin[18], the taxonomy of educational objectives, with its hierarchical classification breakthroughs in recast and continuation projects, is of great contribution for educators. The conscious use of this system offers ways to stimulate reasoning and high-level abstractions from the goals.

In health, the training objectives express where the student, subjected to learning situations can reach. For example, to be able to classify categories of patients by complexity of a fractured femur the student or professional demonstrates understanding of the content involved. Therefore, according to the taxonomy, he reaches the "understanding" of the cognitive domain. By demonstrating initiative to develop a team action plan for care with patients, analyzing the emotional aspect of this objective, professional demonstrates "organization." From being able to combine actions to manipulate tools to meet new need in the execution of a procedure, it can be said that the professional demonstrates "coordination" for the psychomotor domain. The taxonomy, in this sense, systematizes the objectives by verifying complexity, abstraction and internalization.

One of the advantages of using this classification system is that does not have any boundaries or educational strategy modality, therefore the concern is limited to the effectiveness of the process. Thus, the taxonomy demonstrates its relationship with the "how to" implement goals, rather than restrict forms or environments in which learning can happen[13].

Although the taxonomy has been proposed for some decades, it remains present in the educational context for being the basis for the development of assessment tools and considering different levels of knowledge acquisition in different domains. This categorization helps training programs to clear their goals, as well as the focus of the assessment. Similarly, the games and virtual environments, have a set of goals that can be classified based on taxonomy, helping mainly in two aspects: selection and assessment. With this, one can use measures and techniques to verify the student performance over a sequence of activities.

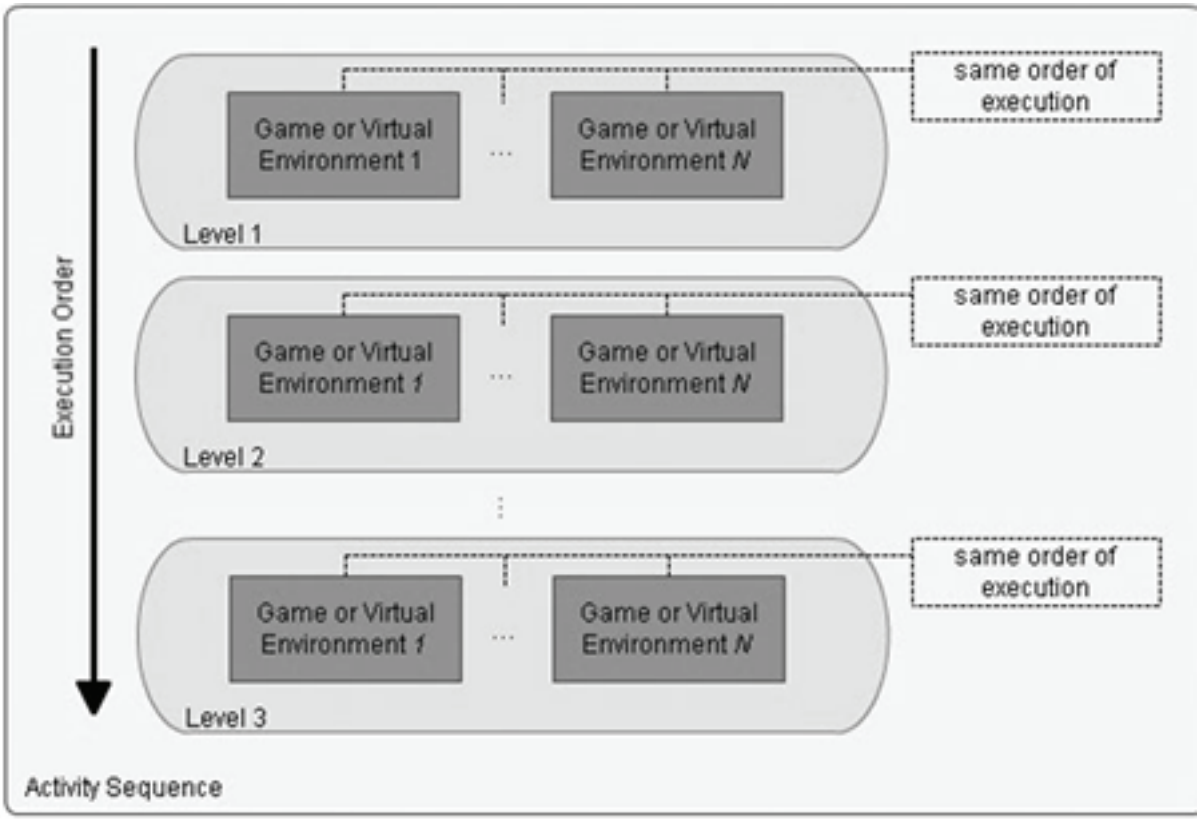
A general performance assessment model

Within the assessment context on game portals, we present an assessment model that is based on the taxonomy of educational objectives to analyze the performance of students during a sequence of activities prepared by the mediator and composed of different games or virtual environments.

Each mediator, when creating the sequence of activities can customize the assessment process, selecting the learning objectives targeted for the specific sequence. Thus, from information sent by games and virtual environments, the assessment module performs the analysis and decision-making on student performance.

The assessment considers that a sequence of activities is composed of hierarchical levels, consisting of a set of games and/or simulations (Figure 1). For being hierarchical, moving to a subsequent level will only be carried out when accomplishing the minimum requirements of the current level. These requirements are stipulated by the mediators, being represented by minimum performance values in learning area categories, depending on the intended objectives. At the end of the sequence, the students will demonstrate they have met the minimum requirements and achieved their purpose.

Figure 1-General composition of a sequence of activities.



Thus, to explain the proposed assessment model for training based on games and virtual environments, it will be presented initially the target of the analysis in the activities sequences. Next the needs and assessment module restrictions will be shown. Lastly, the method will be exposed by which it will carry out the verification and decision-making on the performance.

Object of the analysis for assessment module

The assessment module checks the student's performance at each level of the sequence of activities. Performance is measured based on the achievement of educational objectives established for each level. The definition of objectives is made by the mediator in two steps:

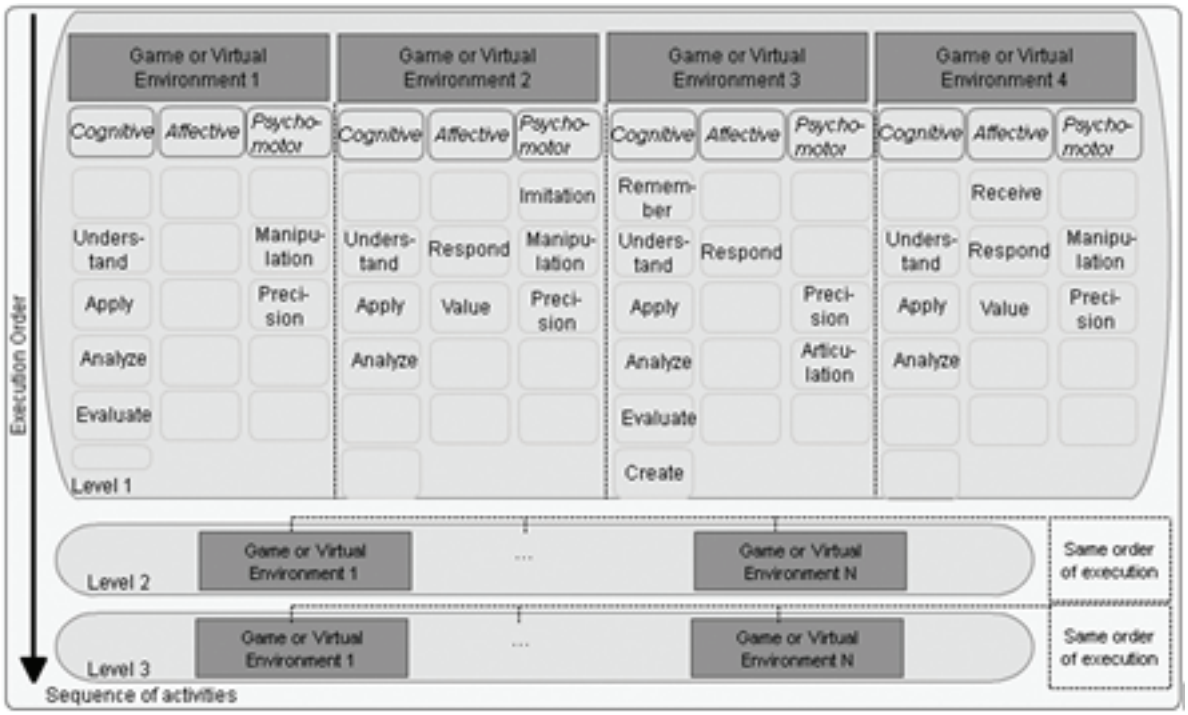
1. Selection of categories of learning domains if they want to evaluate in each game or environment. These categories represent the educational objectives that the mediator wish to work with their mediated;

2. Determination of degree of minimum sufficiency in each educational objective established. This degree of sufficiency is represented by a minimum success value (described in percentage) that a student must obtain in each category that will be evaluated (relevance of the objective in planning).

So, when a user finishes a game/environment contained within a given level of the sequence of activities, the information of success or failure in this application is used by the module to the student performance process assessment in the context of that level. An example of the objective definition process by the mediator is displayed by means of the figures 2 and 3.

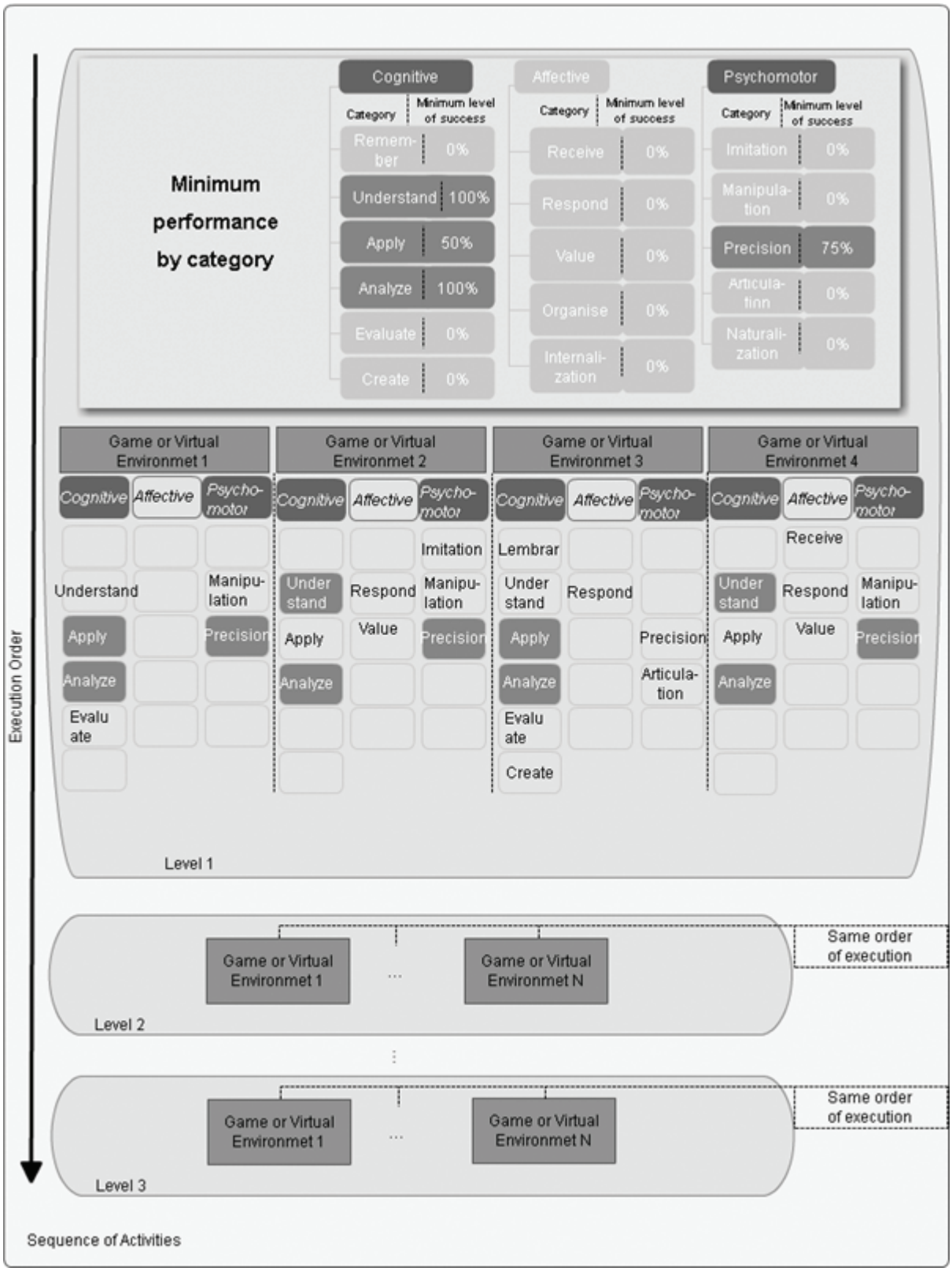
Figure 2 shows a supposed level of a sequence consisting of four activities (games or virtual environments). It is observed that the activity 1 has six educational objectives that were classified in categories present in cognitive and psychomotor domains. Activity 2 has eight educational objectives that were classified in categories present in three domains. Already activity 3 has nine and activity 4 has eight educational goals that were also classified into categories present in the three areas.

Figure 2 - Example sequence with first level composed of four activities: exhibition of the objectives of each game.



The process of defining the objectives for this level of sequence of activities begins with the choice of categories of learning areas to be evaluated in each game or environment. In Figure 3, one sees that only part of the available objectives has been selected to participate in the assessment on this first level of the sequence. This fact is the mediator's option to focus on the assessment of this level in certain aspects it considers relevant to the context.

Figure 3 - Example sequence with first level composed of four activities: setting minimum performance by category.



After the first step, the mediator will define the minimum conditions for saying that the student has passed the level. These conditions are represented by minimum percentages of success required for fulfillment of each category.

Still in Figure 3 are the values specified for completion of level 1. In this figure, there is the definition of the value of 50% for the "apply" in the cognitive domain. Thus, the mediator stating they expect the student meets at least half of the activities that they analyze in this category in order to be considered able to pass the level. As in the example of Figure 3 the category "apply" has been selected only in activities 1 and 3, so it is necessary for the student to obtain success in one of the two activities to achieve the 50% yield and be deemed able in the "apply" in the cognitive domain.

Constraints of the assessment module

The games and virtual environments that make up the sequence of activities must consider two important points:

i. Present educational objectives clearly and concisely.

ii. Return the information of "success" or "failure" for the user after the completion of the application. This information should be provided to the assessment, based on a particular assessment (internal) application which analyses the fulfillment of certain educational objectives.

By considering these points, the objectives declared by games and VAs need to be classified according to the taxonomy of educational objectives [14-15,19]. In the previous section it was shown that the learning areas are divided into categories, allowing the classification of objectives. Figure 4 presents a summary of the areas and categories present in taxonomy and used by the portal assessment module.

From this default, different games and environments can rate their varied objectives in specific categories within the learning domains (Cognitive, Affective, and Psychomotor). With this, you can use measures and artificial intelligence techniques to verify the user's performance over the sequence of activities.

Table 2 presents a fictitious example of a game that could be incorporated into the portal. This supposed game evaluates the performance considering three objectives which the user must reach for success:

1. Run the appropriate decision-making protocol;

2. Correctly determine if patients are physically and mentally prepared;

3. Maintain ethics during the procedure.

Figure 4-Summary of learning domains and their respective categories.

Table 2 - Example of educational objective classification of a supposed game.

Game:	Decisions of dental implant	
Description: 3D game in which students guide their avatar and interact with virtual patients to practice appropriate decision-making protocol to determine whether patients are physically and mentally prepared for dental implant procedures.		
	Objective of the game	**Classification Domain / Domain category**
1.	Run the appropriate decision-making protocol.	"Cognitive / Apply"
2.	Correctly determine if patients are physically and mentally prepared.	"Cognitive / Analyze"
3.	Maintain ethics during the procedure.	"Affective / Categorization"

Source: elaborated by the authors.

Each of these goals are supposed to be analyzed for the internal assessment calculation of the game/environment, therefore, they were classified in the Taxonomy of Educational Objectives, as presented in Table 2. When returning "success", the game ensures that the objectives have been achieved by the user, since when returning "failure" states that the user need to redo the activity. It is important to note that the internal assessment is a requirement of the game/environment, being used by the portal as a performance analysis factor in a context of greater scope.

Performance analysis method

The analysis and decision-making process in the assessment module is accomplished by means of a Rule System Based (RBS). The RBS consists of a set of statements that form a "working memory" and a set of rules that govern how to act according to the statements. The strategy used in this specialist system is that the knowledge of an expert is encoded in a set of rules. Thus, the rules-based system should act in a similar way to the expert[20].

Generally, these systems are simple models that can be adapted for different cases, in particular for cases in which all the knowledge in the area can be described through rules. According to Millington et al.[21], creating a RBS should consider a relevant set of facts, which form the basis of knowledge; and represented by rules, including any possible action. The rules consist of conditions that must be analyzed to direct certain actions.

In implementing the behavior represented by the rules, the entire set is traversed and, for each one of them, the environmental situation is performed to verify whether to trigger. If so, the behavior will be the one described by the rule. In this way, the assessment module performs the performance calculations at a given level and then checks whether the rules were followed. If so the player moves on to the next level, in a negative case remains at the same level.

The assessment is adaptive, i.e., for each level of the sequence of activities, the mediator can select the attributes that will be considered in the performance calculation. Thus, as previously shown, the mediator will need (for each level):

1. select which area categories will be considered in each game;

2. define minimum values (minimum percentages) of success in the categories which have been selected, and it is important to note that these values are unique for each category, i.e. defined once in a level and independent of the game.

The rules will be applied based on those attributes defined by the mediator. Therefore, for each selected category in the assessment:

- There will be the calculation of the player's percentage of success in the category;
- Verify that rule was complied with.

The algorithm is based on rules which must be applied at each level of the sequence of activities, being expressed through the pseudocode shown in Figure 5.

Figure 5 - Pseudocode for analysis and decision making on user performance.

```
1. For each level
   1.1 For each Domain
      1.1.1 If the Domain was selected for assessment, then execute step 1.2, else go back to step
            1.1;
      1.1.2 For each selected Category in the Domain
            1.1.2.1 Check how many games it has been selected for assessment (value1) and,
                  from these games, how many games the user was successful;
            1.1.2.2 Calculate the successful percent: (value2 / value1 ) *100;
            1.1.2.3 Check if calculated value is equal or greater than minimum percentage to
                  pass to other level. If so, pass in the Category, else not pass in the
                  Category;
      1.1.3 If pass in all evaluated Categories or no Categories was selected to assessment, then
            pass in the Domain, else not pass in the Domain;
   1.2 If pass in all evaluated Domains or no Domains was select to assessment, then pass in the
      Level, else not pass in the Level.
```

The RBS was chosen as analysis technique due to its simplicity and effectiveness to the proposed theme. It allows the assessment method presented grant autonomy to the teacher to adapt the analysis to the objectives of planning, at the same time which automates the monitoring of the student during the course of the sequence of activities.

Case assessment model usage

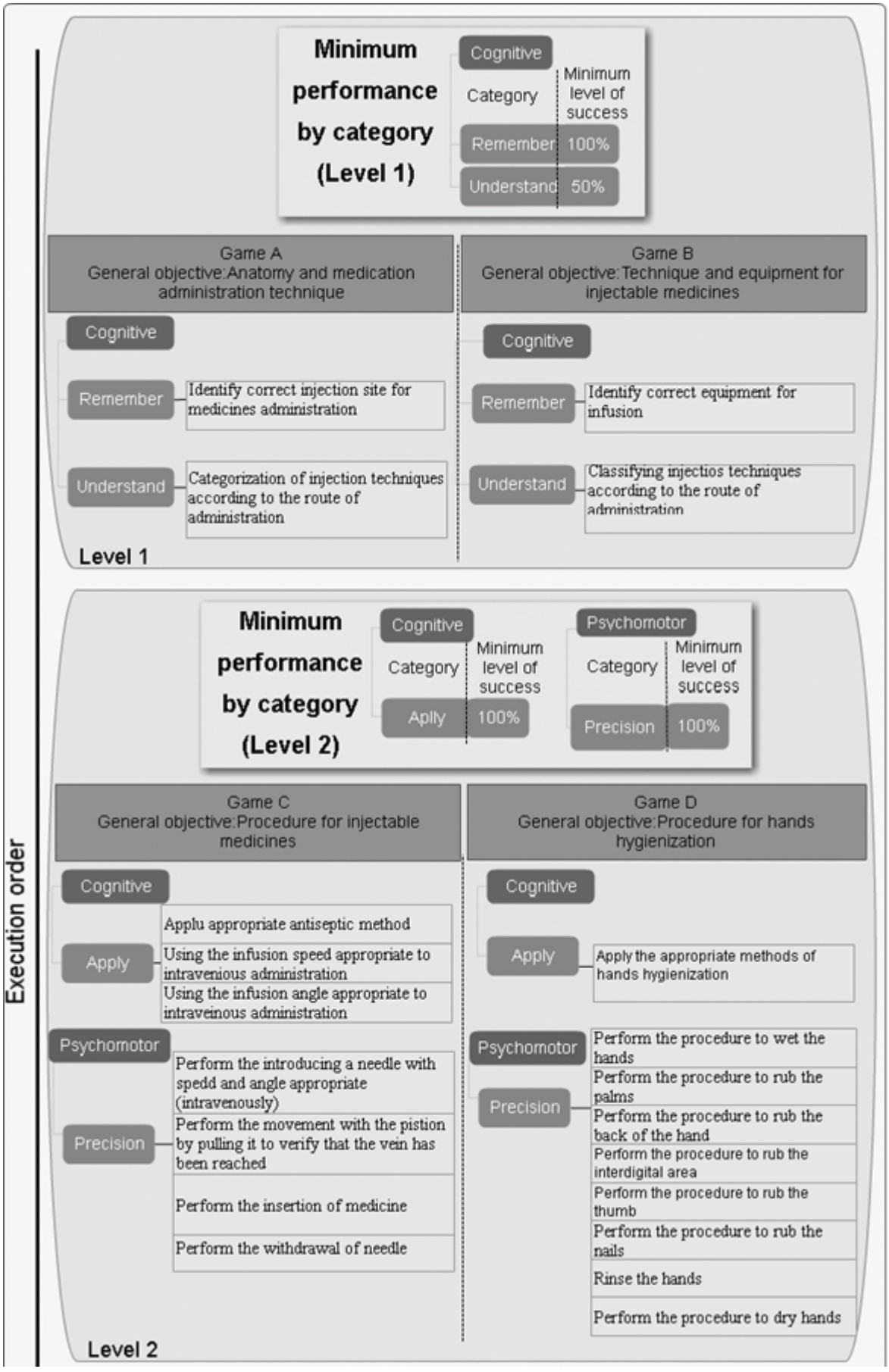
In order to exemplify the use of the assessment model presented in this article, this section outlines an activity sequence that supports learning to administer anesthesia. Therefore, five games were organized in a sequence made up of three levels, as shown in Figure 6.

In the first level are the games A and B. Game A has the general objective of supporting the learning of anatomy and injecting drug administration techniques, focusing on the early levels of the cognitive domain. However, game B has the general objective of supporting the learning equipment and techniques for the administration of injectable drugs, also focusing on the initial levels of the cognitive domain. These games were grouped in a single level to facilitate the qualification on anatomy, equipment and techniques for administering injectable drugs.

At the second level are C and D games. Game C has the general objective of supporting the learning regarding the injectable drug delivery procedure, focusing not only in the application as well as on psychomotor aspects. The game D has as objective the support of learning the procedure of cleaning of hands, also the implementation of procedures, as well as psychomotoric. At level 2, the assembled games seek to enable individual practical implementation procedures, since more basic concepts have been exercised at level 1.

The third level is the game and which has as its objective the administration of anesthesia during a procedure performed with the surgical team. This game provides the application and analysis of administration of anesthesia in the context of teamwork.

Figure 6 - Usage case: sequence of activities comprises three levels support the learning of anesthesia administration.



For each level were (1) select the categories of areas considered in the assessment module and (2) defined the minimum values (minimum percentages) of success in selected categories (Figure 6). In the case of use, to pass the first level the students should be able to remember the content in all games of that level (Remember = 100%) and demonstrate that you understand the content covered in at least half of the games (Understand = 50%).

To pass the level 2, the students have to be able to apply and be precise in all games that make up the level (Apply = 100% and Precision = 100%). Lastly, at Level 3, students need to show that knows how to apply the procedure in the context of work in a team (Apply = 100%).

With this configuration a student assessment that to succeed in the game and didn't succeed in the game B should play the latter again in order to practice and demonstrate that they know ("remember") the content. At the end when completing the last level, they can demonstrate that they have fulfilled the objectives of the sequence of activities.

CONSIDERATIONS

The decision-making processes through AI are present in different activities. In the context of game portals and simulations, machine decision-making processes can also aid the assessment of users with the possibility to control changes in the environment.

The game portals and virtual environments can be used as complementary instruments for the training process in health, helping to organize activities and track the user's performance during the implementation of planned activities, which may include motor skill simulations. From some instruments observed, it was noticed that the services offered by the platforms and portals can include planning and monitoring activities. In this context, the machine decision process is used in assessment processes, assisting in the analysis and control of activities.

In this line, this work presents an assessment model based on the Taxonomy of Educational Objectives to analyze the performance of students considering aspects of games and virtual environments. This taxonomy is used as a subsidy that allows the classification of goals within a portal composed of different games and simulations as a way to standardize the communication language to allow analysis. Thus, the assessment provides an alternative model for performance assessment based on performance analysis objective measures.

The assessment scheme presented enables the mediator to customize the model, giving more focus on the educational objectives of their planning. From the definition of the objectives, the mediator designs their performance assessment diagram and the model through intelligence techniques, perform the analysis for goal verification. The possibility of customization of the assessment, together with the possibility of creating different sequences of activities, allows the use of the model in different stages of the training to assist in individual or team training.

The model presented is in the testing phase, but already offers a differentiated medium for user performance assessment in game portals and VAs from the analysis proposal for the achievement of educational objectives. In addition, it also allows an assessment process which, although it is performed automatically, is designed by the mediator that adapts to the needs of students. In particular, this approach is interesting because it allows them to be considered in the assessment process of the affective domain and psychomotor skills. This feature is relevant in a technological moment in which there is the availability of applications in the form of games and virtual environments that address skills that go beyond the cognitive domain, such as manual dexterity[22] and internalized values[23].

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