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Objectivity and truth in Science of Education as a Design Science

Objetividad y verdad en la Ciencia de la Educación como Ciencia de Diseño

Ana María Alonso Rodríguez[*]
Univerdad de la Coruña, Ferrol-España
a.alonsor@udc.es
Orcid Number: https://orcid.org/0000-0002-2379-657X

Abstract

Objectivity and truth are key issues in Education which affect the reliability of knowledge and consequently, the recognition of its scientific character and the prestige of the teaching profession. This justifies the thematic debate, to which the Philosophy of Science contributes. The objective is to investigate if objectivity, a condition to achieve the truth in Science, is possible in the Education Science. Its artificial dimension is stressed, as Applied Design Science that (i) seeks to solve specific problems; (ii) uses designs; (iii) is a science of synthesis that combines prediction and prescription; and (iv) is then applied in specific contexts.

The methodology is typical of the philosophical-methodological analysis, which attends to the internal and external perspective and the different levels of Science: semantic, logical, epistemological, methodological, ontological, axiological and ethical. It is applied, firstly, to the analysis of objectivity in Science in general and in Education in particular. Next, truth is considered in its semantic, epistemological, and ontological dimensions. It is then examined how the progressive approach to truth occurs in Applied Design Sciences and specifically in Education Science. It is concluded that the debate about the truth in Education cannot be carried out without considering the ends.

Keywords

Objectivity, Truth, Education, Science, Design, Progress.

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[*] Has a degree in Philosophy and Education Sciences from Universidad de Santiago de Compostela. Has a PhD by Universidad de la Coruña. Philosophy professor of Secondary Education. Researcher at the Research Center for Philosophy of Science and Technology (CIFLYT) of Universidad de A Coruña. Research lines: Design Science, Philosophy of Education Science.

Resumen

La objetividad y la verdad son cuestiones clave en educación que afectan a la fiabilidad del conocimiento y, en consecuencia, al reconocimiento de su carácter científico y al prestigio de la profesión docente. Esto justifica el debate temático, al que se contribuye desde la Filosofía de la ciencia. El objetivo es indagar si la objetividad, condición para alcanzar la verdad en ciencia, es posible en la Ciencia de la Educación. Se incide en su dimensión artificial, en cuanto ciencia aplicada de diseño que: (i) busca resolver problemas concretos; (ii) usa diseños; (iii) es una ciencia de síntesis que combina predicción y prescripción; y (iv) se aplica después en contextos concretos.

La metodología es propia del análisis filosófico-metodológico, que atiende a la perspectiva interna y externa y los distintos planos de la ciencia: semántico, lógico, epistemológico, metodológico, ontológico, axiológico y ético. Se aplica, en primer lugar, al análisis de la objetividad en la ciencia en general y en educación en particular. A continuación, se considera la verdad en sus dimensiones semántica, epistemológica y ontológica. Se examina después cómo se produce el acercamiento progresivo a la verdad en ciencias aplicadas de diseño y concretamente en la Ciencia de la Educación. Se concluye que el debate acerca de la verdad en educación no puede realizarse al margen de la consideración de los fines.

Palabras clave

Objetividad, verdad, educación, ciencia, diseño, progreso.

Introduction

Truth and objectivity are traits that define scientific knowledge. In education, they have a theoretical and practical relevance. They affect the reliability of the knowledge generated about education and, consequently, the scientific status of the discipline. Secondly, they have a direct impact on the credibility of professionals in their practical activity, since this knowledge guides their patterns of action. Epistemologically, it is possible to reach and determine the object of education—the educational activity, the action of educating—but, as González (1996) pointed out regarding other Social Sciences, the problem is not so much about knowledge but instead the reliability of what is known (p. 55). This refers to 'objectivity and truth'. Although some truths can be obtained in education, it is not easy to identify new situations in which they are recognized as such. This difficulty arises from the limitations to articulate: educational actions are unique and, although they are similar to other actions, they always incorporate some new ones. Therefore, although it is possible to establish certain regularities, there is no room for a type of regularity expressed in laws, as in physics. This is a problem that concerns the Social Sciences in general.

The educational reality is complex and always changing. In the face of ontological complexity, epistemological objectivity is particularly difficult. It is even more so as the search for universal explanations can distort what is real by skewing the identification and description of the

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problem under investigation. For this reason, it is necessary to define what is the object of the Science of Education and those aspects of educational phenomena that belong to other disciplinary domains[1].

Science of Education is understood as an empirical science, more or less consolidated, based on experimental pedagogy as a result of the 'scientific' of professional practice, as referred by Niiniluoto (1993). It is conceived as an autonomous discipline, whose object of specific study is the action of education, in the field of reality 'education'.

As pointed out (Alonso, 2020a), its diversification is assumed in different disciplines, which are identified with it a) from the epistemological point of view, by using the knowledge of science from which they come; and b) ontological, by the field of knowledge that is their own: Didactics, School Organization, Theory of Education, etc. Other social sciences that deal with educational phenomena are not considered as education sciences when they do not study them as a specific object (the case of the Psychology of Education, the Sociology of Education, etc.) and their generating disciplines are different from the Science of Education, Like Psychology, Sociology, etc[2].

On the ontological level, Education appears as a social activity, with intentional perspective that deliberately seeks to achieve certain purposes—to provide the student something he needs (educare) or to extract and guide something that he already possesses (*educere*)—related to human improvement (cognitive, volitive, affective, social, cultural, etc.). To accomplish this purpose, there is the educational act — the object of the Science of Education — which constitutes an integrative element of theory and practice. It is an artificial reality that adds something to socialization. It has a structural and dynamic complexity, which is subject to historicity as well as the context in which it is performed.

While recognizing its dimension as Social Science, this artificial characteristic also allows it to be placed in a different thematic field: The one that groups areas of knowledge that deal with phenomena that are "adapted to human purposes" (Simon, 1996, p. 3). It is necessary, therefore, to admit its dual character and to deepen its dimension of Science of the Artificial, for being human made. Through the mastery of the artificial, the Science of Education is shown as Applied Science which uses designs to solve specific problems.

This proposal opens up many possibilities to address the main problems of the Science of Education from a new theoretical framework: Science of Design as the Science of the Artificial. Among them, the objectivity of knowledge as a condition for a progressive approach to truth

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('likelihood'), which determines progress in this discipline. Guiding its solution can help consolidate scientific status. These issues concern the Philosophy and Methodology of Science, which has usually not included the attention to the problems of the Science of Education. The analysis available is the input of this article. Its objective is to enable a framework to articulate the cognitive ideals of objectivity and truth — which are a legitimate aspiration of educational research — as a guarantee of rigorous foundation of prescriptions for the improvement of practice.

The methodology used is specific to the philosophical-methodological analysis, according to Wenceslao J. González's approach to pragmatic realism (1990a, 2012 and 2020). The attention is focused in successive moments, on: a) That which is typical of science in general, taking into account its internal and external perspective. Reflection takes care of different areas (semantic, logical, epistemological, methodological, ontological, axiological and ethical), that correspond to the constituent elements of science[3]; (b) that which characterizes a group of sciences (of the environment, social or artificial); and (c) that which is characteristic of each science. According to this procedure, the philosophical-methodological analysis of objectivity and truth in the Science of Education is carried out in a sequence of steps, which determine the structure of the article:

The first is to examine objectivity in Education by considering its nature of science, based on how it is observed in each of the elements that make it up. The second seeks to place its thematic field among those in which scientific activity is diversified, since the characterization of objectivity in a discipline is related to its own scope (of the environment, social or artificial). The third considers its character of applied science with a bidirectional relationship with the application of this science. The possibility of objectivity in the use of scientific content by agents, especially teachers, is investigated in different contexts (i.e., objectivity in the application of science) [4]. Since objectivity is a requirement for truth, from the conclusions obtained, the possibility of truth is finally analyzed — taking into account its semantic, epistemological and ontological dimension — in the science of Education as Applied Science of Design.

Objectivity as a precondition for truth

Philosophy of Science focuses on objectivity over truth, because it conceives it as a precondition — *conditio sine qua non* — to achieve or, at

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least, to approach the true on its various areas. This occurs in both Basic and Applied Science and also in the application of science in its different contexts. Although it is a complex notion, according to González (2015), it can be defined on the basis of its main attributes: (i) it implies 'accessibility to any person' (objective is something that could potentially be understood by any scientist); and (ii) it implies the 'independent existence' of a singular mind (objective is that which cannot be reduced to the possession of the mind of a single scientist). Thus, these traits delimit the conditions of objectivity in scientific research: the object of the research must be real and it is the object that determines the results, which must be inter-subjectively recognizable and verifiable. Such conditions are defined in: a) the process, where the principle of publicity guarantees objectivity; b) the contents, which are obtained from the object under investigation and constitute the basis for an impartial judgment on natural phenomena, social events or human constructs; and c) the results of the investigation, which require rigorous testing to be accepted.

From a realistic perspective such as Niiniluoto (1984), objectivity in research refers to the possibility of a progressive approach to truth. At least in semantic terms, when there is a real referent with a property that really belongs to that entity, the truth is accepted and scientific language is fixed. It also seems legitimate to aspire to true knowledge (epistemological dimension): being reality the one that judges, there are explanations that are better than others and everyone understands that the best is the one that seems closest to the truth. This leads to the idea of 'likelihood' (Niiniluoto, 1987a and 1987b). According to González (1993), the determination is based on favorable empirical support and the critical elimination of error. Accepting the possibility of error and the fallibility of knowledge means admitting 'objective truth', if not as an accessible goal at least as a 'regulatory idea', as mentioned by Popper (1979).

In addition, truth can be understood as a trait of the real. Associating the truth with reality confers it an ontological perspective, which is added to its semantic and epistemological dimensions.

Characterizations of objectivity

Science is a highly complex rational activity, which aspires to rigorous knowledge; it is expressed in precise language, is articulated in a well-formed structure (generally in theories), subjected to filters that guarantee its rigor, proceeds according to a method, and it responds to a certain approach to reality. Moreover, as a human activity, Science is oriented to

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goals and involves values. All these elements (language, structure, knowledge, method, activity, ends and values) define science in general, according to González (1990a). Therefore, these elements must be present in the Science of Education.

Greater reliability is attributed to it than to ordinary knowledge and to knowledge provided by other forms of access to reality by its self-correcting capacity, which preserves its objectivity. The characteristics that define it—potential accessibility and independence of a singular mind—must be present in each of the components of science, so different analysis can reveal different views of objectivity.

(i) As regards the **semantic** level, González (1986) considers that objectivity finds in reference its essential element, since it allows to associate a defined domain of objects to the expressions. Words are given an objective sense by their reference relationship with a reality that can be objective. Thus, if admitted that there is an educational reality, which has certain characteristics that really correspond to it, then the terms of the statements capable of describing them will be equally objective. In this regard, the expressions that make up the statements used in Education must reflect a clearly identifiable reality.

Initially, the ambiguity of educational language suggests that this is not always the case. But this confusion can be tempered if considering that the complexity of educational phenomena requires interdisciplinary intervention. The references to the discourse of the different disciplines (Psychology of Education, Sociology of Education, etc.) are not the same, but only certain attributes of the same reality, in each case: those that correspond to the specific objects of the science from which they originate (Psychology, Sociology, etc.). Therefore, the terms of the statements that give account to it are specific to each science and are part of its specific language and not that of the Science of Education. Thus, even though the expressions are verbally identical, they do not have the same meaning.

Therefore, objectivity is possible in Education whenever its object of study is clearly outlined, specifying those aspects of 'Education' that constitute the references of the discourse of that science: the action of education and the educational act. Recognizing the importance of the use of language, the meaning of the terms of educational discourse must contribute to the explanation of the reality investigated and, it will also be open to future realities emerging from educational dynamics. This is particularly relevant in the face of changes due to the massive incorporation of the technology. As observed in communicative phenomena (Arroyo 2020), as an educational innovation is more sophisticated (such as those

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related to the use of the Internet), the terms should be more precise and their content more delimited.

(ii) The **logical** level addresses the structure of educational theories. It refers again to interdisciplinarity, since the contributions of the different non-pedagogical sciences (Sociology of Education, Economics of Education, etc.) maintain an internal relation with their generating disciplines (Sociology, Economics, etc.). Therefore, it is not possible to confuse the internal articulation of theories that are typical of the Science of Education with those that contribute to Education and respond to the variability of the object studied from other disciplinary fields. In the case of the Science of Education, it can also be expected the articulation that makes it possible to solve specific problems in the Sciences of Design, which, as González points out (2007), is established between prediction and prescription.

(iii) On the **epistemological** area, objectivity implies impartiality and access to any mind, according to Rescher (1997). Popper (1979) also noted that objective knowledge "is totally independent of a subject's claims of knowledge; it is also independent on his belief or willingness to settle or act. Knowledge, from the objective point of view, is knowledge without someone knowing it: it is knowledge without a cognitive subject" (p. 109). In Education, as in other disciplines, researchers and professionals must be able to approach a reality that exists independently of their mind: the objectivity of knowledge can be increased by eliminating linguistically formulated assumptions through critical discussion.

Although theories are true or false and not mere instruments, for Applied Science and for practice, they are also 'instruments'. Thus, in professional practice, objective knowledge should be used for formulating personal ambitions. This is possible to the extent that, although the relationship with the educational act is mediated by the language and knowledge already possessed, when false conclusions are obtained, they can be rectified, getting closer to the truth 'plausibility'. Therefore, educational action as a professional practice and the scientific discipline that considers it as the object of study can achieve a content of knowledge that can be objective.

(iv) **Methodologically**, the Science of Education requires a novel process to increase the objectivity level in problem solving; a methodological orientation capable of bridging the gap between theory and practice. It must allow the setting of a goal that can be achieved and targeted, the selection of guidelines for achieving the objective and the achievement of a result. If successful, it can serve as a model for subsequent interventions;

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otherwise, it must be modified. This 'progressive refinement' is one of the characteristics of the design, where the results are only justified if they meet the epistemological criteria that guarantee their objectivity, validity and reliability. Thus, the above criteria, at the same time, preside over the rules that guide professional practice.

Difficulties may arise at any point in the process (in the selection of goals, in the reliability of predictions, in prescribing strategies to achieve them or in implementing them), due to the interaction of external factors (social, economic, administrative, etc.) in genuinely educational processes. They must be taken into account so that they do not compromise the objectivity of the knowledge acquired for the resolution of specific problems (either in face-to-face education or e-learning).

(v) **Ontological** objectivity means recognizing the existence of some reality independent of the mind that knows it. It is this reality that determines the statements as true or false, regardless of the knowledge possessed. In Education, ontological objectivity is achieved when the properties of the educational action that really correspond to it are captured, without attributing to it others that belong to objects other than the educational field (psychological, sociological, economic, etc.) or biases that come from own expectations or from external factors (social, cultural, economic, political, etc.).

Educational objectivity is related to properties that belong to the educational activity, regardless of who knows it, which is 'discovered' and not constructed[5], although, in order to be able to capture those properties of the real being – changing and subject to historicity–, appropriate categories need to be developed. As mentioned by González (2015), subjective factors intervene—such as reasons, tastes, desires, etc.—but the scientific results are based on what is obtained from the object under investigation. Ontological objectivity, along with epistemological objectivity, is necessary for the recognition of Education as Genuine Science. Ontological objectivity is possible in Education and therefore there may be a Science of Education.

(vi) The activity — initially professional and, later, scientific — is intended for **purposes**. To achieve these, the appropriate means must be used. Values are involved in the selection of purposes and means. A distinction must be made between: (a) the purposes of educational activity, which refers to a fundamentally anthropological and social issue, which is widely debated; and (b) educational research, which is oriented toward a scientific inquiry into an observable phenomenon and, in principle, also experimental. In the first case, they involve human and social values,

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which are the priorities when making an educational choice. According to Nicholas Rescher's conception (1999), objectivity requires that professionals and researchers limit the scope in which they satisfy their preferences, looking at what is the best within certain circumstances, rather than what they would like more or want[6]. In the second case, values have a different character. These include cognitive values such as truth, likelihood, and the link to the validity of knowledge.

(vii) Among the **values** that can influence the selection of ends and means, special attention should be made on ethical values, which are involved in the practical dimension of educational knowledge. In general, human objectives are implicit in the cognitive process, which cannot be subtracted from the pressure of needs and *desiderata* (social welfare, social integration, stability, employability, success, excellence…) modulated according to values. Although needs include fulfilling desires, for Rescher (1999), the real determinant for people's interests is need and not desires: "a person's *true* interests are not those he *has* but those he *should have*, if he properly (sensibly, appropriately) carried out his investigative task and his evaluator task" (p. 91).

The different aspects of objectivity in science, revealed in the previous analysis, lead to the following conclusions: 1) Accepting objectivity implies accepting the possibility of impartiality in the researcher and the professional (which may or may not be the same) and that the contents of Education be accessible to any person. 2) The reality in which Education is concretely — the educational act—exists regardless of the teacher who practices it. Achieving the goal of objectivity requires the objective knowledge generated by the Science of Education. In the meantime, the task of teachers has a high degree of difficulty: (i) they must ensure the objectivity of the language used; (ii) they must justify the possibility of finding the truth through inquiry into the reality of the educational action; (iii) they must legitimize true access to reality; and (iv) they need to consider what their values are and what ethical assessments affect in distinguishing between actions that are appropriate and actions that are not.

The problem of objectivity in education

To address the problem of objectivity (as a condition for truth) in education, an unusual perspective is adopted in this article, which consists in highlighting its artificial aspect as Applied Science of Design. This requires some clarification about the new theoretical framework.

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The differences in the objects of study, the problems raised and the methods used justify the distinction between the different types of science. By influencing the former, the difference is established between formal and empirical sciences and, among these, natural sciences, social and human sciences and the artificial sciences. In deepening on the second, scientific activity is diversified into: a) Basic science — which seeks to expand knowledge of what is real through explanation and prediction to increase its degree of likelihood —; b) Applied science, which directs its activity to the resolution of specific problems and anticipates the possible future to establish guidelines for solutions; and (c) Application of Science in different contexts of use.

Historically, the Science of Education was shaped as Social Science, based on experimental pedagogy. There are reasons of epistemological and ontological character that justify it: it responds to a social need, its object of study is produced in a social environment and refers to intentional, purpose-oriented human actions. But as a human activity, Education is shaped as science from the 'scientific view' of certain skills of the profession, initially based on experience[7]. It is modulated through practice, from which it is fed back. There is application of science when the solutions proposed by Applied Science are oriented to objectives—solving problems—and aspire to results.

This relation between Applied Science and the Application of Science highlights the role of educational designs. Therefore, the characterization of the Science of Education as Social Science is insufficient, since it does not allow to account for what the educational phenomenon currently implies—moreover, mediated by technology—and does not allow to understand its future projection. It is necessary to recognize its dual character: it is Social Science by the reasons already mentioned, and Science of the Artificial, as stated by Simon (1996), for being human made, both in the goals it poses, it uses and the results it obtains[8].

Once the Science of Education has been placed in its dual thematic field—social and artificial—as Applied Science of Design, the philosophical-methodological analysis of objectivity in the Science of Education is carried out from this new perspective. Given difficulties as Social Science, it can provide a different criterion for determining the objectivity — and reliability — of knowledge about Education, which results in recognition of its scientific character.

As Applied Design Science, Education Science: (i) is oriented to solve specific problems at the practical level and (ii) it does so through designs, thus expanding the possibilities of Education (clearly by incor-

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porating technology). These designs need reliable knowledge of the future to predict the evolution of educational situations and to make prescriptions for solving problems.

Predicting and prescribing require objectivity: Education Science helps solve problems if it has objective for anticipating the possible future[9], and can establish solid guidelines for the action only if it has objective patterns. The process for achieving the goal is initially outlined and is gradually articulated, selecting guidelines as the feasibility of the goal. To do this, the appropriate solutions among those used by professionals have been studied (as is appropriate in a discipline that results from the 'scientific' of the rules that guide the practice). This leads to a scenario close to the 'natural selection' proposed by Popper (1979) for theories: those who have proved their suitability survive in a 'struggle' that eliminates the inadequate ones. Because it is Applied Science, the evaluation is carried out based not only on epistemic, but also on practical uses, as mentioned by Niiniluoto (1993).

Therefore, when analyzing objectivity in the field of Education, in its thematic dimension, it must be observed, first and foremost, its presence in professional practice. This affects the objectivity of the Science of Education as Applied Science of Design and the application of that science by agents in different contexts.

When examining objectivity in the professional practice of education, an ethical aspect and an epistemic component must be considered. The first implies the conduction of this practice, because objectivity is possible if it is understood, as referred by MacIntire (2007) as fulfilling the purposes inherent in it (p. 233). With regard to the objectivity of the knowledge involved, if teaching practice is taken as a reference, it is appropriate to consider different types of knowledge that are part of this activity, mentioned by Tardif (2004) as: professionals (those who come from the Science of Education and related disciplines), disciplinary, curricular and experiential.

The objectivity of professional knowledge has been analyzed in the past. Regarding disciplinary and curricular knowledge, it is decided according to the criteria of each discipline. Experiential knowledge (derived from and validated by practice) is configured as rules of action, which are transmitted and used in conjunction with those provided by expert knowledge. Their objectivity can be determined from the uniformity in the observation of success, by different knowledgeable agents, without any involved trait that comes from the subject or from the characteristics of the context.

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When design guides action—outlining objectives, processes, and results, rather than practical rules resulting from accumulated experience—educational research is considered scientific research from a design perspective. Objectivity traits should be sought by the kind of knowledge produced by the applied sciences which, as Niiniluoto explains (1993), is useful knowledge that functions as a tool for the specific objective of increasing the effectiveness of some human activity. Thus, objectivity in the evaluation of results (in epistemic and practical terms) will indicate the measure of the objectivity of knowledge. Although this assessment is always carried out by various subjects, the effectiveness of knowledge in solving problems is independent. Therefore, objectivity should not be confused with agreement: the criterion remains being the 'independence of the subject'.

The difficulty in articulating the singular and the universal—referred to at the beginning of this article—that somehow compromised the pretense of objectivity in educational knowledge could at least be nuanced from this new perspective. While every educational intervention is unique and localized in a spatial-temporal context, the universal character of knowledge that guides the prescription of intervention rules to achieve educational objectives can be accepted. It must fulfill the condition of being 'independent of the subject' and therefore valid for any cognitive subject.

The Science of Education provides objective knowledge to solve specific problems. This is applied knowledge linked to the designs, which allows to characterize the appropriate intervention to improve educational practice and prescribe it. It is then up to professionals to apply science. In order to carry out specific interventions in a given context, they must decide which means are appropriate for the intended purposes. In order to ensure practical success, the application of science must be made in objectivity conditions. As Touriñán and Rodríguez (1993) claim, this implies that intuition or experience cannot be used, but the specialized knowledge that is produced as a result of educational research that has an objective scientific basis.

The semantic, epistemological, and ontological dimensions of truth in science

From the perspective of philosophical realism, science is admitted to progress toward achieving increasingly true theories about the world. The

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mission of the researcher—also in Education—is to achieve knowledge that is more and more in line with reality, i.e., closer to the truth. This means knowing when something is true and how it is achieved. González (1990b) observes that the Philosophy of Science of the 20th century has followed two main paths to understand the epistemological concept of 'truth' and the process to achieve it: 1) the positive path: truth can be accessed and true knowledge can be accumulated and 2) the negative path: false can be rejected by eliminating critical error and this leads to truth as the ultimate goal. Assuming that knowledge is fallible implies the review of knowledge.

The 'positive path', in its attempt to accumulate truths with a total absence of criticism, can lead to a dogmatic attitude, such as that maintained by neopositivism. Moreover, the solution it offers is clearly reductionist: by not distinguishing between meaning and truth, truth is reduced to verification, which is sought through empirical evidence. On the other hand, the 'negative road', in the constant search for error to eliminate it within a progressive approximation to the truth, can emphasize the critical attitude inherent in Popper's position (1983), where experience acquires a negative character it refutes claims, but never confirms them[10].

There is a third route, explored by Rescher (1978) and Ilkay Niiniluoto (1980 and 1984) and followed by González (1993), which is the one taken as reference in this article[11]. By influencing the self-correcting nature of scientific activity, they consider possible that science will reach an objective knowledge of the real world, independent of the mind, through successive corrections. Thus, truth can be reached by accepting cognitive fallibilism.

Niiniluoto has responded (1980, 1984, 1987a and 1987b) to various objections from authors who, from different positions, tried to explain scientific progress without resorting to the truth concept[12]. It offers a rigorous analysis of the concept of truthlikeness as a progressive approximation of the truth, thus restoring it to its central place among the objectives of science.

According to his approach, the fact that something is true does not depend on the researcher, but on the reality that exists before being known and, therefore, is independent of the cognitive subject (of his conceptual schemes and representation). This means rejecting the idea of 'building' reality, which does not mean that the researcher is passive in knowing; the identification of a specific reality (the object investigated) is motivated by cognitive interest and is only possible in a categorical

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structure defined by particular languages. The world can only be accessed through some conceptual framework, and there may not be a single true description because the world (the reality that is out there) does not have its own categorical structure.

Nevertheless, for Niiniluoto (1987a), the fact that the truth is relative to language does not mean that it is relative to each other's beliefs. The world also exists independently of all concepts and has the capacity to determine what the true facts are and what they are not within each of them. Although each conceptual system chooses, in a way, its own facts from its conceptualization of 'the world', that does not mean that it is completely plastic. The world possesses 'facts' in the sense that it is capable of resisting our will.

Hence, from a realistic point of view, it can be argued in favor of accepting the truth in semantic terms: Scientific language has a real reference from which some property is preached, which has been captured. Truth can also be accepted in its epistemological dimension, as it is possible to preach truth (or at least a greater approximation to truth) from those explanations that have empirical support or are maintained after the critical elimination of error and, therefore, are closer to an authentic reality that must be discovered. The existence of this reality makes it possible to approach truth in its ontological dimension. Thus, Science is presented as an attempt to explain reality and truth as its effective goal, to which it is progressively approaching.

The approach of truth in the Science of Education as Applied Science of Design

The Science of Education is oriented, like all science, toward the objective of knowing some truths. As Niiniluoto (1987) says, they are more likely to be achieved if the search is carried out using the best research methods. The best method would be, for González (1996), the one that is coherent with the object investigated. But when considering the development of research carried out in Education, there are different opinions about what its specific object of study is and a diversity of objectives and aims in the research. Hence, the main problem, when analyzing the possibility of truth in the Science of Education is delimiting the reality investigated, which has been identified with the educating process.

Under this object of study, the Science of Education has been placed in the disciplinary field of the Artificial Sciences, as Applied Science of Design. This work refers to the truth of the knowledge that sci-

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entific design shows[13]: In design studies, hypotheses are constructed to solve some practical problems (and it is sought to be especially sensitive to minimal changes in a certain number of observable variables). Throughout the process, due to the progressive refinement of the design, the hypotheses can be modified. The results obtained from the knowledge generated usually lead to the construction of a model, but in any case, they have practical application and must be useful to other teaching professionals. In a discipline that is science-based, the path to truth cannot be dissociated from aspiration to objectivity in decisions and actions in practice.

But if Science does not provide some truth, the professional cannot attribute any superiority to it with respect to other forms of knowledge, such as the one obtained from experience. Reflection on the possibility of truth requires consideration of: 1) language, as the basis of a semantic truth that concerns truthfulness in educational discourse, 2) knowledge, so there must be an epistemological truth that implies concordance between the enunciations transmitted and the phenomena to which they refer. It must also examine its pragmatic dimension as an effectiveness in solving practical problems in education and 3) the reality itself: an ontological truth that implies authenticity in the various actors: individual and institutional.

On the semantic aspect, truth is always true in a language. It concerns questions of meaning, among which the reference is essential. In analyzing the relationships between educational language and reality (current or possible), in order to determine its truth, it is interesting: a) the type of relationship established between terms and statements with respect to the objects and processes to which they relate; b) what the reality (the referent) provides, i.e., what specific attributes of educational action are captured by the specific scientific language of discipline; and c) how to transmit that reference through language, so that it is set in the specific terminology of Education Science used by the scientific community. González (2021) considers that philosophical-methodological debates on the language of science have generally focused on Basic Science and have, as on many other issues, paid less attention to Applied Science. They have dealt with two types of statements: (A) those who provide reasons for why something happens and (b) those who anticipate a possible future, whose correction is sought to contrast. In both cases two relevant aspects are considered: (i) a relationship between meaning and truth where an idea of correspondence is assumed for the statement

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considered true and (ii) the actual or potential existence of the referent designed by the scientific statement (explanatory or predictive).

Although predictive statements are also made as a guide to action, the prescriptive statements are essential to Applied Science, as these sciences are oriented to problem solving. These kinds of statements, which are the basis for performance guidelines, are especially relevant in the Design Sciences. The context is also important for their formulation. Thus, in these sciences, the concept of truth relates to the right path to achieving a desired goal. This is a notion of truth closer to that proposed by pragmatism, which is decided in relation to the effective outcome, which is the one who guarantees whether the path followed has been the right one in certain circumstances.

The concept of truth is linked to practice, in relation to the context of use and the environment (social, economic, etc.) in which it is acted. In professional practice, language is the mediating factor and also the teacher's main intellectual tool. The pragmatic path of scientific language[14] — the language used is conceived as part of a practice and takes place in a context — emphasizes 'meaning as use'. Thus, as González (2021) argues, being able to master the meaning does not, in principle, require being able to know when a statement is true, but to properly use the statements in a given context so that they can facilitate the effective resolution of the problem. Attention to the pragmatic properties of educational discourse can contribute to its truthfulness in the face of mere persuasion promoted by other types of rhetoric.

The problem of truth in educational knowledge also has an epistemological dimension. As applied science, Education Science has a practical (and even pragmatic) task, which is to solve specific problems, but to do so, it must increase knowledge. It does so by providing the 'cognitive basis' for the exact prediction of all events that are predictable. It articulates the 'pragmatic' function of providing the right means to do everything feasible. Thus, two types of truth come into play: (i) truth as a correspondence between the statements described and the educational phenomena; and (ii) pragmatic truth as an effectiveness in solving practical problems in education.

In the first case, it is worth remembering that educational action is a fragment of reality and that it is only accessed through the conceptual framework that provides a certain language. The problem arises as to how the correspondence between the statements and a reality without structure can be established (not conceptualized, not divided into parts). Niiniluoto (1987a) says that although each language establishes its own

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facts from the world, "as soon as a L language is given, with predicates that designate some properties, it is the world and not people who decide which L statements are factually true" (p. 141). Thus, for example, once the meanings of the terms 'multitasking', 'interfering' and 'learning' are set, the phrase 'multitasking can interfere with learning' will be true or false regardless of the perception people have on it. In short, what makes it possible to decide on truth or falsehood is the view that the world has of a certain language.

Another important aspect is the procedure by which those properties of reality are captured. The design provides a guide for systematic and rigorous problem-solving planning in educational action (e.g., designing a learning environment to promote attention to a wider range of multisensory information through multi-tasking). A design is a model, a conceptual 'construct', whose behavior is compared with the behavior of variables in the real situation. The knowledge obtained—and to be used to prescribe guidelines for educational interventions—must be contrasted to judge its validity and truth. The criterion is, in this case, the pragmatic truth which, as explained by Faerna (1991), is on a relationship (contingent, but well founded) between true knowledge and effective action. Thus, this knowledge is considered true to the extent that it provides a reliable guide for practical action, i.e., that the prescribed intervention is successful.

A well-conceived construct is one that enables the problems that are currently (or are expected to arise in the future) to be effectively resolved, so the solutions it offers must be potentially universal. The truth in its pragmatic dimension relates to the satisfaction of practical purposes. But, although the truth is measured by success, it does not derive from success, but from the very properties of the construct to realize the reality. Hence, ultimately, it presupposes a criterion of truth as correspondence.

This refers to the truth in its ontological dimension, which implies the authenticity of the real, from a reality that is not 'built' but must be discovered and has the capacity to determine the facts that are true and those that are not by the theories created by science to approach it. But the action of educating is an artificial reality, a direct expression of human creativity that belongs to the field of what is deliberately sought. How is the authenticity of an artificial reality (which is also subject to historicity) determined? This reflection goes beyond the limits of this article, but since it determines everything that has been argued so far, some considerations are presented:

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First, it refers to the reference of a semantic content, which has features that — even if it is a reality—do not depend on the individual mind of the researcher or a group of researchers, but are used by the scientific community in general, the institutions that support that research, and even the society it affects.

Secondly, Artificial Sciences, as has been pointed out, deal with 'constructs' that are human-made designs. Simon (1996) places his object of study in the space between the internal environment that makes up those designs and the external environment in which they act. Specifically in the cross-link between what affects constructs 'from within' (when making designs), and natural or social laws that correspond to the environment in which these designs are to be applied (with their administrative, regulatory, technological, economic, social limitations, etc.). Thus, the fulfillment of the purpose for which they are built—the adaptation to an objective—implies a relationship between three terms: the end or objective, the character of the artifact, and the means in which the artifact acts. What distinguishes sciences from the artificial is the consideration of the end that guides the performance. So, authenticity in artificial reality is measured by the fulfillment of the ends.

This still requires two observations: (i) the debate about truth in the Science of Education refers to the issue of the ends, like any debate in this discipline; and (ii) it requires authenticity in the actions of the various actors involved on it (individuals and institutions)[15] which should be oriented toward the fulfillment of these purposes.

Conclusions

The progress of Education Science in its approach to truth can be justified when considered as applied science: a) to the extent that it advances in accuracy and precision in the prediction and b) it offers action patterns that expand the success of agents in their professional live. As Science of Design, its progress is measured by the ability to obtain new designs that allow to achieve more ambitious objectives to better select the processes and to obtain satisfactory results in the resolution of concrete problems[16]. But this must be done on an objective basis in internal processes (Education considered in itself) and maintaining objectivity in the knowledge of the external constraints of the environment, which make new developments possible or difficult.

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The finding of the relationship between the progress in Education Science and its consolidation as Applied Design Science suggests deepening on the artificial aspect of the discipline (which does not imply neglecting its social dimension). It is the responsibility of educational research, which cannot ignore the intellectual orientation offered by practice, but also of the Philosophy of Science, which has not usually considered the specific problems of Education.

Artificial Sciences do not intent to understand and explain phenomena (in this case, educational), but seek to improve things by adding new possibilities. Since the artificial dimension of Education Science has been enhanced by the incorporation of technology, its use has to be explored. This requires thinking about what Education wants from it. Thus, the question of ends (led by the debate about truth) has been revealed as the priority inquiry in Education.

Notes

1. Mainly Social Sciences, but also some Natural Sciences such as Biology of Education or Neurosciences. With the incorporation of ICTs, technology and certain Artificial Science, such as Internet Science, come into play.
2. Although the use of the plural 'Education Sciences' to refer to pedagogical disciplines is justified, the singular 'Education Science' is used to highlight the specific scientific status of this disciplinary field.
3. González's pragmatist realism (2013) adds logical, methodological, axiological and ethical factors to the triple dimension of science that regularly contemplates scientific realism (semantic, epistemological and ontological) (pp. 16-17).
4. For the objectivity analysis in the Science of Education, reference is made to the study carried out for the Science of Communication conducted by Arroyo (2020).
5. As educational action is an artificial reality, this statement must be nuanced. It refers, in this case, to the need to grasp the traits that actually define the education process, because they belong to it.
6. "What counts is not preference but preferability: it is not what people want, but what they should want; not what people really want, but what sensitive or right-thinking people want under the circumstances" (Rescher, 1999, p. 90).
7. Niiniluoto explains (1993) how these skills were concretized into rules of action and were systematized, giving rise to an organized body of knowledge that allows to solve specific problems. When the operation of these rules begins to be validated by scientific evidence, a Science of Design emerges.) This is also the case with medicine or pharmacology.
8. It has previously been mentioned (Alonso, 2020b) that the social and artificial duality is a trait of those sciences rooted in human needs and in which what was built overlaps what was given (Economy, Communication Sciences...). These are disciplines that investigate how to expand human potentialities by means of designs, thus entering a purely artificial field. They influence information and Communication Technologies and Artificial Intelligence to modulate the operability of new objecti-

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ves. It clearly happens in Education but has hardly been addressed. There are also a number of disciplines (Communication Sciences, Administration Sciences, Internet Sciences, etc.) that belong to the artificial field, whose development has a direct impact on the current progress of Education.

9. It is the responsibility of Education Science to predict the future of Education. Reliable prediction is needed to prescribe the right actions.
10. The critical attitude leads to rule out scientific statements whose correspondence with the facts is not given. For an analysis of the truth in Popper, González, 2005.
11. González (1993) points out that, although he is more prone to critical attitude, it does not imply the acceptance of the epistemological bases of the popperian falsacionism.
12. Diéguez (1997) states the immeasurability in Kuhn and Feyerabend, the undercompletion of the theories in Quine, the effectiveness in the resolution of problems of Laudan, the empirical adequacy in van Fraassen or the redefinition of the concept of truth in Putnam (pp. 302 and 303).
13. This knowledge is oriented to the resolution of problems related to the action of educating. There is no consideration of the possibility of truth —and the criteria for determining it— of knowledge generated about issues related to the possible causes and consequences of such problems, which may be the subject of inquiry of other disciplines.
14. González points out (2021) that the reference theory can have two main directions: Semantics (which prioritizes the conditions of truth) and pragmatics, which emphasizes 'meaning as use' (p. 49).
15. The focus has been on teachers, but the decisive impact of the actions of other actors, such as administrators or political decision-makers, is not ignored.
16. This is possible in Education, which must be considered with intellectual standards similar to those that are common in other applied sciences. In addition, prior professional practice is available for this purpose.

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