

Cognitive Assessment in Digital Pedagogical Applications: An application proposal for Public Safety

Avaliação Cognitiva em Aplicações Pedagógicas Digitais: Uma proposta de aplicação para a Segurança Pública

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ABSTRACT: *This article describes an evaluation instrument built to qualify the performance of professionals in the public security area, when submitted to virtual simulations that require strategic decisions. As a constituent element of a digital pedagogical application, aimed at use in distance instructional processes, this evaluation model was based on the principles of Cognitive Science, as an epistemological basis for evaluating evidence of Minimized Learning and Metaconsciousness in the subjects surveyed, in addition to the assumptions of Praxiology, to the extent that, in training and instructional actions, typical of professionals in the area of public security, the association of theoretical knowledge with practical experience becomes indispensable. As it is an investigation on educational technologies, we use the Design Based Research (DBR) methodology as a research method. The built modeling showed effectiveness and cognitive adequacy for the assessment of cognitive, operational and attitudinal competences, in public security, making it appropriate for pedagogical purposes.*

COGNITIVE EVALUATION. EDUCATIONAL TECHNOLOGY. QUALIFIED DECISION. PUBLIC SECURITY.

RESUMO: *Este artigo descreve um instrumento de avaliação construído para qualificar a atuação de profissionais da área de segurança pública, quando submetidos a simulações virtuais requerentes de decisões estratégicas. Como elemento constitutivo de uma aplicação pedagógica digital, voltada para utilização em processos instrucionais à distância, este modelo de avaliação baseou-se nos princípios da Ciência Cognitiva, enquanto base epistemológica para avaliar indícios de Aprendizagem Minimizada e Metaconsciência nos sujeitos pesquisados, além dos pressupostos da Praxiologia, na medida em que, nas ações formativas e instrucionais, típica de profissionais da área de segurança pública, tornam-se indispensável a associação do conhecimento teórico com a experiência prática. Por se tratar de uma investigação sobre tecnologias educacionais, utilizamos a metodologia do Design Based Research (DBR), como método de pesquisa. A modelagem construída apresentou resultados de efetividade e adequação cognitiva para avaliação de competências cognitivas, operativas e atitudinais, em segurança pública, tornando-a apropriada para fins pedagógicos.*

AValiação Cognitiva. Tecnologia Educacional. Decisão Qualificada. Segurança Pública.

RESUMEN: Este artículo describe un instrumento de evaluación construido para calificar el desempeño de los profesionales en el área de seguridad pública, cuando son sometidos a simulaciones virtuales que requieren decisiones estratégicas. Como elemento constituyente de una aplicación pedagógica digital, orientada a su uso en procesos instruccionales a distancia, este modelo de evaluación se basó en los principios de la Ciencia Cognitiva, como base epistemológica para evaluar evidencias de Aprendizaje Minimizado y Metacognición en los sujetos investigados, además de los supuestos de la Praxiología, en la medida en que, en las acciones formativas y didácticas propias de los profesionales del área de la seguridad pública, se torna indispensable la asociación de conocimientos teóricos con experiencia práctica. Al tratarse de una investigación sobre tecnologías educativas, utilizamos la metodología Design Based Research (DBR) como método de investigación. El modelo construido presentó resultados de efectividad y adecuación cognitiva para la evaluación de competencias cognitivas, operativas y actitudinales, en seguridad pública, haciéndolo apropiado para fines pedagógicos.

EVALUACIÓN COGNITIVA. TECNOLOGIA EDUCACIONAL. DECISIÓN CALIFICADA. SEGURIDAD PÚBLICA.

Introduction

The discussions concerning the construction of the knowledge, particularly, with respect to the approaches that associate this theoretical contribution to the education technologies, they bring up the role carried out by the digital education science as support of social-constructivist pedagogic projects, modeled for construction and/or improvement of professional competences in the individuals. Of the extensive existent technological options, possible of application for the teaching-learning processes, the digital games, so much for the high immersive and interactionist potentiality, as for the possibility to articulate, in a same Virtual Environment of Learning (AVA), elements activators of cognitive structuring properties of the critical-reflexive thought, are considered means propellers of the development of the *Superior Thought (ST)*.

The adoption of the presuppositions of the Design Based Research (DBR) in digital pedagogic modellings, it demonstrates effectiveness, as being methodological course, for the construction of experiments whose purposes are, necessarily, the resolution of problems that sharpen the PS. From a dialogical continuum, collaborative and inter-rational, the participants, in a condition of decisive perspective, they are stimulated to activate the abilities - collaboration, cooperation, interaction, critical reflection, logical reasoning, among others -, that they already dispose in their cognitive compound, in a way to find the resolution before the proposed problem. That effort, for corollary, is redundant in *Metaconsciousness* or *Minimized Learning*.

Matta, Silva and Boaventura (2014), when agreeing with Herrington *et alli* (2007), they defend that DBR is a methodological approach potentially effective to do the integration theoretical-practice in the researches and scientific studies. For them, in a DBR project, the focus should necessarily be in the participation and collaborative involvement of the individuals involved in practice, being, thanks to that, one of their best virtues, which is: all the participants of the process have knowledge and control of the totality of the investigation procedure.

The theoretical outline of the Cognitive Science supplies the necessary elements together with association to the methodological approach DBR, to produce scientific ballast for the construction of an instrument of applicable cognitive evaluation in digital pedagogic experiments for any areas of the knowledge. In this study, we suggested a protocol of procedures, originally social-constructivist, indispensable to assure the effectiveness in the evaluation process of participants in digital experiments in public safety's area, as integral part of the use of the Role Playing Game (RPG), in a digital version, pointed to improvement of professional competences in military policemen, denominated Digital RPG PMBA.

Wang and Hannafin (2005) define the methodology DBR as a [...] systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories. (2005, p. 06). DBR is: a) interventionist, because the research is elaborated for interventions in a situation of the real life; b) Interactive for incorporating successive cycles of analysis and reviewing; c) Guided for the process, whose focus is in the understanding and improvement of the interventions; d) Guided for the usefulness, in the measure that the results of the projects become effective for demonstrating practicality in the use for users in real contexts; and, e) Guided for the theory, because of the I plan to be based on the conceptual structure and in theoretical propositions. (Plomp *et alli*, 2019).

In the simulations of Digital RPG PMBA, we have made an adaptation in the ways and evaluation criteria of the military teaching to the elements of evaluation referred in DBR. That decision was made together with the group of research development, considering that, starting from the dialogue and the involved actors' several inferences, we agree to be strictly necessary to the construction of an evaluation method that made possible to reach our scientific purpose. Besides, in coherence with the presuppositions of DBR, the group made a commitment of leaving a pedagogic contribution for the formation and the military policemen's of PMBA training.

In a particular way to our learning community, it is possible to indicate that the most adequate solution to the problem investigated is the possibility of reproducing, in a virtual environment, the content and narratives related to the complex phenomena of natural reality in public security, whose resolution will serve to stimulate the logical reasoning and the critical view of the military police. We believe that the simulated and mediated praxis in a virtual environment, provided by the RPG Digital PMBA, will produce *Minimized Learning* that, to a certain extent, will imply changes in the *modus operandi* of these subjects, enabling new practices to solve old and new problems. Based on this conception, we built an evaluation model, associating both the guidelines of the DBR methodology and the conceptual elements of Cognitive Science to the specificities of our learning community, the result of which we call *Qualified Decision*.

1 Educational Technologies and Cognitive Science

The global society is experiencing immeasurable technological advances in the area of information and communication, the forerunners of successive and continuous reformulations in the area of education. Artificial Intelligence (AI) systems and programs, such as virtual simulations and electronic games, are continuously developed to support the teaching-learning process. The focus is to activate thinking in a continuous process of construction and reconstruction of knowledge. It is the relative knowledge, applicable to the context and the proposed circumstances.

You learn when you think. Thinking about what you do, about what you did, about what you believe, about what others do or believe or about your own thinking. Collaborative, active and historically engaged social thinking. Thought is always engaged in some activity and / or reflection and, in this role, it serves as a mediating element of learning and the construction of knowledge. (Matta, 2006. p. 64).

The construction of individual intersubjectivity, constituted from a shared processing of collective ideas and meanings, can be improved in mediated socio-international contexts. The structuring of a pedagogical modeling essentially requires social-constructivist foundations that legitimize them as an effective cognitive tool for instruction and the improvement of professional skills and, therefore, allow engagement, dialogic social-interaction, shared knowledge and, for all that, development of *Metaconsciousness*.

In public security, the inseparable relationship between theory and practice represents a *sine qua non* for the instructional process. From the understanding that "[...] the nature of development itself changes, from biological to social-historical [...]" (Vygostky, 2008, p. 63), and that "[...] cognitive approaches try to relate intentional properties of mental states with their causal capacities to affect behavior [...]" (Fetzer, 2000 *apud* Santos, 2013, p. 04), the selection of cognitive variables must prioritize this association.

In this sense, the first variable to be considered is the *Internal Code*. For Cognitive Science, the human mind is an internal code. It concerns the nature and function of mental representation. It is the place where knowledge and growth conditions are located in view of the exposure of specific *inputs* to a given situation. Its internal structure is established in the regularity of human thought, in the act of thinking and this, in turn, explains the representational significance of social actors. (FRAWLEY, 2000).

[...] the internal code is an immense learning network with nodes and connections, built from simple units with levels of activation, joined to each other by weighted connections that inhibit or activate other nodes. The entire network is subject to certain general conditions in learning. The input activates the input units appropriate to the properties of the input; these are connected to hidden units, in the intermediaries that recode the input information and which, in turn, are connected to output units that produce the desired behavior. (Frawley, 2000, p. 75).

The growth of the *Internal Code* is specific to the task as a result of its learning history, so that it happens through the triggering of its updating devices, triggered by means of inputs. The knowledge acquired, compatible with a Minimized Learning does not change its structure significantly, but it can significantly improve specific activities through constant updating. (Frawley, 2000).

The second variable is the *Architecture* that, according to Frawley (2000), it corresponds to the structure of administration of the thought drawn in module formats, *Modularity*, with its own requirements and contents, whose space distribution helps the interactivity, especially for the fact that the knowledge is distributed anywhere in the network, *Interactionism*.

The *Development*, third variable, bases on the change aspects and growth. The change idea, comprehensible in the context of Marxist speech, it brings up the individual and the social progress through the work, that ends up being redundant in growth, in a vygotskian perspective. Derived of that category, we have: *The Superior Thought, The Individual and the Group and the Method*.

For Vygotsky (2008, 2009), the *Superior Thought, Metaconsciousness or Superior Psychological Functions*, is a dependent variable of the environment and of the personal acting, in the measure in that it lives in the cultural and social-historical context external to the apprentice; its analysis requests a glance out on social-cultural information of the *Internal Code*. Lima, Jimenez and Carmo (2008) they reiterate that, in the conception of Vygotsky, those functions had as common line the fact of they be mediated processes, whose appropriate understanding should go through, unfailingly, for the individual's historical-cultural dimension, because "[...] the superior psychological functions appear in the arrangement of the relationships historically produced by the men's group." (2008 p. 05).

Considering the *Superior Thought* as social-cultural, the sub-variable *Individual and Group* if it develops in the proportion in that the individuals are socialized.

The direction of the metacognitive development, therefore, it moves away of the individual towards the practices in group [...] the metaconsciousness is, before anything else, a property of the social group and it is then, appropriate for the individual that can, in his turn, repositionate it in the group, depending on the task in subject. The superior thought is at the same time double and flowing, being transmitted of the group for the individual and again for the group. (Frawley, 2000, p. 91).

Wertsch (1985) *apud* Frawley (2000) says that, for Vygotsky, the development should permeate the practices of *Observation, Experimentation and Analysis* that compose the *Method*. The *Observation* and the

Experimentation represent a microcosm of the development; the *Analysis* concentrates on the development of the superior thought through the relationships between the individual subject and the group. And it increases, "[...] the objective of the thought in itself, is to promote the development - not only to register it - doing with that the superior thought appears for the controlled exam. The experimentation method is the microgenesis, in other words, growth and change in a short term." (Wertsch 1985 *apud* Frawley, 2000, p. 94). They are constituent elements of the Method, according to Frawley(2000): a) *The Collapse*, that refers to the interventions done in the experiment that, for the given difficulty, they stimulate the subject to structure the task seeking to solve it and, b) *The Help* that, in Collapse situation, the individuals fall back upon the group and the external social circumstances, in search of aid. In experimentation situation, the experimenter should supply help to the individual in difficulties. This way, the experimenter, the individual and the experimental situation form a social group unified in operation.

According to Frawley (2000), for the cognitive science, the *Processes of Development*, fourth variable, it is the combination of the elements that favors the *Superior Development*, that is: a) *Internalization of social relationships and external meanings*. This element is described by Vygotsky as the internal growth of the lived experience and transformed in personal signs; b) *Mediation of the time and of the action*. Vygotsky approaches, in this component, the correlation between language and thought, emphasizing the cultural features of the language as means of development of the thought; and, c) *it Controls of the thought and of the action*, composed for: a) *Planning*, that corresponds the regulation of the action and of the thought through the language; b) *Inhibition*, working as a type of cognitive filter regulator of the actions; and c) *Control Location*. In this conceptual unit, Vygotsky affirms that the metaconsciousness can be regulated by the object, for the other or for himself.

The last variable, *Context*, refers to the conditions, in groups, under which the development of metaconsciousness takes place. Such conditions explain that "[...] individuals achieve intersubjectivity through the establishment of a common definition of the situation [...]" (Frawley, 2000, p.100). Associated with the context are two properties: a) *The Theory of Activity* that provides explanations about the practical relationships of the subjects with the environment and with the group relating their respective impacts for the emergence and control of higher thinking. This theory "[...] relates to the way in which the individual uses the environment and the conditions under which an individual's thinking changes" (Frawley, 2000, p. 101). Also according to this author, the subjects use the circumstances of interaction with objects, with others and with themselves (self), as a guiding activity to structure the solution of the problem and, b) *Immediate Development Zone (ZDI)*, or originally translated, as a *Zone of Proximal Development (ZDP)*. This variable can be understood as a gap between the level of real development (independent problem solving) and the level of potential development (problem solving with the help of third parties); through the ZDP, "[...] those functions that have not yet matured, but that are in the maturation process are defined, functions that will mature, but that are currently in an embryonic stage." (Vygotsky, 1984, *apud* Zanella, 1994). It emerges "[...] as the intersubjective context for growth through aid". (Frawley, 2000, p. 102).

[...] the ZDP can be naturally or deliberately built, as long as it reflects a difference between real and potential growth. Certainly, school tasks have this difference, but the same can happen with any practical, routine and also with the game. Vygotsky (1978), in fact, places a special emphasis on it because the game allows the child to participate in an activity that is "well above his head", but without direct social consequence of failure. The study of mental life, therefore, need not be restricted to experimentally planned situations, since any situation based on the difference between real and potential development constitutes a microcosm of growth. (Frawley, 2000, p. 102).

Another characteristic of the ZDP is that the structure for the development of higher thinking must be intersubjective, but asymmetrical. Through intersubjectivity, the subject must engage in joint attention with at least one of the pairs, aiming to acquire a shared definition of the situation and, by corollary, to obtain intersubjectivity and growth perspectives. Due to the asymmetry, the difference

between the performance capacities in the tasks ends up raising the real level of growth of the less capable. (Frawley, 2000).

Activity theory and ZDP give us a way to analyze the individual's relationships with the world. We can identify the cultural context of mental life more precisely than just stating that minds are contextually situated. Some parts of language follow the goals and motives of individuals; in fact, they give individuals ways to objectify and, therefore, to achieve, their goals and motives. A context is not so much a determinant of thinking, but rather a place where individuals speak in order to manage the difference between their own abilities and those of the more capable peers - collaborators. (2000, p. 103)

Doing in collaboration, for Vygotsky (2009), stimulates the creative participation of the subjects, in addition to making it possible to measure their level of intellectual development, their ability to discern, to take the initiative, to volunteer in the proposed activities and, more importantly, it serves as an evaluation criterion of the effectiveness of the teaching-learning process. It is a stage in which improvements are seen in the immediate performance of new content and new skills that have been acquired in the teaching-learning process; it is the revelation of what can be done today, but which could not be done yesterday.

In digital media, simulations are important tools to stimulate the construction of collaborative knowledge. Regarding these, Lévy (1993), defining it as a computer-aided imagination, affirms that the simulation allows to manipulate complex situations in environmental contexts similar to natural reality, being, therefore, fundamental to anticipate consequences on human reactions when subjected to specific situations, that is, "Computer simulation allows a person to explore more complex models and in greater numbers than if he were reduced to the resources of his mental imagery [...]" (1993, p.127). For Prensky (2012), "[...] any synthetic or counterfeit creation or even [...] the creation of an artificial world that approaches the real" (2012, p.290), is characterized as a simulation. J. C. Herz, quoted by Prensky (2012), says that

[...] the simulation is not a noun, but a verb. (Or, in her terms, a predicate, rather than a subject). So, if an object (real or virtual) "simulates" something, it is a simulation. If a "toy" "simulates" something, it is a simulation. If a "story" "simulates" something, it is a simulation, and if a game "simulates" something, it is also a simulation. According to this definition, "tools" can also be simulations, and they usually are. (2012, p. 292).

Lévy (1993) says that the stages of *imagination, mental bricolage and trial and error* are anticipated before the exposure of the real world.

Our ability to mentally simulate possible movements and reactions from the outside world allows us to anticipate the consequences of our actions. Imagination is the condition of choice or deliberate decision. (What would happen if we did this or that?). We take advantage of our past experiences, using them to modify our mental model of the world around us. The ability to simulate the environment and its reactions certainly plays a fundamental role for all organisms capable of learning. (1993, p. 125)

With a view to anticipating the occurrences of professional practice by military police officers, the virtual simulations provided for in the RPG Digital PMBA assume a decisive role for the performance of these social subjects, insofar as they represent the reality in which they act, without adding aspects dangerous, commonly found in these environments.

1.1 O Design Based Research (DBR) and digital pedagogical applications in public security

The Design Based Research (DBR) methodological approach, by correspondence with Socioconstructivism, responds adequately to studies with Communities of Practice¹. Its use in cognitive studies, through *application cycles*, provides for a progressive refinement of learning projects, making them more and more appropriate to the real and specific needs of the social subjects involved, resulting in continuous improvements, built collectively, collaborative and dialogic.

Scientists Brown (1992) and Conllins (1992) were pioneers in using DBR to build virtual learning environments and studies of cognition. This methodology was developed, according to Collins, Joseph and Bielaczyc (2004) from the approach of central elements for learning studies: study of theoretical phenomena in learning contexts, approaches broader than those achieved by traditional learning methods and perspectives to obtain results from formative assessment research that are more robust and applicable to everyday school environments.

Baraq and Squire (2004) *apud* Matta, Silva and Boaventura (2014) define the DBR as a set of research stages used to develop pedagogical solutions that are potentially applicable and useful to the existing learning processes. Due to this attribute, the DBR is

[...] an innovative research approach that brings together the advantages of qualitative and quantitative methodologies, focusing on the development of applications that can be carried out and in fact integrated with community social practices, always considering their diversity and specific properties, but also that that can be generalized and thus facilitate the resolution of other problems. (Matta, Silva and Boaventura, 2014, p. 26)

Ramos, Giannella and Struchiner (2009), present it as a methodology that aims to respond to specific theoretical claims about teaching and learning, whose interventions are seen as redefinitions of parameters and variables in order to meet the demands of the specific group, as a *redesign* of the project guided by the contribution of the subjects who participate in it.

For this specificity, research in education and/or studies of cognition, use it when they want results originating from the collaboration of the research partners involved in the realization and improvement of the problems to be treated. This makes it possible to devise a shared and collaborative action project with the focus group, prioritizing their most concrete needs. This aspect becomes crucial, insofar as it brings out the endogenous needs of the engaged learning community and, thanks to this, it is possible to particularize the solution, as close as possible to the investigated reality. The DBR appropriates the characteristics of the subjects that compose the empirical field investigated to build, in collaboration, the project to be implemented, giving it legitimation and internal validation.

As a sub-category of Action Research, this methodology is not committed to a representative sample of a certain group, nor does it seek absolute results from variables controlled in the laboratory: the DBR monitors the behavior of the variables preliminarily selected by the group and for the focus problem, at each application cycle. Considering the characteristics of procedural and continuous application of this methodology, it is possible to classify it as a continuing education program, designed for the development of specific educational technology solutions and refined to each application cycle in order to meet the situational circumstances of the collaborating subjects.

Matta (2014) makes relevant considerations about the robustness of this methodology when stating that,

[...] DBR will produce discussion and theoretical advancement (emphasis added), by causing the tension of the practice conducted on the theories and dialogues that produced the proposed application; with one of its returns, DBR receives responses and criticisms to the theories and bases of construction, resulting in new reflections and understandings about these bases. The solution is iteratively conducted in work and continuous applied improvement, and the

¹ On Community of Practice see WENGER (1998)

knowledge, including theoretical knowledge about a process of understanding gradually deepened through dialogue with praxis. (Matta, 2014, p. 09).

Through the epistemological basis of Praxiology, it is possible to reconcile the inseparable binomial - Theoretical conceptual foundation and Professional practical application -, characteristic of the area of public security. His theoretical postulate, whose basis of support is in the *praxis* of the subjects as a transforming action of their social relations, states that “[...] *praxis* occupies the central place [...] not only as an interpretation of the world, but also as an element of the transformation process.” (Sánchez Vásquez, 2011, p.30). This author clarifies that among the fundamental forms of *praxis* is the productive practical activity, the productive praxis, understood as the material and transforming relationship of the individual with society, through his work, becoming, therefore, an indicator of the social relations through which it reproduces.

Considering that “[...] the police activity is carried out by a specific social group, which shares a feeling of belonging and identification with their activity, sharing common ideas, values and beliefs based on a conception of what it means to be a police officer.” (Poncioni, 2003, *apud* Fraga, 2006, p. 03), the evaluation of its *modus operandi*, through the evaluation proposal for digital pedagogical applications, *Qualified Decision (QD)*, allows us to qualify the decisions of the military police, understood as its productive *praxis*, to solve the problem situations presented.

As qualification parameters, we associate such decisions with the professional competencies of the National Curriculum Matrix (MCN) of the National Secretariat of Public Security (SENASP), namely: a) Cognitive Competencies, relational to *Knowledge*; b) Operational Skills, which relate to *Knowing How to Do*; and, c) Attitudinal Competences, which represent the *Knowledge Being*. (Ribeiro, 2013, p.08) highlights that this document “[...] privileges, among others, the development of cognitive, operative and affective competences to stimulate reflection before, during and after the actions, with a view to strengthening their Intellectual Autonomy.”. In this sense, we recognize as appropriate the innovative pedagogical practices that reinforce the guiding concept of these professionals, namely: the effectiveness and efficiency of the services provided in meeting the demands of society and in facing the current challenges, as a central element of the training and improvement of professionals public security.

2 The Qualified Decision (QD): A cognitive assessment model applicable to digital training and instructional actions in public security

Particularly for evaluation in digital simulations applied to public security, the forms and criteria for evaluating military education were associated with the elements of cognitive assessment established by the DBR. Thus, the DQ consisted of: a) *Authenticity, Cooperation and Validation*, as the problem situations were built from the collaborative dialogical confrontation between the subjects of the learning community and the researchers-coordinators, based on facts that occurred in the natural environment of these subjects, bringing to the fore their real demands with respect to issues of education, training and professional development; b) *Socioconstructive scientific seat*, used as a structuring pillar for the construction of the evaluation tool. In this sense, Cognitive Science scientifically supports this evaluative instrument.

Following the DBR application guidelines, we designed a structure in 3 steps with their respective assessment instruments (Figure 01), namely: (a) *The pre-test*, applied in step 01, whose purpose is to diagnose the level of real knowledge of each participant before the experiment; (b) *Experimentation*, which is the digital pedagogical application itself, whose assessment tools are observation, mediation and records; and, (c) *The post-test* whose purpose is to verify the level of learning in ZDI.

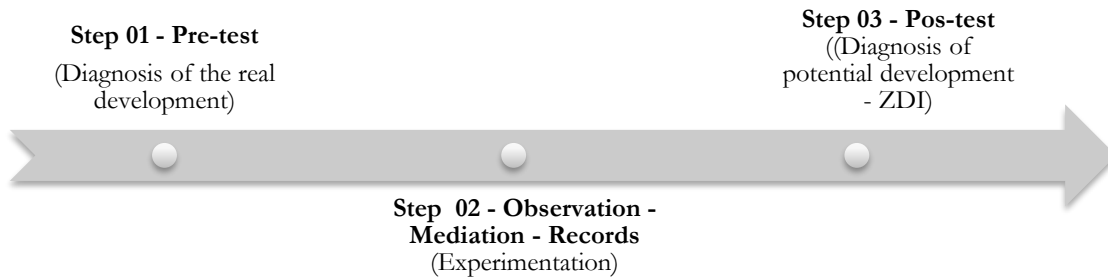


Figure 01: Schematic drawing of the cognitive assessment based on DBR. Own authorship.

In sequence, we constructed the schematic design of cognitive assessment (Figure 02) for the area of ostensive policing and specialized policing in tourism, considering that the subjects participating in our experimentation are military police professionals from the Battalion Specialized in Tourist Policing (BEPTur).

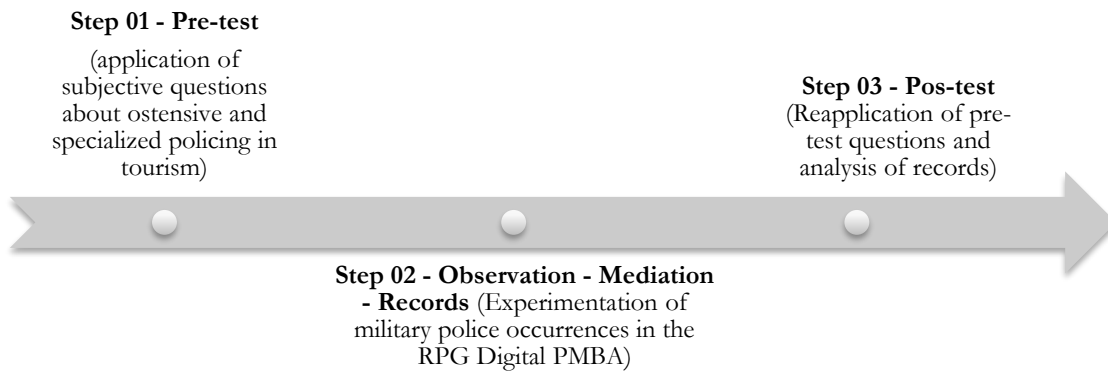


Figura 02: Schematic design of the cognitive assessment for the RPG Digital PMBA. Own authorship.

In the interpersonal aspect, the socio-interactionist conception must prevail for the definition of the four elements that will compose the evaluation. The purpose should be to share and reconcile the interests of the researchers with the concrete demands of the subjects undergoing experimentation (Figure 03)

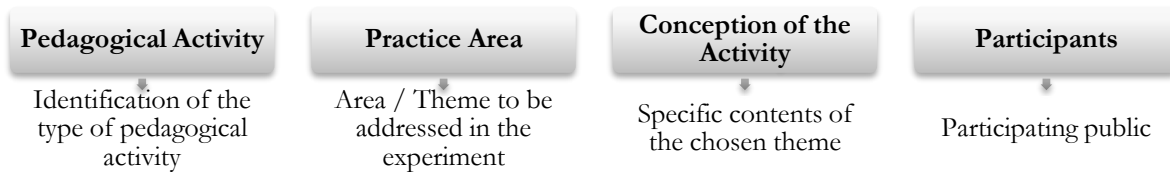


Figura 03: Schematic drawing of interpersonal assessment based on DBR. Own authorship.

The interaction with the learning community signaled the constitutive elements that would be contemplated in the interpersonal assessment. Considering the priority area of activity of the researched subjects, we designed a structure based on these dialogues, as shown in Figure 04, for the experiment in the RPG Digital PMBA.

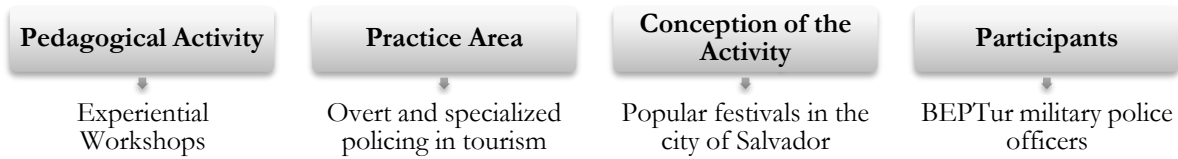


Figura 04: Schematic drawing of the interpersonal assessment in the RPG Digital PMBA. Own authorship.

The Dependent and Independent Variables are instruments for measuring the effectiveness of the proposed pedagogical application and, as such, are linked to its evaluation instrument. The dependent variables make up the structure of the experiment, divided into three categories: (a) *Environmental Variables*, in which they must be defined: (i) *The Virtual Learning Environment (VLE)* to be used in the experiment and (ii) *The Mediation* to be performed during the experiment; (b) *Cognitive Variables*, which define: (i) *The Content Approach*, and (ii) *The Resolution Strategies* possible for use by the participants; (c) *Systemic Variables*, whose parameters involve elements of the operational system of the pedagogical application: (i) *Sustainability and Stability*; (ii) *Ease of adoption*; (iii) *Remote operation* (Figure 05).

Categories	Procedure in the Experiment	Pedagogical Purpose
<ul style="list-style-type: none"> • Environmental: Virtual Learning and Mediation Environment. • Cognitive: Content approach and resolution strategies. • Systems: Sustainability & Scalability, Ease of Adoption and Remote Operability 	<ul style="list-style-type: none"> • Details of activities and actions corresponding to the categories of variables that will be developed in the experiment. 	<ul style="list-style-type: none"> • Details of the pedagogical objectives corresponding to the categories of variables that must be achieved with the experiment

Figura 05: Schematic drawing of the composition of the dependent variables for digital pedagogical applications. Own authorship.

For the purpose of this study, we compose a structure for use in military police instruction programs. Such sub-variables derive from the structural composition and functioning of the application, whose procedures in the experiment were coherently articulated to the pedagogical purposes provided for in this research, as shown in Table 01:

Categories	Elements	Procedure in the experiment	Pedagogical purposes
ENVIRONMENTAL	Virtual learning environment	Internal Media: images and videos sent to the WORDPRESS library; Maps of the regions of the City of Salvador and insignia of the PMBA Operational Units	Understanding the contextualized environment, Incorporation and awareness of the character's patterns, attitudes, personality and values
		External Media: images and videos external to the WORDPRESS library, used via link	Complement the internal media to facilitate learning
	Mediation	Mediation: The Rules System will give the experiment Mediator (Master) the authority to promote the interventions	Stimulate reflection, Promote interaction, Present feedback, Regulation by the Rules System
COGNITIVES	Content approach	Inclusion of occurrence information	Develop the experiment, Promote simulated praxis via Digital RPG
	Resolution strategies	Interventions with Collapses and Aid during the experiment	Encourage decisive strategies of ostensive policing and specialized policing
SYSTEMIC	Sustainability and Scalability	The RPG Digital PMBA was built in the WEB SERVICE environment, with support for the PHP programming language and the mysql database, with WORDPRESS	Enabling the reproduction of the experiment on a large scale
	Ease of handling		Favoring its application other PMBA operating units
	On-line Operability	The RPG Digital PMBA was built on a technological platform to be used over the internet	Enhance the RPG Digital PMBA as an educational technology accessible to all operational units of the PMBA

Table 01: Schematic drawing of the composition of the dependent variables for the RPG Digital PMBA. Own authorship.

The independent variables refer to the parameters that will be observed in the behavior of the military police, when submitted to the decision perspective. Our reference for evaluating this behavior was the Professional Competencies, Cognitive, Operative and Attitudinal, of MCN - MJ / SENASP (2008).

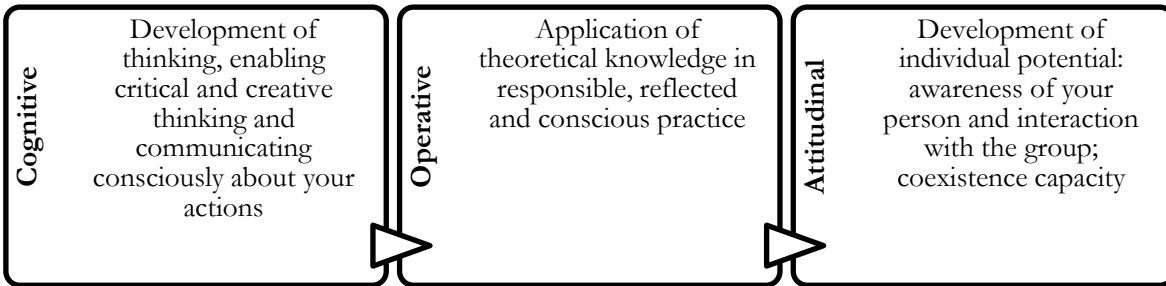


Figure 06: Schematic drawing of the composition of the independent variables for the RPG Digital PMBA. Own authorship, adapted from MCN - MJ / SENASP (2008).

The *Qualified Decision (QD)* is a proposal for an assessment instrument that aims to monitor, measure and qualify the procedures adopted by the individuals in the experiment to solve the problem situations that require reflection. Composed of three progressive and interdependent phases, the QD includes elements of *Quantification* and *Qualification* of the results, emphasizing the specificities of each phase, whose conceptual values contemplates the representative weight of the action in each phase, while establishing qualitative concepts of the action in itself.

The element of quantification, called *Representativeness*, described in percentage terms, corresponds to the weight of importance of the content of each phase on the police occurrence as a whole. The second element, called *Qualification Factor*, fragmented into progressive phases, designates evaluative concepts according to the prevalence of Professional Competencies observable in the military police practices of

the participants. In the impossibility of determining, with precision, the ideal conduct to solve the problem, this cognitive assessment tool makes it possible to indicate the most appropriate solution to the problem investigated, based on an analysis of the content and the narratives presented during the virtual simulations.

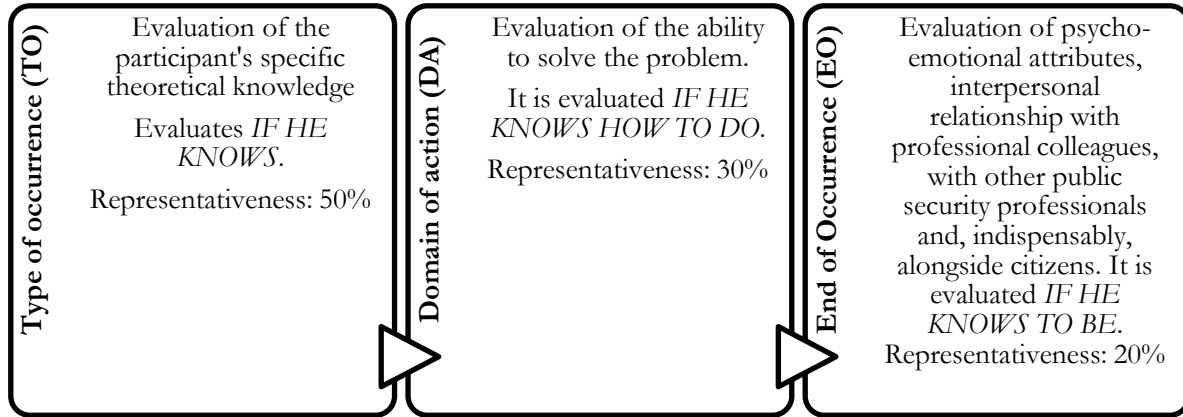


Figure 07: Schematic drawing of the stages of the Qualified Decision of the RPG Digital PMBA. Own authorship.

The *Qualification Factor* was prepared taking into account the legal and administrative measures to be taken by the military police at the time of the occurrence:

Qualification	Concepts	Procedures
	Qualified	Compliance with legal rules for finalizing the occurrence + Obedience to the operating circumscription of the institution to which it belongs + Employment of the Professional Competences of the MCN - MJ / SENASP, especially the Attitudinal Competences
	Obedience	Compliance with legal rules for finalizing the occurrence + Obedience to the circumscription of activity of the institution to which it belongs
	Adequate	Non-compliance with legal rules for finalizing the occurrence + Disobedience to the circumscription of the institution to which it belongs
	Adequate	Failure to comply with legal rules for finalizing the occurrence + Disobedience to the circumscription of the institution to which it belongs + Disrespect to third parties

Table 02: Composition of the Qualification Factor concept scale for use in the RPG Digital PMBA. Own authorship.

The composition of the elements of the QD would allow to evaluate, cognitively, the decisions made by the participants in the simulations in the RPG Digital PMBA. The narratives recorded during the experiment were used to evaluate the decisions made. Based on the parameters established by the QD, it was possible to analyze and qualify the groups of military police professionals from the Tourist Police Battalion (BEPTur). As a result, we identified evidence of collaborative work, reconstitution of theoretical conceptual elements, reactivation of memories and experiences in daily work, among others.

In the *Typification of Occurrence (TO)* phase, 87% of the participants in the test group demonstrated having specific theoretical knowledge compatible with the occurrence presented, considering that they defined and typified, with reasonable precision, the problem evidenced in the experiment. In addition,

this group used the parameters of the Professional Competencies of the MCN - MJ / SENASP, for example to understand the need for an integrated and community management of the Public Security System and to relate the use of force and the firearm to the legality, necessity and proportionality principles. Thanks to this, in the next stage - *Domain of Action (DA)* -, this group acted directly on the occurrence, including on the Collapses incorporated throughout the experiment, acting in order to protect people, perform teamwork and multiple teams at the same time. time, among other competencies. In the *End of Occurrence (EO)* phase, even due to a succession of correct decisions, this group was able to demonstrate security, patience, perspicacity, ability to deal with the complexity of situations, risk and uncertainty, discipline and firmness of character in addition to having acted with civility, respect and common sense. For this group, we take the concept of *Qualified* to military police action.

The remaining 13% of participants showed that they knew the problem-situation posed in the experiment, however, they were unable to make a conceptual correlation with the theory addressed during their formation or with the skills of MCN - MJ / SENASP. As a result, the identification of the type of occurrence was compromised, requiring a more in-depth discussion between them, which ended up having an impact on the resolution of the following steps. For this group, the concept of *Adequate* was attributed.

Final considerations

This article presents a proposal for cognitive evaluation for digital pedagogical applications in the Virtual Learning Environment (VLE) RPG Digital PMBA, with the purpose of evaluating the cognitive development of professionals in the area of public security, when submitted to decision-making perspectives in simulated cases. military police. We were able to structure a *cognitive design*, based on the Design Based Research (DBR) methodology associated with the conceptual elements of Cognitive Science which, when tested, showed effectiveness for use with military police professionals.

DBR is a methodological approach very suitable for use in educational technological modeling projects built for the development of *Metaconsciousness*. In public security, due to the indissociation between theory and practice, this methodology meets this integration effectively and efficiently. Cognitive Science provides precious conceptual elements to assess the level of the Zone of Proximal Development (ZDP), in participants of digital experiments, giving scientific robustness to educational innovations.

The simulations, as a way to anticipate the *imagination, mental bricolage* and the *trials and errors* in the real world, are recognized to be compatible with the particularities of training for public security agents, due to the possibility of correlating theoretical knowledge with a dramatized practice without real risks of the natural environment of professional activity. Considering the elements of interactionism, cooperation, creativity, collaborative action, decision sharing, among others, incorporated into the simulations, it was possible to observe signs of stimulus to criticality and cognitive curiosity in the participants of the experiment. The *Qualified Decision* instrument demonstrated effectiveness for cognitive evaluation in digital pedagogical simulations formulated from the composition of these elements. By this observation, and from the examination of the methodological structure built, it is possible to ensure that this protocol of procedures becomes applicable in various areas of knowledge and for different audiences.

References

- Brown, A. L. (1992). *Design Experiments: Theoretical and Methodological Challenges in Creating Complex Interventions in Classroom Settings*. The Journal of the Learning Sciences. 2(2). 141-178. Lawrence Erlbaum Associates, Inc.
- Collins, A. (1992). *Toward a design science of education*. In E. Scanlon & T. O'Shea (Eds.), *New directions in educational technology*. Berlin: Springer-Verlag.
- Collins, A., Joseph, D. e Bielaczyc, K. (2004). *Design Research: Theoretical and Methodological Issues*. The Journal of the Learning Sciences. 13(1). 15-42. Lawrence Erlbaum Associates, Inc.
- Fraga, C.K. (2006). Peculiaridades do trabalho policial militar. *Revista Virtual Textos & Contextos*, nº 6, dez.
- Frawley, W. (2000). *Vygotsky e a ciência cognitiva: linguagem e integração das mentes social e computacional*. Tradução: Marcos A. G. Domingues. Porto Alegre: Artes Médicas Sul.
- Herrington, J., McKenney, S., Reeves, T., Oliver, R. (2007). *Design-based research and doctoral students: Guidelines for preparing a dissertation proposal*, Edith Cowan University: ECU Publications. Recuperado de <http://ro.ecu.edu.au/ecuworks/1612/>.
- Lévy, P. (1993). *As tecnologias da Inteligência: O futuro do pensamento: A era da informática*. Tradução: Carlos Irineu da Costa. Ed. 34. São Paulo.

Lima, M. F., Jimenez, S. V. e Carmo, M. (2008). Funções Psicológicas Superiores e a Educação Escolar: Uma leitura crítica a partir de Vygotsky. Verinotio - Revista On-line de Educação e Ciências Humanas. Nº 8, Ano IV.

Matta, A. E. R. (2006). Tecnologias de aprendizagem em rede e ensino de história – utilizando comunidades de aprendizagem e hipercomposição. Brasília: Líber Livro Editora.

Matta, A. E. R. (2014). Desenvolvimento de Metodologia de Design Sócio Construtivista para a Produção de Conhecimento. [Texto apresentado pelo autor na disciplina Tecnologias da Informação e Difusão Social do Conhecimento-Doutorado Multi-Institucional e Multidisciplinar em Difusão do Conhecimento-Universidade Federal da Bahia]. Salvador.

Matta, A. E. R., Silva, F. de P. S. da, Boaventura, E. M. Design Based Research ou pesquisa de desenvolvimento: metodologia para pesquisa aplicada de inovação em educação do século XXI. Revista da FAEEBA – Educação e Contemporaneidade, Salvador, v. 23, n. 42, p. 23-36, jul./dez. 2014.

MJ/SENASP (2008). Matriz Curricular Nacional para Ações Formativas dos Profissionais da Área de Segurança Pública. Ministério da Justiça e Secretária Nacional de Segurança Pública. Versão Modificada e Ampliada, Brasília.

Prensky, M. (2012). Aprendizagem baseada em jogos digitais. Tradução: Eric Yamagute; Revisão técnica: Romero Tori e Denio Di Lascio – São Paulo: Editora Senac São Paulo.

Ramos, P., Giannella, T. R. e Struchiner, M. (2009). A pesquisa baseada em design em artigos científicos obre o uso de ambientes de aprendizagem mediados pelas tecnologias da informação e da comunicação no ensino de Ciências: uma análise preliminar. VIII Encontro Nacional de Pesquisa em Educação em Ciências. Florianópolis. 8 de novembro de 2009. ISSN:21766949.

Ribeiro, J.B. (2013). Conhecimento por simulação e segurança pública: O *role playing game* (RPG) *by Moodle* como tecnologia educacional para desenvolvimento de competências profissionais. VII Colóquio Internacional “Educação e Contemporaneidade. Departamento de educação. Universidade Federal de Sergipe (UFS). Aracaju.

Sánchez Vásquez, A. (2011). Filosofia da práxis – 2ª ed. – Buenos Aires:Consejo Latinoamericano de Ciencias Sociales – Clacso : São Paulo : Expressão Popular, Brasil.

Santos, J. M. (2013). A Pesquisa científica em segurança pública: Um estudo sobre os cursos de pós-graduação lato sensu como instrumento de gestão do conhecimento institucional na Polícia Militar da Bahia. Trabalho de conclusão de curso do Programa de Pós-graduação em Segurança Pública. Convênio Universidade do Estado da Bahia (UNEB) e a Polícia Militar da Bahia (PMBA). Salvador.

Vygotsky, L. S. (2008). Pensamento e linguagem. Tradução Jefferson Luiz Camargo; revisão técnica José Cipolla Neto – 4ª ed. - São Paulo: Martins Fontes.

Vygotsky, L. S. (2009). A construção do pensamento e da linguagem. Tradução Paulo Bezerra; 2ª ed. - São Paulo: WMF Martins Fontes.

Wang, F., Hannafin, M.J. (2004). Design-based research and technology-enhanced learning environments. ETR&D 53, 5–23. <https://doi.org/10.1007/BF02504682>

Wenger, E. (1998). *Communities of Practice: Learning, meaning and identity*. Cambridge: Cambridge University Press.

Zanella, A. V. (1994). *Zona de Desenvolvimento Proximal: Análise teórica de um conceito em algumas situações variada*. Temas em psicologia. São Paulo.

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Submitted: Aug. 28 2021
Accepted: Feb. 11 2021