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Las Tecnologías de la Información y la Comunicación en nexo con el Modelo Van Hiele

Information and Communication Technologies in nexus with the Van Hiele Model

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RESUMEN: En Cuba, el empleo de las Tecnologías de la Información y la Comunicación en nexo con el Modelo Van Hiele ha sido insuficientemente investigado como propuesta para perfeccionar la formación didáctico-metodológica del profesor de Matemática en formación. En este sentido, se ofrecen recomendaciones metodológicas para el diseño de materiales didácticos digitales como respuesta a esta problemática. Para su diseño se emplearon los métodos de análisis, síntesis, inducción, deducción y la revisión de documentos existentes en la literatura nacional y extranjera. Su aplicación contribuyó al diseño, ejecución y control del proceso didáctico durante la Covid-19.

Palabras clave: Modelo van hiele; Tecnologías de la información y la comunicación; Materiales didácticos digitales; Geometría.

ABSTRACT: In Cuba, the use of Information and Communication Technologies in nexus with the Van Hiele Model has been insufficiently investigated as a proposal to improve the didactic-methodological training of the Mathematics teacher in training. In this sense, methodological recommendations are offered for the design of digital didactic materials as a response to this problem. For its design, the methods of analysis, synthesis, induction, deduction and review of existing documents in national and foreign literature were used. Its application contributed to the design, execution and control of the didactic process during Covid-19.

Keywords: Van hiele model; Information and communication technologies; Digital didactic materials; Geometry.

Introduction

Cuban social policy expresses the need to "Give continuity to the process of informatization of the education system, making optimal use of the services of the telematic network, educational technology, the introduction of robotics, automation and the generation of digital and audiovisual content". (PCC, 2021, p.70).

In addition, "The education system ensures the training of skilled labor force, according to the capabilities and needs of the development of the country and each territory" (PCC, 2021, p.13).

This demonstrates the Cuban social policy of training increasingly competent education professionals capable of using the most modern technology available in order to achieve superior results in the processes it manages.

For its part, Higher Education encourages the "introduction of information and communication technologies (hereinafter ICT) in all spheres of society and in the predominant conceptions of its management" (MES, 2022, p.2).

In order to achieve this, the career is oriented to "encourage the development and use of educational resources, prioritizing the use of information and communication technologies" (MES, 2022, p.28).

In the Discipline group, the need to contribute, with the joint action of the subjects that compose it, to the students' protagonism in the teaching-learning process "with the support of educational resources in any support, prioritizing the use of information and communication technologies" (MES, 2022, p.34) and within the functions of the subject group it is proposed, among others, "to propose the complementary bibliography of the subject in any type of support, with emphasis on the use of information and communication technologies. To ensure its quality based on the following indicators: correspondence with the general objectives of the analytical program; didactic structure, adequate level of updating, motivation and others" (MES, 2022, p.38).

In spite of the growing importance of the use of Information and Communication Technologies (hereinafter ICT) in the teaching-learning process of Mathematics, this study plan "E" does not have a discipline where the elements of Basic Informatics, necessary for the subsequent competent performance of the graduate teacher, are taught, which leads the different disciplines to work on these contents as The Curricular Strategy "Informatization".

In the teaching of Geometry, the use of ICT should be oriented "for the construction of the contents in a more motivating way with the aim of achieving the general objectives of the discipline and the use of Dynamic Geometry programs, especially GeoGebra" (MES, 2016, p.180). These Dynamic Geometry softwares have proven to be versatile tools that not only facilitate the visualization of figures and shapes, but also allow students to explore complex mathematical relationships in a more tangible and concrete way. Their effective use in the classroom can encourage active student participation and promote greater interest in learning Geometry, which in turn contributes to the achievement of the overall educational objectives of this discipline.

"For the latter, as much as for the use in lectures, teaching tasks supported by GeoGebra should be elaborated that allow the rediscovery of school contents, as well as gaining skills for the use of this software" (MES, 2016, p.181).

There is regularity in Mathematics teachers who graduate from the University of Las Tunas do not always know how to effectively direct the teaching-learning process of Geometry in the different grades of Secondary Education.

That is why this article, result of the theoretical systematization of the main author in his doctoral research, has the objective: to support the use of ICT as a mediator in the teaching-learning process of Geometry to prepare Mathematics teachers in initial training based on the application of the Van Hiele Model.

Development

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1.1 The Van Hiele model

Graduates of the Bachelor's Degree in Mathematics Education at the University of Las Tunas should be prepared to lead the pedagogical process in "the different types of institutions of Basic Secondary, Pre-university, Technical and Professional and Adult Education, as well as the pedagogical school" (MES, 2016, p.7).

Part of this process is constituted by the teaching-learning process of Mathematics, and within this that of Geometry as an area of Mathematics. This model will offer you the possibility of effectively diagnosing the level at which your students are and will guide you where to direct your efforts to achieve the best possible results.

One of these tools, internationally accepted in different models and educational levels, is the Van Hiele Model. "It was developed between 1957 and 1984, by the Dutch couple formed by Pierre Marie Van Hiele and Dina Van Hiele-Geldof, both were teachers in secondary education" (Valeria, 2021, p.16).

This model constitutes a theoretical tool for the teaching-learning process of Geometry, it is formed "by two components, the five levels of reasoning or thinking and the five phases of the levels of reasoning through which a student must pass to advance to a level of thinking" (Mora-Reyes et al., 2015, cited by Remolina, 2021, p.91) since it "describes the process of cognitive growth of students when learning plane geometry" (Hernández, 2021, p.27).

In order for "each schoolchild to advance in the active construction of knowledge and reach a higher level of understanding, he or she must overcome these phases". Van Hiele (1957) cited by León and Barcia (2016, p.10).

"It is not possible to alter the order of acquisition of the levels; each one serves as a basis for the next one, has its specific language associated with it; and its passage through them depends more on the instruction received by the student than on biological maturation" (León and Barcia (2016, p.10).

The Van Hiele Model can be used in the planning of the teaching-learning process of Geometry in the long and medium term, so that each link of the class system constitutes a fundamental piece in the student's transit through the levels.

Van Hiele model levels

Level 1. (Visualization): Contains the first knowledge of geometric concepts, "Students recognize figures by their appearance, without their properties playing an explicit role in the identification" (Hernandez, 2021, p.28-29) in this one they work "without detailing the properties of their components" Alarcón, 2012, p.21. It can be affirmed that a student is at this level "when he can manipulate the known characteristics of a figure that is familiar to him. For example, if he is able to associate the name "isosceles triangle" to a concrete triangle, knowing that it has two equal sides" (Van Hiele, 1957, p.144).

Level 2 (Analysis): This level operates "through the identification of the components and attributes of the figures, with the purpose of characterizing the members of a class or family of objects" (Hernandez, 2021, p.29). Emphasis is also placed on the general properties of figures, where "They begin to analyze some geometric concepts using, for this, observation and experimentation (...) to conceptualize the classes of figures, and thus the figures will be recognized as a set of parts and at the same time recognized by these" (Alarcón et al. 2012, p.22). Furthermore, "As soon as (the student) learns to manipulate the interrelationships of the characteristics of geometric figures" (Van Hiele, 1957, p.144) it can be stated that he has reached the second level.

Level 3. (Abstraction or informal deduction): students "determine figures by their properties, establish interrelationships of properties within figures and between figures" Alarcón et. al. (2012, p.22). This facilitates interpreting the properties of figures and grouping them into families, as well as establishing points of contacts and differences between them. "the learner understands the definitions, recognizes classes of figures, details the figures in a judicious way, but can only follow steps, but they still do not manage to correctly understand the axioms" (Valeria, 2021, p.19). We can affirm that the student has reached this level "when he begins to manipulate the intrinsic characteristics of the relations. For example, if he can distinguish between a proposition and its reciprocal" (Van Hiele, 1957, p.144).

Level 4. (Deduction): At this level "The interrelationships and the role of undefined terms, axioms, postulates, theorems and proofs are understood" (Alarcón et. al., 2012, p.22). In this one, not so complex demonstrations are performed that require theoretical and practical mastery of axioms, theorems, properties and formulas by several ways that help to corroborate the theses from which they start. "Here the student already understands the deductions to constitute a geometric conjecture" (Valeria, 2021, p.19).

Level 5. (Rigor): "can work with different axiomatic systems and compare them, so it allows analyzing the degree of rigor of various deductive systems" (Alarcón et. al., 2012, p.23). It "can work very well with a diversity of axiomatic methods and can grasp geometry in abstract form" (Valeria, 2021, p.19).

As a complement to these levels, the model also contains five phases that help the transit through each of these. The actions taken in each phase should correspond to the level in which the students are.

Phases of the Van Hiele model

Phase 1 (Inquiry or Information): In this first phase consists of exploring the knowledge possessed by the student regarding the content to be studied. "Asking questions according to the students' previous knowledge, which are necessary for the work" (Alarcón, 2012, p. 23). It is important to understand the particularities of the group, in order to identify their strengths, which may be exploited through collaboration to facilitate progress throughout the different educational levels. "The proposed activities do not necessarily have to have the purpose of being solved, they can simply serve to situate the problem to be addressed or to raise various options that otherwise the student would not consider. (Valeria, 2021, p.17).

Phase 2 (Guided Orientation): According to De la Torre (2003), who is quoted by Valeria (2021, p.17) this phase should be constituted by short tasks designed to obtain specific answers about the students' current state. The objective is for students to discover, understand and learn what the concepts are. New vocabulary is introduced and new situations are illustrated.

Phase 3 (Explanation-Representation): It is based on the diagnosis made regarding "the previous experiences that the student brings, they express the vision they have of the observed objects and exchange opinions with their classmates" (Alarcón, 2012, p. 23).

In this phase the geometric vocabulary acquires vital importance, not only because of the theoretical mastery of properties, relations and theorems, but also because of the meaning of each one and the characteristics of the concept that the student learns. Students should be aware that they will have to explain the solution of the activities and then draw conclusions and express what they have learned. The leading role is played by the student, while the teacher only guides and controls.

Phase 4 (Free Orientation): In this phase, activities of higher complexity than the previous phases are carried out, which can be solved by several ways. It usually employs "general and open-ended activities, to find their own way in the network of relationships" (Valeria, 2021, p.17).

Phase 5 (Integration): Students go through the whole process of solving the proposed activities, analyze the analysis and synthesis of what they have learned, abstract, elaborate concept maps and correct incomplete details of learning.

1.2 Dynamic geometry

Geometry is an area of Mathematics characterized by its high theoretical load. In it, students must demonstrate mastery of axioms, theorems, properties, formulas, etc. that are the result of years of study and that lead to the resolution of calculation, demonstration, problem solving and multiple choice exercises, among others. This requires theoretical tools that provide guidance to the teacher on how to direct the teaching-learning process of Geometry to achieve these goals.

The geometric content studied at school allows students to acquire the "basic knowledge of this discipline and to understand the relationships established in the three-dimensional world in which they develop" (Rodríguez et al. 2010, p.40). This should be restructured by being approached from the dynamic approach based on problem solving, where the student is productively involved in its resolution (search for the conjecture) on the basis of exploration and experimental verification.

This way of working enables students to "ask themselves new questions, which allows them to expand their knowledge by discovering for themselves new relationships that may or may not have been contemplated in the programs" (Rodríguez et al. 2010, p.40).

This depends on the level of development achieved by students with these new ways of working.

The presentation of content with this approach should be presented through learning situations that allow the realization of tasks on geometric representations or figures where it is possible to perform transformations to explore how these figures vary, the elements that compose them and their properties in order to master most of the content being learned.

The introduction of this approach contributes to the development in students of skills related to measurement, tracing, construction, transformations and comparison; now from the point of view of the contribution of teaching aids that favor this approach and, in particular, geometric processors.

The teaching-learning process should not be designed only for the use of technology, because one can fall into the error of losing certain basic skills of classical geometry such as tracing, measuring, comparing and constructing with the use of appropriate drawing tools. There are some skills inherent to this approach, such as: determining free points and varying figures from them, and the computer skills necessary for working with technological resources.

The graduating Mathematics teacher should be able to direct the teaching-learning process of Geometry from the mastery of basic geometric concepts in the Seventh Grade of Basic Secondary School to the resolution of geometric problems and integrating exercises in the training for the entrance exams to Higher Education. This generates the challenge of being prepared to meet the cognitive needs of their students and to do so, they should use as many didactic resources as possible.

ICT in the teaching of Geometry is a set of technological tools and resources that allow the digitization, modification, storage, dissemination, visualization or projection and elimination of information to teach Geometry..

The use of ICT can be used in the development of digital teaching materials (seen as virtual, dynamic, interactive and contextualized materials that support the content in the teaching-learning process of Geometry), where it is necessary to take into account some fundamental elements that are referred to below.

The general characteristics that they should have are: They must have an attractive and original design, they must have simplicity (materials of short duration), preferably in multimedia format, they must have hypertextual organization, whenever possible they must be interactive (the student can act on it and the material "reacts" or shows the effects of varying lengths, amplitudes, etc.) and they must be accessible and easy to navigate.

Some of the didactic characteristics are: that the content is valuable, relevant and of proven scientific accuracy, that the information is structured and well organized (going as far as possible from the simple to the complex, from the easy to the difficult, it can be a linear or cyclical organization for example), that they are adapted to the characteristics of the students and that it is coherent with the other components of the teaching-learning process of Geometry.

Among the types of digital didactic materials that the authors suggest be elaborated for the teaching-learning process of Geometry are: digital documents (preferably in "pdf" format), electronic presentations (PowerPoint), concept maps, videos, tutorials, representations and interactive activities elaborated in mathematical assistants (GeoGebra, Derive, Cabri 3D).

For the design of interactive digital didactic materials, it is recommended that GeoGebra be used because: it is feasible to use, it is free software oriented to the teaching-learning process, there is a theoretical framework in Spanish and a diversity of manuals and video-tutorials that explain its use, teachers of different levels have shared their computer products elaborated with this software in the official web page (www.geogebra.org) where they can be downloaded and used.

Conclusions

The Van Hiele model constitutes a powerful tool of obligatory consultation for the Mathematics teacher in training, since it will help him/her to direct the teaching-learning process of Geometry in Secondary Education.

The digital didactic materials that are elaborated for the teaching-learning process of Geometry must be in correspondence with the approach of dynamic Geometry, in order to achieve the necessary dynamism as a way to fulfill the objective

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