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PROFESSIONAL DIDACTICS AND COURSE OF ACTION THEORY: DIFFERENT CONTRIBUTIONS TO PROFESSIONAL TRAINING

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Abstract: The development of practical skills has been a challenge for several areas interested in learning at work. The Didática Profissional is a discipline that combines the Analysis of the Activity and the Piagetian theory for the formation of new competences in the work. The Course of Action theory, based on the perspective of Suchman's Set Action and the Ergonomic Work Analysis (AET), addresses the issue of learning by a different bias from the first. Although the analysis of the activity of experts and novices in real work situations, the theoretical framework underlying the analysis of the activity changes the way of analyzing the activity and of understanding the teaching-learning process. This article aims to discuss the contributions and differences of both perspectives in the professional training of practice workers through the analysis of the activity of construction professionals.

Keywords: Professional Education, Vocational Training, Ergonomics of Work

1. INTRODUCTION

The area of Professional Education has been dedicated to discussing the topic of learning due to its great importance in work processes. Learning, becoming more competent and effective, is imperative in organizations that seek greater competitiveness and is, therefore, a central issue for Work Psychology, Educational Psychology, Professional Education and Ergonomics. This article aims to debate the perspective of Professional Didactics based on the analysis of activity intertwined with Piagetian learning theory, in contrast to the Course of Action approach, which also analyzes activity but associated with the proposal of Situated Action (Theureau, 2004; Suchman, 1987; Lave, 2011).

To debate this theoretical-conceptual controversy in the field of professional education, the research carried out with construction workers solving practical problems involving mathematical operations on the construction site proves to be pertinent to show whether representations, such as mathematical knowledge, are sufficient to be effective in solving practical problems, as advocates of Professional Didactics state, in contrast to the Course of Action Theory, which defends the primacy of social practice in effectiveness. This research is based on a demand for professional qualification of construction workers made by engineers who attribute the low performance of professionals to the lack of school mathematical knowledge. The absence of this scientific knowledge is, according to engineers, the cause of sloppy work, rework and errors. Given this hypothesis, professional training along school lines, culturally considered the privileged place for the development of such skills and the transmission of academic mathematical knowledge, therefore presents itself as a solution to improve the performance of these workers. This demand, already formulated in terms of diagnosis and solution – errors occur due to lack of knowledge mathematical - is evidently shaped by common sense that overvalues scientific concepts, especially when mathematics is involved, in the development of professional skills and in improving performance.

The use of mathematics is particularly interesting because it takes to the extreme the relationship between logical-formal abstractions (mathematics is seen as a pure form, independent of any social or practical context) and everyday practice. Precisely because mathematics occupies this place of universality in scientific discourse, this article aims to contribute to reflection on the relationship between scientific representations and social practice in the production of effective action. Is it really, as engineers believe, that mathematical knowledge is what makes action intelligent and effective in solving practical problems in construction? The relevance of such a discussion consists of the search for better teaching-learning processes for work, given the great demand and need to think about more effective ways to develop and improve professional performance. The thesis we defend is that effectiveness does not only depend on the mastery of mental representations, such as concepts and rules, but above all on social activity shaped by professional tradition and the object of work. It is not enough to have concepts, mathematical knowledge, formulas and rules, first of all it is necessary to master the rules and values of the métier1, the professional tradition, the social norms of that practical situation, which depends less on mathematical and scientific techniques and more on engagement in a social practice (Collins, 1992; Schön, 2000; Lave, 2011). As Lave (1996) says, mathematics is only part of the problem to be solved, with practical activity being a broader and richer problem than the simple application of school procedures. The subject in practical life does not solve a mathematics problem, but a problem

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[1] Set of norms, rules and values of the profession that are shared and practiced by workers.

practical within a social activity, which implies mastering non-mathematical criteria and values that also determine the solution to the problem.

The objective of this article is to show that mathematical knowledge is necessary but not sufficient for the development of practical skills on the construction site, which would prove the thesis of situated action over the primacy of social practice in effective action. This controversy is the heart of the difference between Professional Didactics and Course of Action Theory, which adopt different positions on the analysis of activity, its constituent elements and consequently, the learning process.

Professional Didactics and Course of Action Theory: Cognitivism x Situated Action

Professional Didactics (Pastré, 2011), based on the Piagetian perspective, argues that the key point of effectiveness depends on the mastery of mental representations, such as concepts and rules. It is anchored in the cognitivist paradigm in which representations are the cause of action (Vera & Simon, 1983), that is, for a given action to be effective, it is essential that there is a representation or concept in the mind determining what the body should do in a given situation. In this way, mastery or possession of a representation is a condition for effective action.

The proposal of Professional Didactics is, based on the analysis of the actors' activity in real work situations, to identify and describe the representations underlying the actors' actions. Once the representations behind effective action are known, they are taught to those who are less effective or novices, and with this, new skills are learned and developed. In the specific case of construction workers, the analysis of the activity of those in charge of the work would focus on the concepts and rules behind effective and ineffective actions, in order to identify the knowledge of the competent that is not present in the minds of the less competent. As these are problems involving mathematics, this knowledge

would encompass mathematical knowledge, such as rules, formulas and algorithms.

On the other hand, supporters of Situated Action defend the supremacy of social practice in effective action (Suchman, 1987; Lave, 2011; Ingold, 2010; Theureau, 2004). Without disregarding the role of representations in action, the significant difference between the cognitivist approach and that of Situated Action is the status they have in effective action. While cognitivism places them as a cause of action, situated action places them as a means of action, its resource, attributing to the genesis of effective action the subject's engagement in social practice, which means mastering the rules of the métier and judgment and hierarchization of social and professional norms and values (Lave, 2011, Collins, 1992).

The Course of Action Theory, developed by Theureau (2004) within the scope of French traditional ergonomics, works with the hypothesis of situated action anchored in the paradigm of enaction (Varela, 1994). Starting from the notions proposed by Suchman (situated cognition and action) and Schön (reflection in action and dialogue with the situation), the Course of Action allows describing how the subject's engagement with the situation occurs, whose meaning is the result of the composition between elements of experience and elements of the situation (including the body) here and now. The significant unit for the actor is a tetradic sign (taken from Peirce's semiotics) that must be described taking into account four components: the field of possibilities open to the subject in the situation (Open), the perception of the elements of the situation (R) , the representations (I) that result from conscious reflection (every actor reflects on their experience) and the actions, communications and feelings produced in this interaction

(U). Representations, as you can see, are just one of the elements to be described in the analysis of the activity, which differs from Professional Didactics. More important than analyzing the representations, the dynamic combination of the four elements is the unit of analysis that explains the subject's engagement in social practice, and consequently, their effective action.

The analysis of the activity of those in charge of the work solving problems involving mathematics was carried out according to the theoretical-methodological perspective of the Course of Action, since our objective was to understand effective and non-effective action from within, that is, from bodily engagement of the actors in the situation, thus focusing on their experience and the significant elements of the situation here and now. The cognitivist paradigm, focused on representations, did not provide the necessary support for analyzing the body engagement of those in charge in the situation, making it necessary to employ a new methodology that would actually allow the thesis present here to be validated: effectiveness in solving practical problems depends, ultimately, the subject's engagement in social practice.

2. METHODOLOGY

The qualitative methodology used was Activity Analysis developed by Course of Action (Theureau, 2004). This methodology uses observation and interview methods in self-confrontation to describe the constituent elements of the actor's engagement in practice (openness, perception, representations and actions) as the activity unfolds.

The research was carried out in a building project in the metropolitan region of Belo Horizonte for a year and a half. The data collected from systematic observation were obtained in problem-solving activities involving mathematics. All situations were filmed and worked on in self-confrontation interviews. Two managers with different experiences participated in the research. One has more than thirty years of experience (E) and the other is a novice (N), having recently completed the professional training course for master builders, where he learned how to solve the problem of the size of the steps. The experienced person learned his trade in practice with other managers and never attended a professional training course. The data analyzed were collected during the finishing activity of the concrete staircase. The task was to calculate the measurements of the steps of the finished staircase. Below is a description of the activities of both those responsible for solving the problem of measuring the stair step.

3. RESULTS AND ANALYSIS

THE LADDER AND THE CALCULATOR

The task is to find the measurement of the finished steps (steps with the finished finish) of a staircase. The activity begins with measuring the height of the ceiling height of the concreted stairs (measured from level to level of the floors), then a calculation of the division is carried out on the calculator (height of the ceiling height by the number of concrete steps, figure 1), ending with obtaining the measurements of the finished steps (figure 2).

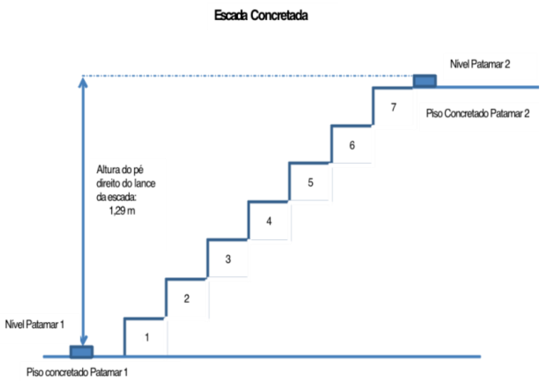

Figure 1: Concrete staircase

Source: Research data (2014)

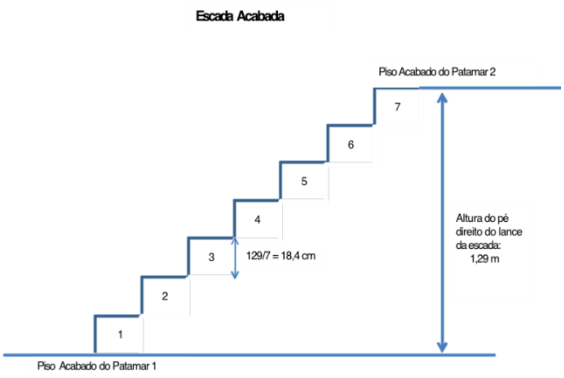

Figure 2: Finished staircase
Source: Research data (2014)

The issue is that the measurement obtained by the calculator is not always exact, and most of the time it is a periodic decimal. How to treat this number obtained from division, what to do with the decimal, what should the step measure be? Interpreting the division result on the calculator is a key issue in this activity, as depending on its interpretation, the steps will have different sizes, as occurred in the activities of the experienced and novice supervisor. The manipulation of data on the calculator was done in the same way by the two people in charge. The difference starts with the interpretation of decimal numbers and your subsequent actions. We will begin by analyzing the novice foreman's problem-solving strategies.

The novice measured the height between the landings, obtained the measurement of one meter and twenty-nine centimeters (1.29m), and divided it on the calculator by seven (number of steps on the concrete staircase). The result obtained is: 18.428571. Then, he selects the 42 after the decimal point, resets the calculator screen and divides this number (42) by 7. The result is 6 and he then concludes that the measurement of the finished step is 18.6cm.

The expert performs the same division operation: he divides the height of the ceiling by the number of steps and obtains 18.428571. He then discards the numbers starting from the second decimal place – 18.4 28571 and considers the step measurement to be the number with just one decimal place: 18.4cm.

Beginner's calculation	**Calculation of the experienced**
1,29m ÷ 7 steps = 18,428571	1,29m ÷ 7 steps = 18,428571
Select 42 (18.428571) which is the “leftover”, reset the calculator and divide 42 by 7 steps: 42 ÷ 7 = 6	Cut the decimal places after 4 from the measurement (18.4 28571)
Conclude that the measur e of step is: 18.6cm	Conclude that the step measurement is 18.4 cm

Table 1: sequence of calculations by the deputy in charge and the person in charge

Although the differences are visible, as shown in table 1, the reasons for each person to think and act this way are not evident. Below is the beginner's explanation for this calculation: “You have to have the exact number, I have 7 steps to divide 42 between seven steps. It would be uneven, if I put 18.42cm it would be higher (than the exact measurement), so I took these 42 and divided the 42 between the 7 steps. Then I got the 6 mm, then something is more certain, if I put 18.42 it would get up here, it wouldn't work, the step there (the last one on the landing stairs) would be smaller”.

He “sees” 42 as the remainder of the periodic decimal, since he learned in the course that when the number has several decimal places, it means that the division is not exact, that is, that it has a remainder. And remainder is what remains of the whole numbers (after the decimal point). If you leave the measurement with the remainder (42), 18.42cm, the remainder will increase the size of the step, producing steps of different sizes, “the last one will be smaller”. He learned in the professional course that the steps have to be uniform, and therefore, in a periodic decimal, the correct thing to do is to divide the rest so that they all have the same size.

His objective in this task is to obtain uniformity of the steps. He learned on the course that the work only receives Habite-se[2] if the steps are the same size, otherwise it is not released for housing. When he divides 42, which is the remainder after dividing the integers (18),

[2] Occupancy is a civil construction standard that validates the work and authorizes it for housing

based on the number of steps (7), he is sure he found the exact measurement of the steps (18.6cm). He thus achieves his objective, finding uniform measurements for the step, believing he has carried out an effective action. The problem is that his measurement is wrong, as we will see in the expert's activity.

The experienced person, unlike the novice, when seeing several decimal places, considers the measure only the numbers before the decimal point (whole number) and the first place after the decimal point, because according to him, the rest is leftovers, and the leftovers have to go to the “last one doesn’t get too big”. “From here to here (18.428571) it’s leftovers (bold), we have to leave. If I leave the excess, the size will increase, because it will gain a little more, it won't close the ceiling at the top”. If the step measurement increases by one millimeter, times the number of steps (7), the last step will exceed the level of the landing by almost one centimeter. He knows, from practical experience, that every time the step measurement increases by one millimeter (if he considered the excess in the measurement), this impacts the ceiling height of the landing, which creates problems at the floor level.

His biggest problem is his right foot, which is a top priority in his activity. According to him, if you leave an excess in the measurement, all the steps will be larger, which will affect the height of the staircase. If the height of the stairs increases in size, the last step of the stairs will be higher than the height of the landing, that is, the floor of the stairs will be higher than the floor of the landing. This creates a serious problem in the uneven floor work, compromising the opening of the staircase door and the elevator door in the hall. To avoid this problem, since the consequence when this occurs is to break the ladder again, the expert always rounds the step measurement down, even if the last step is a little lower (2 millimeters) than the floor level of the floor. (18.4cm x 7 = 128.8cm ≠129cm). But this difference is easy to resolve, just add a little more mass to the last step in order to get the staircase floor in the same alignment as the landing floor. The result of this operation is a difference, considered minimal (the Habite-se rule has a certain tolerance for differences in step measurements), of two millimeters between the first six steps (18.4cm) and the last (18.6cm) . Thus, unlike the novice who favors the uniformity of the steps as a maximum rule (“the last step cannot be smaller than the others”), the experienced person prefers to create a difference in size between the steps but ensure the leveling of the stairs and the floor. landing (“the last step cannot grow into the ceiling height”). It is, therefore, a definition of priorities and objectives in the activity, determined by the professional experience of each of them with this practice.

Esse cálculo da divisão na calculadora (1,29 ÷7) foi o primeiro cálculo feito pelo novato na solução do problema da escada. Até então, como pedreiro, ele só havia resolvido esse problema aproximações sucessivas, que consistia em descobrir o tamanho dos degraus por tentativa e erro. Começava marcando o degrau, de baixo para cima na escada, com uma medida “padrão” para degraus de 18,5cm. Se chegasse no último degrau e este tivesse maior ou menor que os anteriores, significava que a medida não estava correta. Recomeçava com uma nova medida até encontrar aquela que resultasse numa medida uniforme para todos os degraus. O nível do pé-direito existe na sua atividade, ele é a referência que o pedreiro não pode ultrapassar nem ficar abaixo, e por isso, seu raciocínio é encontrar a medida uniforme dos degraus dentro daquele espaço físico delimitado (nível do patamar). Mas agora como encarregado, ele não tem mais essa barreira física do nível no momento do cálculo, este é um “número” na calculadora e por isso ele não sabe que, na prática, uma medida errada não produzirá medidas diferentes dos degraus (um maior que o outro), mas sim problema no pé-direito. O pedreiro que for realizar o serviço não fará mais experimentos para saber se a medida informada pelo encarregado resultará em degraus uniformes respeitando o nível do andar, ele fará o serviço de acabamento considerando-a correta, o que gerará o problema do pé-direito no final da atividade. E isto de fato ocorreu. Quando o pedreiro foi fazer o acabamento dos degraus com a medida de 18,6cm, fornecida pelo encarregado novato, a altura do pé-direito da escada aumentou 1,4cm, o que é problemático para o nivelamento dos pisos. O pé-direito, até então, nunca tinha sido problema para o encarregado novato, e por isso ele definia seu problema como uma questão de uniformidade entre os degraus, o que fazia todo o sentido dividir o resto da divisão não exata (dízima).

O experiente conhece os problemas de uniformidade entre os degraus (regra do Habite-se) e o impacto no pé-direito e elege o pé-direito como o problema principal a resolver nessa atividade. A regra de tolerância aplicada à diferença de tamanho nos degraus (até dois milímetros) mas não ao aumento do pé-direito devido às consequências concretas na obra, faz com que o problema do pé-direito seja primordial, o que dá sentido ao seu tratamento da dízima (arredondamento para baixo). Dois objetivos diferentes (Abertos) conduzem a lógicas distintas de percepção, ação e pensamento. Quando o novato é confrontado com a medida do experiente, ele não compreende seu erro e nem as operações realizadas pelo experiente, está convicto da sua lógica, baseada nas regras aprendidas no curso (divisão não-exata), como também na sua experiência prática de pedreiro. Ele só entende o seu erro e a lógica do experiente quando ele é levado à escada e vê o erro no nivelamento do piso. Aí ele compreende que mais importante que a uniformidade, é a medida do pé-direito.

A nova possibilidade de engajamento (Aberto) proporcionada pela percepção situada do problema do pé-direito na escada entrelaçada à nova maneira de resolver o problema (arredondamento para baixo) e às explicitações das normas e valores pelo experiente (melhor ficar diferente a medida do degrau em milímetros do que aumentar o pé-direito do degrau) determinou a aprendizagem de uma nova maneira de resolver o problema do cálculo da escada, o que confirma a proposta da Ação Situada. A aprendizagem ocorre na mudança de objetivos e prioridades (Aberto) decorrente de novos engajamentos corporais do sujeito na prática social (compartilhamento de novos valores e normas não matemáticas), e não apenas no domínio de representações matemáticas sobre a resolução do problema. Com isso, confirma-se a tese da Ação Situada do Curso da Ação, na qual as representações matemáticas não são suficientes para tornar a ação eficaz na resolução This division calculation on the calculator (1.29 ÷7) was the first calculation made by the novice in solving the staircase problem. Until then, as a bricklayer, he had only solved this problem by successive approximations, which consisted of discovering the size of the steps by trial and error. He started by marking the step, from the bottom to the top of the ladder, with a “standard” measurement for steps of 18.5cm. If he reached the last step and it was larger or smaller than the previous ones, it meant that the measurement was not correct. He would start over with a new measurement until he found the one that resulted in a uniform measurement for all the steps. The ceiling height exists in his activity, it is the reference that the bricklayer cannot exceed or fall below, and therefore, his reasoning is to find the uniform measurement of the steps within that delimited physical space (landing level). But now as a person in charge, he no longer has this physical barrier of the level at the time of the calculation, this is a “number” on the calculator and therefore he does not know that, in practice, a wrong measurement will not produce measurements different from the steps (a greater than the other), but rather a problem with the right foot. The bricklayer who is going to carry out the service will no longer carry out experiments to find out whether the measurement informed by the person in charge will result in uniform steps respecting the floor level, he will carry out the finishing service considering it to be correct, which will generate the ceiling height problem in the building. end of the activity. And this actually happened. When the bricklayer finished the steps with a measurement of 18.6cm, provided by the novice supervisor, the height of the staircase increased by 1.4cm, which is problematic for leveling the floors. The ceiling height, until then, had never been a problem for the new manager, and that's why he defined his problem as a question of uniformity between the steps, which made perfect sense to divide the rest of the non-exact division (tithe).

The experienced person knows the problems of uniformity between the steps (Occupancy Rule) and the impact on the ceiling height and chooses the ceiling height as the main problem to solve in this activity. The tolerance rule applied to the size difference in steps (up to two millimeters) but not to the increase in ceiling height due to the concrete consequences on the work, makes the problem of ceiling height paramount, which gives meaning to its treatment of the decimal (rounded down). Two different objectives (Open) lead to different logics of perception, action and thought. When the novice is confronted with the measure of the experienced, he does not understand his error nor the operations carried out by the experienced, he is convinced of his logic, based on the rules learned in the course (non-exact division), as well as on his practical experience of mason. He only understands his mistake and the logic of the expert when he is taken to the stairs and sees the error in leveling the floor. Then he understands that more important than uniformity is the measurement of the ceiling height. The new possibility of engagement (Open) provided by the situated perception of the problem of the right foot on the stairs intertwined with the new way of solving the problem (rounding down) and the explanations of norms and values by the experienced person (better to keep the step measurement different in millimeters than increasing the height of the step) determined the learning of a new way of solving the problem of calculating the stairs, which confirms the Situated Action proposal. Learning occurs in the change of objectives and priorities (Open) resulting from new bodily engagements of the subject in social practice (sharing of new values and non-mathematical norms), and not just in the mastery of mathematical representations over problem solving. This confirms the thesis of the Situated Action of the Course of Action, in which mathematical representations are not sufficient to make the action effective in solving practical problems in construction, thus contradicting the engineers' representation of practical effectiveness.

de problemas práticos na construção civil, contradizendo assim a representação dos engenheiros sobre a eficácia prática.

3. CONCLUSION

The professional training involved in the analysis of activity aimed at developing practical skills can be anchored in two distinct paradigms: cognitivist or situated action. In the first, mathematical knowledge would be the cause of the success of effective action, while for the second, the subject's engagement with social activity, mediated by norms and values, is the privileged locus of effective action. The implications of the first approach are the identification of representations present in effective action in order to share them with others, without discussing the hierarchy of social and technical rules, the objectives constructed by the actors and the intertwined relationship between professional history, norms of the profession and the characteristics of the situation, a contribution brought by the Course of Action. Analyzing the subject's engagement with the situation shows that more important than the mastery of mathematical rules for the effective solution of the problem in construction, is the definition of the problem that if you want to resolve it. Paraphrasing Schön (2000, p. 16), “People who have conflicting points of view pay attention to different facts and have different understandings of the facts they observe. It is not through technical solutions to problems that we convert problematic situations into well-defined problems; rather, it is through designation and conception that technical problem solving becomes possible.” The technique is dependent on the actor's engagement in social practice, which is why it must be prioritized when learning new ways of doing things, as the Course of Action does. The novice only realized that he had made a mistake in his calculation and the measurement of the step when he was taken to the concrete situation and faced with the consequences of its measurement in ceiling height. Access to a new engagement provided by the expert who showed him how to place the problem of ceiling height as a priority in relation to uniformity in the course of action made it possible to create a new practical experience, thus generating a new possibility in his field of possibilities, and with that, new learning.

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