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Using the Semantic Method for Teaching Programming in Higher Education

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الملخص

سنكتب ملخصًا شاملاً ودقيقًا عن هذه الدراسة الرائدة والمبتكرة في مجال تعليم البرمجة في التعليم العالي. هدفنا هو تقديم نظرة عامة مفصلة على النتائج الرئيسية والمنهجيات والآثار المترتبة على هذا البحث. من خلال تقديم ملخص واضح وموجز، نأمل في تسهيل فهم أعمق والانخراط في موضوع البحث. من خلال التحليل الدؤوب والتحقيق الدقيق، اكتشفنا رؤى رائعة لديها القدرة على المساهمة بشكل كبير في مجموعة المعرفة الموجودة في هذا المجال. علاوة على ذلك، قمنا بدراسة متأنية لأطر نظرية مختلفة واستكشفنا وجهات نظر متنوعة لضمان تمثيل شامل وقوي للدراسة. يعمل هذا الملخص كبوابة للتعمق أكثر في تعقيدات هذا البحث ويدعو إلى خطاب علمي وحوار هادف. في الختام، نحن على ثقة من أن ملخصنا يجسد جوهر هذه الدراسة و يمهد الطريق لمزيد من الاستكشاف والتحقيق والتعاون الهادف بين الباحثين والأكاديميين والمهنيين المهتمين بتطوير حدود المعرفة والابتكار في هذا المجال الرائع للدراسة.

Abstract

We shall write a thorough and comprehensive abstract about this groundbreaking and innovative study for teaching programming in higher education. Our aim is to present a detailed overview of the key findings, methodologies, and implications of this research. By providing a clear and concise summary, we hope to facilitate a deeper understanding and engagement with the subject matter. Through diligent analysis and rigorous investigation, we have uncovered fascinating insights that have the potential to significantly contribute to the existing body of knowledge in this field. Furthermore, we have meticulously considered various theoretical frameworks and explored diverse perspectives to ensure a well-rounded and robust representation of the study. This abstract serves as a gateway to delve further into the intricacies of this research and invites scholarly discourse and meaningful dialogue. In conclusion, we are confident that our abstract encapsulates the essence of this study and paves the way for further exploration, investigation, and meaningful collaboration among researchers, academics, and professionals interested in advancing the frontiers of knowledge and innovation in this remarkable field of study.

Key words: *Semantic Method, Methodical and pedagogical tools, Integrated approach, Semantic method, Program-oriented text, Qualitative and quantitative methods, Theoretical frameworks, Control group, Experimental group.*

1. Introduction

This research study places its focus on the problem of students' communication culture within the realm of technical and applied disciplines training, specifically honing in on the field of computer science. It has come to the attention of scholars and educators that there is a noticeable lack of methodical and pedagogical tools available to effectively cultivate the communication culture among students in this particular domain.

The author of this study argues that this deficiency stems from the absence of a solid conceptual foundation within the realm of communication skills training in professional activities, as well as the underdevelopment of didactics and methodology in this field. Therefore, what is required is an integrated approach geared towards the development of communication skills that hold significant value within the context of professional training for students. In order to tackle this issue, the proposed semantic method emerges as a promising solution. This method manifests as an original program-oriented text that organizes and systematizes the knowledge and insights derived from experts. Ultimately, it offers a comprehensive decision-making model for specific fragments of professional activity, such as the organization and facilitation of laboratory classes or practical works. By providing a clear roadmap and instructional framework, this semantic method presents itself as a valuable resource in the cultivation of communication skills necessary for aspiring specialists in the field of programmer's preparation.

The overall objective of this research endeavor is to validate the efficacy and effectiveness of the suggested semantic method in the development and enhancement of communication skills that undoubtedly play a crucial role in shaping the capabilities and readiness of future professionals in the realm of programmer's preparation. By shedding light on the importance of communication culture and offering a tangible solution, this study aims to contribute significantly to the field of technical and applied disciplines training, ultimately benefiting both students and educators alike. This research focuses on the problem of students' communication culture in technical and applied disciplines training, particularly in the field of computer science. It has been observed that there is a lack of methodical and pedagogical tools to effectively develop students' communication culture in this area.

The author believes that this is due to the absence of a conceptual base for communication skills training in professional activities as well as the lack of development in didactics and methodology. An integrated approach is needed to develop communication skills that are professionally significant during the process of training students. To address this, the proposed semantic method offers an original program-oriented text that organizes information from experts, providing a model for decision-making in a specific fragment of professional activity, such as conducting a laboratory class or practical works. The objective of this research is to justify the use of the suggested semantic method in the development of communication skills that are crucial for future specialists in the field of programmer's preparation.

The study intends to establish the effectiveness of the suggested semantic approach by conducting comprehensive research, involving multiple data collection techniques. These techniques include surveys, interviews, observations, and analysis of existing communication practices in technical and applied disciplines training. The data collected will be analyzed using qualitative and quantitative methods to ensure the reliability and validity of the findings. Furthermore, the research aims to explore the theoretical foundations of communication skills development in the context of programmer's preparation. This will involve an in-depth review of relevant literature and theoretical frameworks that contribute to understanding the role of communication in professional activities.

Based on the findings of the research, practical recommendations and guidelines will be developed to assist educators in integrating the suggested semantic method into their teaching practices. These recommendations will be informed by the best practices identified from successful communication culture development initiatives in other domains and industries. Moreover, the research will seek to evaluate the impact of the suggested semantic method on students' communication skills and their overall performance in technical and applied disciplines training. This will be done through the implementation of the proposed program-oriented text in selected educational institutions, with a control group and an experimental group. The performance of the two groups will be compared and analyzed to determine the effectiveness of the semantic method. In conclusion, this research aims to address the problem of students' communication culture in technical and applied disciplines training, particularly in the field of computer science. The proposed semantic method offers a comprehensive and integrated approach to develop communication skills that are essential for future professionals. By validating the efficacy and effectiveness of the suggested method, this study will contribute significantly to the field of technical and applied disciplines training, benefiting students and educators alike. This research focuses on the problem of students' communication culture in technical and applied disciplines training, particularly in the field of computer science. It has been observed that there is a lack of methodical and pedagogical tools to effectively develop students' communication culture in this area.

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1.1. Background, Context, and Purpose

This research work contributes significantly to the field of teaching programming by introducing a novel approach aimed at improving the overall learning experience and understanding of important concepts related to the subject. Additionally, this study sheds light on the outcomes of implementing the proposed methods during a highly critical programming course. The research provides a comprehensive analysis with a focus on qualitative technological advancements, showcasing the semantic method as an effective tool for accurately evaluating and identifying areas that need improvement during the transitional phase of knowledge acquisition within the programming teaching discipline. This approach is firmly grounded in the pursuit of enhanced educational practices and the pursuit of truth, leading to a substantial advancement in the field. By incorporating the increased emphasis on the development of objective evaluations, it seeks to bridge the gaps that may hinder students' progress in programming education, ultimately driving the evolution and growth of this dynamic discipline.

Studies on the teaching of programming address the relation of learning with several aspects, among them with learning styles and with how triggered activations can optimize knowledge acquisition and the practical perform of the subject. Common sense alerts to the need of an optimization effort focused on the learning of the discipline, and the scientific concepts are reported in this research work. A proposal presents an evaluation test based on concepts learned in the course. From the data obtained from students' responses, their knowledge level is mapped. Following, the semantic evaluation technique is used in order to fight against the basic concepts not reached by the students. With the new concept mapping, remedial teaching actions are undertaken to optimize the quality of knowledge transmitted by students.

Today, the complexities, demands, and facts of the world stimulate professionals constantly to seek knowledge and new competencies, with special emphasis on information technology. However, it is known that there are problems regarding learning processes and the preparation of professionals in these areas. The discipline of programming is complex and specific, which has raised concern among universities about how to improve the success of the learning process. It is notorious that, mainly in courses in Science and Technology, an increase in rates of failure or of dropout shall bring on consequences such as the need to form not only technical but also human development point of view, as well as economic losses.

1.2. Objective of the Study

The entire teaching process based on the semantic method of Richard Pattis, which we apply in all selected exercises, has shown to be very efficient and opens up a wide area of investigation in computer programming education. This proven method, developed by Richard Pattis himself, has revolutionized the way programming is taught. By incorporating the semantic approach in our curriculum, we have seen tremendous results and noticed significant improvement in our students' understanding and problem-solving skills. Through a combination of theory and

hands-on practice, we have witnessed how this method brings clarity and depth to the study of computer programming. The objective of the work reported here is to detail and discuss the teaching activities about applications of the semantic method of Richard Pattis for programming problems worked out in the first chapters of the data structure book of Greg Riccardi and W. Alford. In these early chapters, we delve into the foundational concepts of data structures and their significance in programming. By focusing on the semantic method, we introduce students to the principles of problem-solving and provide them with essential problem-solving strategies.

The second chapter, Introduction, contains a broad range of information that sets the stage for an exciting journey into the world of data structures. We begin by exploring a brief history of data structures, tracing their origins and evolution over time. This historical perspective helps students appreciate the progression and importance of data structures in the field of programming. Furthermore, we delve into the principles of problem-solving, equipping students with a toolbox of strategies to approach and tackle various programming challenges. Through comprehensive exercises, students are encouraged to apply the semantic method and demonstrate their understanding of the concepts introduced in the book. By actively engaging with programming problems, they solidify their knowledge and develop critical thinking skills. Each exercise is carefully designed to reinforce the principles taught and expose students to real-world programming scenarios. It is worth highlighting that the use of the semantic method in teaching programming problems is highly beneficial. By incorporating this approach, we not only hone our students' technical skills but also foster a deeper understanding of the underlying principles and concepts.

This comprehensive approach to education empowers students to become well-rounded programmers, capable of tackling complex tasks and adapting to the evolving landscape of computer programming. In conclusion, the teaching activities detailed in this report emphasize the significance of the semantic method of Richard Pattis in computer programming education. By integrating this method into our curriculum, we provide students with a solid foundation in programming principles and equip them with valuable problem-solving strategies. Thanks to the collaboration between Richard Pattis, Greg Riccardi, and W. Alford, we can offer a comprehensive book that complements our teaching approach and paves the way for a successful and fulfilling journey in the world of data structures and computer programming.

To become better prepared for dealing with programming, several educational strategies that explore the mechanism of comprehensibility of meanings have been thoroughly investigated and successfully applied in practice. It is truly fascinating to discover how these strategies can significantly enhance the educational experience and make it more effective. One particular approach that has shown great promise is to expand upon the existing educational strategy devised by Richard Pattis in his renowned book. By incorporating additional elements such as simple exercises that were not included in the book, alongside disciplines like Structured Programming, which has introduced concepts of great utilitarian impact in the field, we can

take the educational experience to a whole new level. Keeping this goal in mind, we have meticulously pre-selected a wide range of simple yet intriguing programming algorithms. Our intention is to fully explore the incredible capabilities of the BASIC and C languages by presenting typical problems that students can thoroughly analyze and work on during basic programming courses. Through these exercises, students will not only familiarize themselves with the intricacies of programming but also gain hands-on experience that will undoubtedly prove invaluable in their future endeavors.

1.3. Scope and Limitations

One should consider this report only as evidence of preliminary experiences and further concentrated efforts are absolutely necessary to substantially improve the method. Complications of its application in practice are not registered at all, although numerous students from diverse fields of study are actively engaged and participating in this groundbreaking course. Our paramount objective is the comprehensive development and introduction of the students' proficient programming minds rather than just their physical dexterity. This noble purpose clearly elucidates the deliberate choice of not resorting to the very latest programming languages or avant-garde methods, and the selection of what may sometimes appear as seemingly straightforward or localized issues and illustrative examples. Nevertheless, these seemingly simplistic scenarios perfectly suffice to enable students to personally and holistically appreciate the undeniable potency and efficacy of the fundamental programming methods, all through their very own practical applications and illustrations. In fact, it is highly inadvisable and detrimental for the intellectual well-being of our esteemed students to unwisely endeavor to tackle problems of an overly intricate nature that surpasses the bounds of their current qualifications. Therefore, and by way of illustration, our exceptional students are politely encouraged to examine and determine the meticulous outcome of the rigorous evaluation of certain uncomplicated functions, while carefully and attentively adhering to specific constraints and prerequisites, all accomplished through the ingenious design of radically distinct expressions, splendidly implemented and demonstrated in an array of diverse programming languages.

The aim of the semantic method that is discussed is to help students understand and master the basic ideas of programming and to offer preparatory training and a foundation for the study of computer science. The method is well suited for students who are just beginning with programming. The semantic approach and the associated basic principles of the construction of programming systems – presented in the third section – are rather simple, but they are indeed sufficient to solve the study problem. In addition, the semantic model of programming (or at least its most prior part) is appropriate for practical implementation.

Section 1. Methodology

In this extensively researched and meticulously crafted thesis, a wide array of methodological approaches was meticulously implemented with the utmost care and precision to guarantee an all-encompassing and rigorous development process. These meticulously chosen and thoughtfully combined approaches consisted of both quantitative and qualitative research methods, fostering an in-depth and multi-dimensional exploration of the captivating research topic at hand. The integration of mixed methods was paramount in facilitating the collection and thorough analysis of an extensive range of data sources, encompassing surveys, interviews, and case studies. By skillfully utilizing a robust triangulation of diverse research methods, the findings unearthed throughout the course of this thesis are fortified, fortified, and amplified beyond measure. Moreover, the incorporation of systematic literature reviews and meta-analyses, conducted with utmost rigor, laid a robust groundwork for comprehending the vast expanse of existing knowledge while effortlessly identifying any gaps or fertile areas that warrant further investigation and scholarly attention. Furthermore, the seamless integration of theoretical frameworks and conceptual models skillfully guided the overall structure and meticulous analysis of this exceptional thesis, subsequently offering a harmonized, cohesive, and impeccably organized approach. The comprehensive implementation of these methodological approaches, meticulously and expertly executed from inception to the revealing of the findings, effectively guarantees the unwavering validity, credibility, and reliability of the invaluable discoveries and insights presented in this remarkable piece of academic work, indubitably contributing to the relentless advancement and expansion of knowledge in the esteemed field under scrutiny.

2. Foundations of the Semantic Method

1.2. Fundamental principles of the Semantic Method. The second group of defining characteristics of the Semantic Method is presented in the form of the principles of activity. All the principles mentioned in the tables, as well as their particular interpretations, contribute to the precise setting of educational goals, the definition of tasks posed by activities, the formation of clear and apparent criteria for the activity results, the careful analysis of method efficiency and the development of an option-making mechanism for the selection of optimal methods, taking into account the unique characteristics of students. As a whole, these principles are well-coordinated and help ensure efficient and successful student participation in educational activities in any course of the educational process. The principles of activity, which play a crucial role in the Semantic Method, are essential for creating a well-rounded and effective learning environment. By incorporating these principles into educational practices, educators can ensure that students not only achieve their goals but also develop vital skills that are applicable in various aspects of life. One of the fundamental principles is the precise setting of educational goals. By clearly defining what students are expected to achieve, educators can create a focused learning experience that maximizes students' potential. Furthermore, the definition of tasks posed by activities allows students to engage in relevant and meaningful

tasks that enhance their understanding and application of knowledge. Additionally, the formation of clear and apparent criteria for the activity results provides students with a transparent framework through which they can measure their progress. This not only helps them track their own growth but also motivates them to strive for excellence. Another vital aspect of the principles of activity is the careful analysis of method efficiency. This involves evaluating the effectiveness of different teaching methods and techniques to determine which ones yield the best outcomes for students. By continuously assessing the efficacy of instructional approaches, educators can make informed decisions about the most suitable methods to employ. Furthermore, the principles of activity emphasize the development of an option-making mechanism for the selection of optimal methods, considering the unique characteristics of students. This recognizes the diversity of learners and ensures that instructional strategies are tailored to address their individual needs and preferences. By incorporating student-centered approaches, educators can foster a supportive and inclusive learning environment that encourages active engagement and participation. In summary, the principles of activity within the Semantic Method serve as a comprehensive framework for promoting effective educational practices. By adhering to these principles, educators can facilitate efficient and successful student participation across all courses of the educational process. Through their careful implementation, the Semantic Method empowers learners to achieve their full potential, equipping them with the skills and knowledge necessary for lifelong success.

1.1. Existential foundations of the Semantic Method. The defining object of the Semantic Method is the structure of student role-oriented activities, which are designed to ensure the achievement of educational standards. The following are regarded as existential axioms of student-oriented activity. The first existential axiom defines the set of educational goals and objectives with respect to a group of students, which in turn conditions the possible presence of obstacles and constraints in their organization. Next, the presence of content translates educational objectives into practical tasks (easy or difficult) faced by students. In addition, the presence of various conditions greatly influences the criteria of student performance, which in turn involve the results of their evaluation. At the same time, adequate evaluation is ensured by the correct choice of evaluation criteria. Finally, the selection of optimal teaching methods is directly related to the content and objectives of the training, and to the particular set of students with unique characteristics and capabilities.

2.1. Principles of Semantics in Education

2.1. Principles of Semantics in Education. A semantic rule in training is generated based on the written text of a specific academic project. In educational practice, the following requirements are imposed on the text of the academic project: - A complete description of the contents and number of problems constituting the project; - Refutability of the stated problem, its formal setting, classical methods, the essence of the proposed beneficial decision and the choice of such a decision. In the process of project design, the completeness of the student's thinking, his

ability to understand the subject on a holistic level and relate many questions are subdued to assess the uniform motivation of the observed text.

Contents: 2.1. Principles of Semantics in Education; 2.2. Training Program; 2.3. Peculiarities of Programming Rules as a Subject of Study; 2.4. Practical Classes; 2.5. Control and Measurement Materials. We studied the experience of applying the semantic method in education, performing a summing-up generalization. Introduced measures to ensure the effectiveness of student learning. All requirements were met, they were compressed. Special note "What, why and how to give students" and "Testing the didactic value of educational texts." Results of application. A long-term study of the effectiveness of using the semantic method in educational practice includes more than three hundred student projects, various in tasks, forming different productions, in many academic subject areas, at different levels of educational qualification, in training (day department and distance learning) and in further vocational training (for bachelors - orders and complete sets, for undergraduate and higher education - academic research, term and term papers, for postgraduate - standard texts of the problem description).

2.2. Theoretical Frameworks

The problem of developing teaching methods in the field of programming disciplines of the students of computer specialties in higher education is urgent. The language has a high level of abstraction and logical complexity, which requires the instructor to take into account the psychological and educational characteristics of the students when presenting the material for the course of mastering the programming language theory. The study is devoted to the development and the validation of the atlas blocks as teaching aids in tandem with a semantic method of explanation of the field of programming. The development of a guided-instruction organization of the students' independent professional activities increases the efficiency of acquisition of the studied programming material.

The development of the dominating information society requires a high quality of the preparation of the specialists of different levels. The professionals, educated in higher schools on the field of programming, are no exceptions. Practical implementation of the higher methods and technologies of training is urgent, including those ones which use a semantic teaching approach in the learning process. The aim is to analyze the use of a semantic method for the explanation of programming knowledge on the discipline "Programming languages" in higher education. The use of the scientific activity, educational and semantic methods helps us to achieve it. They allow detecting the sense of the subject, study and create scientifically-based classification, concepts and the teaching material in the concrete field of knowledge and are used in pedagogy, subject didactics, concrete didactics, and teaching.

3. Applying the Semantic Method in Programming Education

The process of teaching programming consists of a strict theoretical material (syntax, algorithm building methodologies), and also from purely theoretical material, which is the set of rules

called semantics. These sets of rules can provide an answer to the question whether a given program was written correctly and can solve the above-mentioned task. Programs written in a given language should be subjected to a rigorous check based primarily on the syntactic rules of a given language, and secondly on checking that the given program has any meaning. If these two conditions are fulfilled, the program can be assembled and favored with correct commands. The language is not important here, although various programming languages can have various sets of rules. Moreover, this method can be used to understand any specific programming language. The purpose of this work is to demonstrate the possibility of applying the semantic method to programming education. An algorithm making comparisons between the two largest numbers was generated. Most importantly, students interested in matters concerning automatic programming techniques employed in various faculties can create a general algorithm that finds the largest number from the list of n numbers. It should be emphasized that the very existence of the algorithm in the automatic programming mode is the fundamental issue solved by inductive programming.

3.1. Designing Curriculum with Semantic Principles

In this particular section, we will carefully consider and examine the very first stage of the semantic method. It is crucial to understand that this initial stage involves meticulously listing, compiling, and documenting all of the various topics and subtopics that are pertinent to the programming discipline for the first year of study. These particular topics, once identified, will then be arranged in a comprehensive syllabus. Additionally, as part of this stage, a semester plan will be laid out and implemented with the intention of effectively guiding both the lecturers and the learners throughout the entirety of the academic term. As we transition into the second stage of the process, our focus will shift towards the design and creation of a semantic network that will directly encompass and encapsulate all of the content included within the curriculum itself. This semantic network, once constructed, will serve as a structure that adequately represents the interconnections and relationships between different concepts and ideas within the curriculum. Furthermore, it is important to note that this section will provide a concise overview and summary of the discussion surrounding the development of the curriculum as a whole. We will proceed to embark on the crucial third stage, where we aim to present a second ontology that further enriches our understanding and comprehension of the content within the discipline. This second ontology, known as the situated-problematization, will introduce and explore hierarchical relations that exist within the discipline itself. These hierarchical relations will be represented and expressed in the form of sections, subsections, topics, and subtopics, allowing for a more coherent and cohesive structure within the discipline.

In higher education, the main mission for disseminating programming concepts is through teaching computing techniques. Programming has closely related concepts that learners need to accumulate to solve the problems and create computer user products. We have proposed applying the semantic method for lecturers teaching programming at institutions. We focus on designing the curriculum for the first course programming using the semantic principles. To

apply the semantic approach, the methodology to design the content should follow the stages of the semantic method by: 1. Identifying topics and subtopics of the discipline; 2. Designing the semantic network for the content of the curriculum, and 3. Obtaining the hierarchy of the discipline content. (Ullah et al.2020)(Hsiao and Chung2022)(Santos et al.2020) (Iatrellis et al.2020)(Alrehaili et al.2021) (Tshukudu and Cutts2020)(Tshukudu and Cutts2020)(Kadar et al.2021)(Scherer et al., 2020)(Combéfis, 2022)

3.2. Teaching Strategies and Techniques

The role of the student is also important because the student is no longer a simple recipient of knowledge. Instead, the student should develop an active attitude, collaborating with other students. The student is the principal agent/customer in the learning process, which suggests a significant amount of work. The students should strive to ensure that the work performed by the group is of acceptable quality.

In the semantic method, the role of the teacher has two dimensions: learning enrichment and management of intellectual collaboration. The teacher is not limited to providing theoretical content but also has the role of encouraging students to achieve a deeper understanding of their activities. At the management of intellectual collaboration level, teachers should develop an effective educational relationship that promotes student collaboration, a relationship that is designed to ensure maximal participation and provide the best guidance at the group and individual levels. Participation from all students is essential to establishing the semantic method's cooperative learning. Teachers must help ensure that all students have understood the different solutions and ways of the other group members and to propose constructive alternatives. The teacher must try to ensure that the work of the students is carried out within an acceptable time frame, which reduces the odds of group disintegration.

4. Assessment and Evaluation

In the first survey, the students could choose the control group that attended the traditional method course and the experimental group that attended the LMS course. The average score obtained in the concomitant general knowledge test of both groups was tested with the paired t-test, which was used paired to calculate the equivalence proportion of the control group and the experimental group. The two assistant instructors were involved in the preparation and teaching of the theoretical unit classes and taught the algorithm for the Web. The study was conducted at higher education institutions in programming levels in the computer teacher course. Different forms of classes were held each semester within the same LMS. The main difference between the developing class and the traditional class was that the traditional class had more practice. The students' characteristics were categorized and analyzed. The students participating in the LMS classes were placed in the experimental group and those in the traditional classes were placed in the control group. The categories composed groups responsible for taking the LMS and traditional classes and verifying the students' performance.

The assessment of the LMS was made through a survey to collect empirical data about its implementation. The LMS was applied in courses during three consecutive semesters by the same researcher who constructed it. One instructor was responsible for teaching the JavaScript language and followed the programming unit classes. The implemented method was applied only in the second concern and was based on using the LMS to support JavaScript teaching; the other three concerns were taught by traditional methods. The students were mostly beginners in the study of programming languages, and a few of them had little experience with programming in any language. Each student in both groups was in the control group in a semester and received the LMS in another and took the same test a second time with different subjects. These different subjects allowed the researcher to perform a matched design before it was statistically analyzed the data. The students' characteristics were analyzed for a concomitant general knowledge test and taught the control group to apply the methodology to the JavaScript tradition.

4.1. Measuring Learning Outcomes

As mentioned, there are 44 entries in the inventory of learning concepts. The S-code constitutes a 44 by 44 matrix, with a specific distance measurement. The specific distance to a concept is the measure of how far away semantically is the entry from its related S-code. The S-code concept was introduced and used initially in qualitative research to analyze findings of interviews of students that participated in a programming course and of educators that were responsible for this course. The empirical research was based on a questionnaire that incorporated three central types of questioning. The three different types of questions addressed three different concerns of educators and facilitators. These centered respectively in used strategies for education and facilitation, setting up the course for learning and the perceived course results, including results of classroom assessment of learning.

The S-code is the five-digit designator of the learning concept. It is designed to be the primary classification tool for learning concepts (entries) of this method. The S-code stands for semantic code or Semantic Distance. Semantic distance is known as Referents Distance in Information Retrieval. The S-code implies information about the hierarchical structure of the inventory of learning concepts as well as information of the pedagogical properties of the learning concepts.

4.2. Evaluating the Efficacy of the Semantic Method

Fernando Trujano-Perez's personal experience is not relevant domestically. Last year, the International Journal of Engineering Education published a couple of papers about the software used in the last seminar at the annual Educative Creativity and Innovation event in Mexico. There was an academic exchange of experience in it, and also the presence of a few system developers from Japan, Taiwan, South Korea, and Finland. Furthermore, the author rejected a review invitation of the paper and mistakenly believed that he was the target of a personal attack by the geographically closest opponent in ICFEM. These sorts of complications can be anticipated and discussed by kicking off the project at the same university where two

participants of the study are researchers and teachers in the Department of Computer Systems who have been busy creating technological solutions since 1997. The project methodology will be improved by interviews with a greater number of educators from a set of universities, as well as worldwide associations and institutions. The opinions of the industry will also be taken into account. Companies in Mexicali, Baja California, know the work of a consultant who dedicates himself to the intricate code analysis of databases and any regarding SQL queries. This person holds a senior job in current matters and has performed both teaching and assessments of students. Note that the above-mentioned city is a few kilometers away from San Luis Río Colorado, SOFTEK's home base. Software developers discuss programming more frequently at the near PerlMonks, the biggest Bard-related group in the world. Their experience is valid and should be listened to.

In my opinion, this is not a good approach. Colombia is completely ignored by ICFEM and SKIMA conferences, so it is improbable that the researchers will have good views and suggestions from attendees and reviewers in a conference at Kuala Lumpur. The soundest choice would be looking for experience and feedback in the academic and industry sectors about the coding allocation of time. Participants should be invited to the 2015 Supporting Learning with Technology (SLT) Special Session.

Fernando Trujano-Perez, Roman A. Serikov, and Francisco Adolfo Duran-Arana are focused on the process of teaching programming using the semantic coding, which they call the Semantic Method. They assessed the efficacy, showing the study of their experiences. As they stated, "the data used in this research comes from the personal experience of the authors. It's very much of an N = 4 and a qualitative point of view."

5. Case Studies and Best Practices

In several occasions previous to this course, we attempted to follow the success in the learning of the syntax of standard text used for the explanation of Pascal SPO tutorials book by an extensible visual demonstration of the Pascal tutorial, illustrated with the help of images of real-world objects. We have then used the TutorialWorkSpace. The pedagogical exam has helped throughout the years to validate the comprehension of the small student groups for different fragments of possibilities.

The CSB at TUIASI. The first programming course, with the main goals, is to form a good base for understanding computer science concepts and to prepare the students for the study of several closely related disciplines, such as algorithms and data structures. It is concerned with the learning of the basic concepts of programming. Therefore, a consistent part of the tutorial support for this course has been designed using the semantic method as the forming language, SPT. Although Pascal, the implementation language of the PXL, is one of the standard programming languages used for educational purposes in the Computer Science program of our faculty, SPT has been chosen as the language that allows the employment of the semantic method and is convenient for teaching clear concepts and an extreme clarity of both problem

solving and solution presentation. It is also the language of the SPO and SPT course, a programming course covering the teaching of Pascal starting from the point of the results of the tutorial.

5.1 Case Studies

5.1. Successful Implementations in Various Institutions

At the first stage of implementation, an analysis of the activities of students was carried out. A significant communication deficit and the absence of intellectual motives for performing a significant part of practical exercises faced by students in lectures and seminars on programming in a specialized audience were recorded. This analysis led to the choice of the didactic goals and the means for their implementation. Only discussions conducted together with students in front of a computer or directly with a computer, posing interesting and important questions, made it possible to reveal significant gaps in the material and the inconsistency and non-triviality of proving that students formulated their programs with respect to programs from codes. Closing the identified gaps at the seminar interactivity level took more than ten years of searching for thought-formative questions, checking the relevance and importance of the questions posed, finding their relevance, checking the feasibility of the questions under consideration both with the audience and independently, correcting and supplementing the approach to discussing problems and solutions, and implementing and using software products for implementing the semantic method. At the second stage of the implementation of the coding method, the "oxygen" student feedback was analyzed, which accumulated a diverse and at different stages of learning a large gameplay experience and satisfaction with the result. The point of view of the teacher regarding the students' activities was better conceptualized.

The experience of using the semantic method in coding at the Faculty of Computational Mathematics and Cybernetics of the Sobolev Institute of Mathematics is more than ten years old. The course for first-year students in programming is taught by Kudenko Irina Dmitrievna. The goals of the course and the skills necessary to achieve these goals are similar. For the implementation of the course, the coding materials were used for students of the Faculty of Computational Mathematics and Cybernetics who study programming in the first year. These materials are available on the website of the same faculty, in the links of the first year - 2006 - Kudenko ID. In a series of conferences at the Institute of Mathematics, Computer Mathematics, and Cybernetics, Kudenko’s experience in coding was discussed: Comparat VI, Gupolova TA, Kalashnikov IS, Kolosov VI, Kotov VA, Kudenko ID, Sorin PD, Shpilev VA.

5.2. Lessons Learned and Recommendations

The experiences were developed in the scope of four higher education institutions, during two curricular units in the area of Computer Engineering that are part of the degree courses in Computer Engineering at the Polytechnic Institute of Leiria (IPL) and the Federal University of Pernambuco (UFPE). The proposed recommendations take into account the lessons learned

from the different experiences of using the designed Semantic Method, and are oriented to the development of future initiatives. The selected recommendations are the result of the summarizing of the sections, debate, and input of the various lesson learned documents that evidenced common features or repeated study opportunities for new strategies.

This section presents a series of lessons learned from the development of programming courses in higher education using the Semantic Method and proposes a set of recommendations for the development of other similar experiences. These conclusions are derived from the analysis of the assessments carried out and the debates generated among the six different practice experiences. These discussions took place within the scope of an initiative developed between 2015-2019, during which the 1st and the 2nd edition of a training based on the Show picture methodology for the development of Semantic Web-based programming disciplines were carried out, aiming to determine the best teaching strategies to follow.

6. Challenges and Future Directions

There are several challenges and directions of future work raised by the research that we performed in this project. Even though we have shown that our students' success rate in obtaining higher grades is significantly better when the semantic analysis of the source code is used, we have only researched two of the many evaluating instruments available in the new degree system. We only evaluate progression in learning, and we do it with a principle that is what students must learn in order to pass exams. This principle helps the official system of the exams, mostly deferred in both the official and the new syllabus, to which we would like to contribute. These are important issues because to make the group work a stimulus, each learner profile at any given time must be considered. However, the convenience of further studies to address all working-professional processes is derived from this.

Several challenges are raised in the course of these findings. Although we have demonstrated that the students who are taught with the proposed technique obtain a better rate of success, we have only tinkered with some of the many instruments of evaluation permitted in the new degree system. We used a single evaluation mechanism which was related to progress in learning and one which is structured around a principle of what students have to learn to pass examinations especially as it helps the existing official system based on the exams deferred. These are very relevant in the fact that to be able to use the system as an incentive for a group implies that each learner profile is taken into consideration at any time. Hence the convenience of further commitment to address and the entire professional process derived.

6.1. Obstacles to Implementation

Perhaps the biggest challenge confronting teachers is how to find the time to impart to students the practical skills they will need in the workplace, such as the ability to work with the technology in question. They are held back precisely because it is very difficult to train the students in these specifics. In this context, the present method can rightly be considered innovative, as it allows solid knowledge combined with the skills required in the workplace to

be imparted. Thus, the Bologna Declaration in higher education is being implemented, and student motivation is also being raised. Indeed, properly structured theoretical knowledge together with the practical application of automated theorem proving as part of this method help to systematize the material and increase professional motivation. Any programmer should recognize and value the effectiveness of this approach.

Let us consider the choice of method in more detail. Below, we reveal the specifics of how the method affects programming and the extent to which it complies with the benchmarks of higher education (the Bologna Declaration). We also address the results of a survey conducted at several universities to ascertain the readiness of the educational system for the use of this innovative method. The responses of educators gave us an idea of the barriers to its implementation.

6.2. Innovations and Potential Developments

With a large number of students lacking basic computer literacy, but wishing to become software developers, accelerated training, which is an intensive course on basic disciplines in computer science at schools, can be a solution. In order to find the optimal structure of employment on an accelerated course, interactive training mechanisms were proposed, which are learning in pairs or small groups in the classroom or audience with free access to computers and other necessary equipment on the program complexity classes developed in the LaTeX language. In the development of additional materials, the over-the-internet testing capabilities of the Moodle learning management system were used, which consist of numerous open and qualifying tests and practical tasks adapted to the current situation, as well as in the use of the Wink program, which was used to create step-by-step multimedia material explaining complex tasks and problems with unreliable and confusing explanations for students.

Different subjects from other courses of similar specialization are recommended as prerequisites for various special departments, which requires the development of a set of basic computer literacy tests before admission to determine the permissible level of training school graduates for the study of programming. With this approach, students with insufficient basic training reduce the percentage of deductions in the initial discipline because they systematically correct the existing knowledge, which leads to better results for them. The developed basic computer literacy tests cover theoretical issues, a practical skills matrix, testing, and include a methodology for determining the students' level based on the test results so that the teacher can provide adaptive measures in the educational process.

7. Conclusion

Specifically, the Semantic Method of teaching, which focuses on understanding concepts deeply and applying them in various contexts, has been extensively discussed and researched in multiple educational conferences worldwide. Its effectiveness and practicality have been exemplified through the development of numerous interactive CD-ROMs, offering learners an interactive and engaging learning experience. Thus, it becomes imperative to conduct a comprehensive range of experiments, allowing not only the method's creators to analyze its efficacy but also enabling diverse groups of professors and students to assess its impact from their unique perspectives. By gathering a diverse range of experiences and opinions, we aim to garner further support and validation for the observations we have made thus far. As we are currently in the second term of the first year, we anticipate providing a more comprehensive and detailed analysis of our findings as this academic year progresses. (Salloum et al.2020)(Kumar, 2021)(Mejia et al.2021)(Patel and Jain2021)(Shen & Ho, 2020)(Jung & Lee, 2020)(Rano2020)(Taipalus and Seppänen2020)(Chaccour et al., 2024)(Guo et al.2022)

This paper discusses curricular and methodological issues of programming in Brazilian education. In general, the discussions can be used for different contexts and to implement educational politics in computer education area. In CS, the text will stand alone if it exhibits clear contributions to computing or its applications. Contributions in the teaching area are more important. These can be in the form of development of new methodologies for teaching computing, the introduction of new content and its motivation, empirical results of use of various methods in the classroom, and the relevance of the approach presented.

Summary of Key Findings

In summary, this chapter employed continuous assessment evidence using the Semantic Method between the years 2011-2015. Findings resulted in the provision of formative feedback supporting development in students' learning. Finally, key implications and learning drawn from the student learning data outcomes are identified and discussed. With the increasing importance and interest in higher-order thinking among tertiary educators, the principles of the Semantic Method can be used as guidelines for assessing and enhancing students' cognitive learning outcomes. We argue that in addition to written code, evidence of students' thinking about code can be valuable in the evaluation of program code and of the students' understanding of programming concepts.

This chapter presents the collection, analysis, and findings of student data generated from the use of the Semantic Method. Section 7.2 summarizes the context and pilot study. Section 7.3 outlines the method used for gathering evidence of students' learning, while Section 7.4 describes the coding process and categories used for the data analysis process. Finally, Sections 7.5 and 7.6 provide a detailed account of the pre- and post-results and a summary of the key findings together with the implications for teaching and learning first-year programming in higher education.

Implications for Practice and Research

This article presents a solution to a question that is relevant due to the spread of computing and rising concern for computer literacy as an important issue: "How to teach programming in higher education?" The semantic method serves as a basis for the theoretical-methodological approach and the proposal formulated in order to respond to this question. Such a means of demonstrating the educational implications of our work in teaching programming, utilizing the semantic method, aligns with the perspective of educational and philosophical investigation listed in the area of research in education. The appropriateness of the specific methodological option, the Semantic Method, aligns with our educational and philosophical thinking, grounded on the work of the Russian philosopher M. Bakhtin. The curriculum articulation, critical issues, and main points will clarify the structuring of the article. To conclude, we propose the development of the research topic raised in the introduction.

Concerning our own research and guided by our experiences, we summarize the theoretical-methodological approach underpinning a solution to the question we are asking: How to teach programming in higher education? We use the semantic method to present the following findings: educational-philosophical issues - the selection of the semantic method grounded on the understanding of teaching, learning process, and pedagogical implications. Theoretical-methodological issues - the curriculum articulation and proposals for teaching/learning drawn from the referential framework, selecting the Constructivist and Semantic Methods.

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