# Educational Games in the Construction of Knowledge in Programming Logic

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## Abstract

*This paper presents results of an "action research" developed in the subject of Programming Logic. The proposal of a pedagogical intervention occurred after teacher reports on the difficulties in the teaching-learning process of the discipline. The research allowed identifying and analyzing the main difficulties, as well as the progress after the intervention. Based on the Historical-Cultural Theory of Lev Semenovich Vygotsky, and considering the mediating elements, Zone of Proximal Development and social environment, backed the hypothesis that a methodological process, involving an educational game in the representation of algorithms constitutes a tool for the discipline*

**Keywords:** Programming Logic; Algorithms; Educational Games.

## 1. Introduction

During the teaching and learning process of the discipline of Programming Logic, from the Computer Science Technical Course, integrated to high school, of the Federal Institute of Education, Science and Technology of Rondônia (IFRO) - Campus Ji-Paraná/Rondônia/Brazil, it was found that some students presented difficulties in abstracting the contents of the discipline and transforming them into instruction

sets to be executed later by a computer; therefore causing serious problems for these students in the continuity of said course.

These sets of instructions are necessary steps of solving a given problem in everyday life, called algorithms. According to [5], an algorithm is "a sequence of steps aimed at achieving a well-defined goal."

An algorithm can be developed using several tools, among them, there are graphical tools (Block Diagram or Chapin Diagram) and textual (Narrative Description or Pseudocode), for example.

It is understood that, in this scenario, the school should provide the student with the necessary tools to develop their knowledge and skills through a social, cultural and educational environment; stimulating the curiosity of this student so that he is able to continue his studies.

In this article, it was described a study with approximately 50 students, in which the main difficulties in the contents of the discipline of Programming Logic, to understand the use of educational games in the process of teaching and learning of algorithms, to understand the use of the diagram blocks and, at the same time, minimize these difficulties through a teaching-learning process using an educational game based block diagrams as a methodological resource.

## 2. Related Work

For the development of the research, having the goal of identifying similar difficulties, initial research was carried out in several databases available on the Internet, for example articles, dissertations and/or theses, such as the works by [2], [1] and [4]. These researches demonstrated that the problems in several schools were similar to those found in classes in "X's" Programming Logic discipline.

The proposed solutions in those works were through softwares [11], [1] and [4], with the purpose of assisting in the construction of knowledge, but for different reasons the results fell short of its goals.

Thus, this research did not seek to confront these softwares during the teaching-learning process, but to produce clarifications for the students' performance, suggesting a teaching process for the contents of the discipline, using an educational game based on the graphic tool of block diagram.

The choice of using a game was due to the fact that educational games allow to strengthen and enrich the pedagogical act by providing the student with "finding solutions to the challenges encountered, diagnosing abstract information, developing strategies, proposing solutions, among others" [6]. According to the author, playful activities, not only facilitate the acquisition of meaningful learning, but also promote the construction of knowledge in a more fun and interactive way.

It is understood that games, when used in combination with planning and defined goals, stop being just for fun and become a learning tool in a playful as well as educational way, when used inside the classroom.

It is believed that through the educational games it is possible to act in the Proximal Development Zone (ZPD) of the student in difficulty, stimulating their cognitive habilities for the construction of new knowledge, in a social environment using mediating elements (instruments and signs), as proposed by [14].

In addition to allowing the role of stimulator / mediator to be given to the teacher in the construction and reconstruction of knowledge in a more dynamic and meaningful learning process, it also avoids a traditional approach, which would consist in transmitting-receiving-memorizing the contents.

## 3. Literature Review

Here we present a brief overview of the term algorithm and how this term was associated with the area of computing, as well as its importance in the development of computer programs. It is also shown the use of logic in the construction of algorithms and the forms of representation of these algorithms through graphical and textual tools, with emphasis to the block diagram graphic tool.

### *3.1 Algorithm: Concept*

In computer science, the term algorithm may be one of the most important of all, because of its applicability in the field.

This term came from the references and annotations by Ada Augusta Byron King[1], known as Countess of Lovelace, who is considered the first computer programmer [9]. These notes were definite instructions so that the Analytical Machine, idealized by Charles Babbage[2] in 1834, could compute the values of mathematical functions.

Since the machine of Charles Babbage did not work, because of the technology available at the time, the concepts of instructions were transformed much later in algorithm and used in the Machine of Turing, of Tuby Alan Turing[3], in 1936.

Alan Turing was able to show through his machine that a well-designed algorithm is needed for its operation. Thus, the term algorithm has been used in computing to represent a sequence of instructions [9].

### *3.2 The Importance of Logic in the Algorithm*

The logic when applied in computer programming has the objective of rationality and development of techniques for the production of logical solutions with the purpose of solving problems, in this way, the logic is treated as programming logic, which can be represented in any existing programming language. Thus, to represent the rationale of logic more accurately, we use the algorithms. [9].

It is understood that, when an algorithm is elaborated, it must be considered that the specifications of the actions need to be well defined, following a rule of execution, with the objective of achieving a final result, that is, the solution of a certain problem. This implies that if the constructed logic is correct, it will be possible to achieve the expected result. According to [4], even if the solution of a problem is considered simple, the student will need to understand the statement and adopt logical procedures to solve it.

Thus, the algorithm must, therefore, anticipate all situations that may occur when it is transformed into a programming language, thus allowing the programmer to express his or her logical reasoning, regardless of the language that will be used, without computational details.

### *3.3 Forms of Representation of Algorithms*

An algorithm, according to [3], can be represented in several ways depending on its developer. The main

[1] Ada Augusta Byron King, born in London on (1815 – 52), was a mathematician and english writer. Source: [9].
[2] Charles Babbage, scientist, mathematician, philosopher, mechanical engineer e english inventor; born in London (1791 – 1871). He was best known for introducing the idea of the Analytical Machine, considered the precursor of the computer.Source: [9].
[3] Alan Mathison Turing, mathematician and computation scientist; born in Londres (1912 – 1954). Source: [9].

ones are: Narrative Description, Pseudocode, Block Diagram and Chapin Diagram.

According to [9], the forms of representation use a structured programming technique or modular programming, being in line with the thought, which is structured.

Structured programming allows one to subdivide a given problem into smaller problems, “subproblems”, so that the larger problem can be solved. To solve each subproblem, one must have an algorithm.

There are some methodologies that are focused on Object Oriented Programming. In this methodology, the central idea is the decomposition of data rather than the decomposition of functions [9]. For [11], "the differences between both intensify only at the moment of coding the algorithm through a programming language".

Given the following example "Elaborate an algorithm that shows the mean value between two numbers", the solution through Narrative Description [3], which is developed through stages and using the English language here, is presented in Table 1 below.

Table 1. Narrative Description

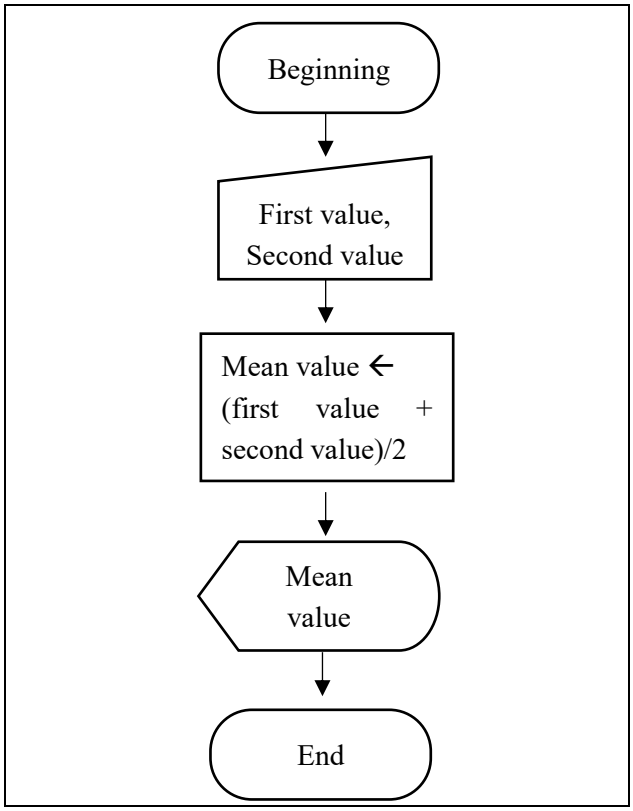
| |
|---|
| 1) Read first value (Ex.: 10) |
| 2) Read second value (Ex.: 4) |
| 3) The mean value is the sum of the input values divided by 2. Eg: [10 + 4] / 2. |
| 4) Show the average value |

Source: Researcher's database

Since the algorithm is personal, each programmer can solve with the information he considers appropriate, as long as he shows how to solve a certain problem.

Table 2 depicts the same example represented by the Block Diagram [9], [3], which uses a graphical form and is formed by geometric figures; the symbols are standardized.

Table 2. Block Diagram




Source: Researcher's database

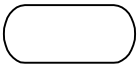
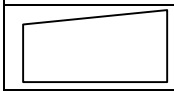
Considering the above, it is considered that the representation of an algorithm through a given tool is essential to visualize and analyze all the existing steps in a given task.

### *3.4 Block Diagram*

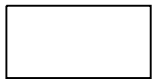
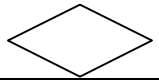
The block diagram is one of the graphical tools used in the logical designs of a given program, allowing the computer programmer to draw the line of logical reasoning. Its elements allow visual and universal communication, as it is one of the most well-known tools in the area of software development and its symbols are standardized through ISO 5807: 1985 (E). [8]

However, it is believed that if ISO[4] 5807: 1985 (E) is used in a manner in which the programmer doesn't know its goals, it will provide documentation of an incomprehensible project. The Block Diagram symbols are represented in Table 3.

Table 3. Symbols of a block diagram

| Symbol | Description |
|---|---|
|  | Terminator: Represents the start and end definition of the logical flow of a program. |
|  | Manual input: Represents manual data entry. |

[4] ISO are the initials for Organization for Standardization, founded in February 23, 1947, in Geneva, Switzerland. The ISO approves the international guidelines and rules in all technical fields. Source: http://www.iso.org/iso/home.html. Accessed on: October 25, 2018.

| | |
|---|---|
|  | Process: Represents the execution of an operation or group of operations. |
|  | Display: Represents the execution of the visual data output operation. |
|  | Document: Represents the execution of the printed output data operation. |
|  | Decision: Represents the use of conditional variances. |
|  | Preparation: Represents the modification of instructions or group of instructions in relation to the action of its subsequent activity. |
|  | Connector: Represents the input or output in another part of the block diagram. |
|  | Line: Represents the link action existing between the various symbols in a block diagram. |

Source: (ISO 5807-1985 (E) apud [8], [9]

These symbols can be drawn through specific software or an official template, as shown in Figure 1.

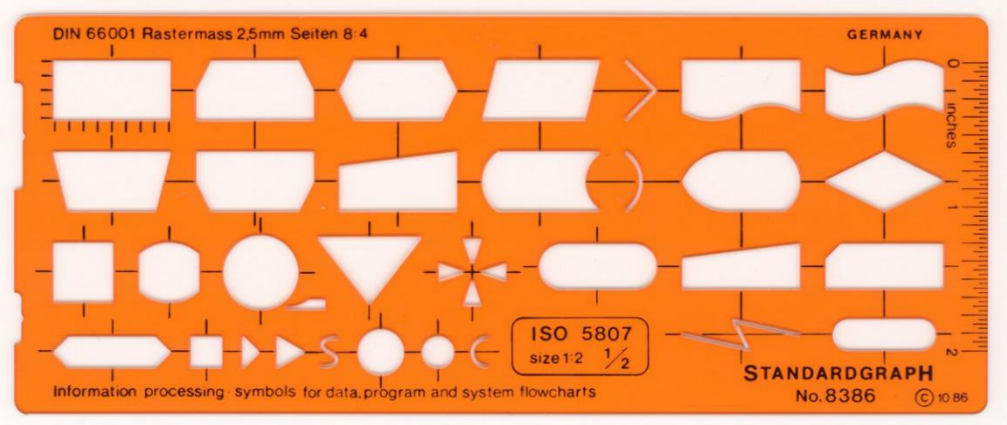



Figure 1. Template for Program Diagramming.

Source: http: //www.fh-jena.de/~kleine/history/software/iso5807-flowchart-template-halfsize-huge.jpg

## 4. Methodology

The research-action method was used, which linked research to practice or action, thus developing knowledge as part of practice. The method allowed studying the transformations that occurred during the interventio. The authors [13], [12], were the theoretical contributions used in this method.

According to [13], action research is a method in which practice is investigated for the purpose of improving it, proposing a reflexive pedagogical action.

The subjects that participated in the research were 37 students from the 1st. year, 11 students from the 2nd. year of the course in Information Technology Integrated to High School and the teacher in the discipline of Programming Logic of the Federal Institute of Education, Science and Technology of Rondônia (IFRO) -

Campus Ji-Paraná/Rondônia/Brazil.
The students of the 2nd. year were invited by the teacher to participate because they had knowledge of the subject and could contribute with their experiences.
This research was triggered after the teacher expressed his concern with some students in the classroom. The teacher identified that during their classes, in the construction of algorithms, these students were presenting unsatisfactory learning results, such as: difficulty in interpreting question statements, developing logical reasoning, and constructing algorithms.
The research was developed using the inductive method, with a qualitative and quantitative approach [10].

### *4.1 Research Instruments*

As data collection, several questionnaires were used at different moments, applied to the teacher and students, with open, closed, multiple choice and yes or no questions, and observations of the development of the respondents, as well as bibliographic searches, hoping to find clarifications on the surveys carried out.

### *4.2 Planning*

Planning encompasses the initial schedules of the research, involving literature reviews, questionnaire applications, and observations. The initial objective was to understand the main difficulties of the students in the discipline, how the discipline was being conducted and what educational tools were used in the classroom to represent the algorithms.
It was verified that every other classe took place in the computer lab, using the narrative description and the pseudo-code as tools. However, the students presented a high degree of difficulty in the discipline.

### *4.3 Proposed Action: Intervention*

The proposed intervention was of a workshop, entitled "Workshop of Logic of Programming using the Diagram of Blocks" tool, with duration of 20 hours. During this phase the basic exercises and rules and the applicability of an educational game were defined.
At first, there were meetings with the 2nd year students and in a second moment with the 1st year students. Lastly, the 2nd year students, researcher and teacher developed all activities together.
This division was necessary, since the students of the 2nd. year had more experience in the discipline in relation to the 1st graders. Thus, these meetings had specific objectives, such as preparing them to be mediators in the teaching-learning process.

Figure 2. Students from the 1st. Year
Source: Researcher's Stock Image

According to the data collected, 94% of the students of the 1st. year said that the block diagram tool facilitates the representation of algorithms. Corroborating with [8], when the author comments that through the block diagram tool it is possible to obtain a better clarity of the algorithms.

Figure 3. Students of the 1st. Year with students of 2nd. Year
Source: Researcher's Stock Image

The students of the 1st year when asked if the interaction with the most experienced students (2nd year) facilitated in the process of teaching and learning algorithms, 100% answered positively. Thus, in a Vygotskian socio-interactionist approach, it is perceived that in addition to the student being active in the construction of his knowledge, this construction will also happen with the interaction between teachers, colleagues and object of learning.

### *4.4 Data Encounter: Result of the Action*

After the action, the application of the knowledge was registered through a championship entitled "CHAMPIONSHIP OF PROGRAMMING LOGIC - USING THE BLOCK DIAGRAM TOOL", in which the students applied their knowledge before a new context. It was constructed an educational game[5] with its rules using the elements of the block diagram to be used in the championship. The game allowed the students manual contact with the elements of the tool and representation of the algorithms in a playful way.

[5] Product patent requested on the Federal Institute of Education, Science and Technology of Rondônia (IFRO). The answer from responsible parties is still awaited.

The championship was carried out with 7 teams, in 3 phases with punctual exercises for each phase. At the end of each exercise, every mistake was pointed out, so that competitors could learn from these mistakes as well. In the perspective presented by [7], the error is considered a stage of learning.
After the game, a questionnaire was applied for the final data collection of the proposed methodology.

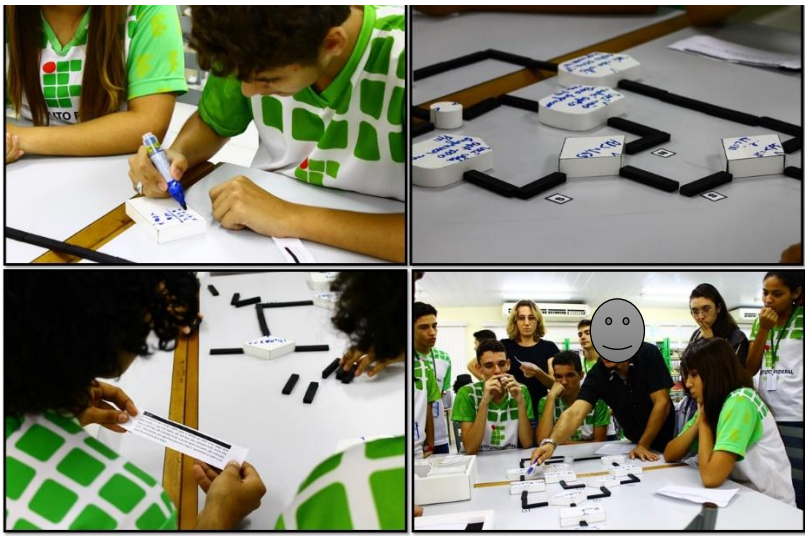


Figure 4. Championship of Programming Logic
Source: Researcher's Stock Image

In the students' opinion, a tool such as educational games, could be used to provide necessary interaction between the subjects; and through this interaction it is possible to achieve the desired objectives and to provide the construction of knowledge.

## 5. Conclusions

The game used in the process of knowledge acquisition, made possible to verify that the use of classroom games is one more playful and creative tool that teachers can use during their classes. For they have broadened their knowledge about algorithm building, according to the students.
Thus, the proposed strategy of a methodology using educational games was considered valuable in the process of knowledge construction by the students. The game allowed the integration between students and teachers, through moments of relaxation aimed at (re)building knowledge. It is worth mentioning that for this it is necessary to have defined goals, and not being taken as an activity of dispute between students, but rather, a possibility to seek and develop students' potentialities of learning and creativity, cooperation, interaction, among others skills.
It is believed that the teacher can use several methods to minimize the obstacles in the teaching-learning process. However, the methodology applied with the interaction between teacher and students involved, with mediating instruments, and in an environment built with defined purposes, proved to be a point of reference for the applicability during the classes of the Programming Logic discipline.

## 6. Acknowledgement

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