

**LANGUAGE, SPEECH AND SEMIOSIS: APPROACHES TO
POSTCONSTRUCTIVIST THEORIES OF LEARNING IN MATHEMATICS**

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In the usual constructivist view of learning mathematics the student is engaged in the active process of constructing meaning for instructionally given target concepts. Cobb, Yackel, and Wood (1992) and others propound an alternative view, social constructivism, which treats mathematics both as an individual constructive activity, and as a social practice. On this view, learning operates as an individual cognitive action (construction of interpretations) made compatible by social interaction with the collective interpretations of mathematically acculturated practitioners. One argument used by Cobb et al against standard forms of constructivism is that they commonly rely on an essentialist theory of knowledge. In this paper, however, it is argued that the notions of interpretation, meaning, and construction crucial to the position of Cobb et al also depend on essentialist theories of knowledge. Approaches to validating this claim are made in three lines of inquiry drawing upon notions of theory of practice, philosophy of language, and the science of signs or semiotics. Important parallels between these discussions, and between certain poststructuralist formulations are noted in the process of argument. An outline of elements of a new postconstructivist theory of learning emerges. A touchstone for these ideas is provided by Lave and Wenger's (1991) theory of learning as legitimate peripheral participation; allusions to this theory are made throughout the paper, although no direct study of it, or its relation to the theory figured here is attempted.

Viewed as a strategy to oppose the traditional "broadcast" view of education (Seeger and Steinbring, 1992) constructivism provides a valuable space in which teaching alternatives more favourable to the learner as an active meaning maker may be developed. Whether this strategy has been successful in reformulating classroom practice may be a moot point, however, we can say that as a name signifying a coherently organised set of beliefs about learning and teaching mathematics, constructivism has been singularly unsuccessful. Indeed, attempts to transcend an essentially negative, or mainly polemical formulation, have lead researchers to a wide variety of sometimes incompatible theoretical positions; Ernest (1991), for example, has observed a "panoply of theoretical positions" and that no single theory of constructivism holds general sway. One aim of this paper is to strengthen this observation by advancing the view that constructivist theories are obliged to covertly reinstate notions of knowledge characteristic of the "broadcast" model, and that therefore, no *positive* theory of constructivism is, in principle, possible. Three lines will be involved in establishing this argument, and these will draw on theories of practice, language, and signification and will be treated in separate sections below. The theory of 'social constructivism', as set out by Cobb, Yackel and Wood, in their article "A constructivist alternative to the representational view of mind in mathematics education" (1992), will be used to illustrate the main points.

Wittgenstein remarked that his work could be distinguished from his predecessors in that he found difference where they found identity, and identity where they saw only difference. Perhaps a clue for future directions in educational theory may be found in this remark; certainly, amongst recent authors, Lave and Wenger (1991) are exemplary in their treatment of theoretical issues in learning consistent with this dictum. At root, it may be observed that constructivism is beset by two levels of false identification: first, there is the forced insistence of an identity between terms such as "knowledge" "construction" "meaning" "interpretation" *etc*; and second, related to this, there has been too ready an acceptance of the view that there must necessarily hold an identity between a theory of learning, and a theory of learning *for teaching*. Such an identity carries with it the dubious assumption that teaching is principally a technical problem to be addressed by an appropriate learning theory in conjunction with the a correct method for transferring this knowledge to pedagogic sites.

On the other hand, attempts to develop a positive theory of constructivism are frustrated by what Lave and Wenger have call "discourses of duality". Dualities constitute and affirm the objects of theoretical knowledge, in doing so they afford the structures by which traditional theories of learning/teaching are proposed and validated, but in the process, it is crucial to recognise that they systematically distort the focus of their inquiry. This insight will be revisited frequently in the paper, although not explicitly discussed. Dualities to be addressed and questioned more

or less openly in this paper will include: learner/teacher, {learner/teacher}/researcher, mind/body, language/world, structure/function, psychological/social.

In raising the above points an outline for a theory of learning alternative to the constructivist model will be provided. Such an alternative may be called *postconstructivist* since it would reject both transmissionism and the constructivist variations. Postconstructivist theories of learning transcend epistemological constraints, in particular, covert essentialism, and attempt to subvert and reorganise structures of identity and difference. Such theories take their cue from a remark of Lave and Wenger (1991, p 35 and p 93) who urge that learning be considered "an improvised practice". Approaches to such a theory, it will be suggested, emerge from theories of practice, Wittgenstein's later philosophy of language, and poststructuralist theories of signification.

SUMMARY OF A CASE FOR SOCIAL CONSTRUCTIVISM

Cobb *et al* (1992) argue that mathematics is "both a collective human activity and an individual constructive activity" (p 17). Individuals construct mathematical meanings (interpretations), and these are tacitly identified with "internal representations" (p 2). Cobb *et al* note, however, that the concept of representation typically functions in two ways: "internal representations are located in students' heads and external representations are located in the environment" (p7) and it is this separation that their analysis is designed to side step. One way to consider the efficacy of the individual construction of representations considered by the authors relies on a philosophical position known as the *representational view of mind* whose central tenet, Cobb *et al* report, may be summarised as follows

To know is to represent accurately what is outside the mind; so to understand the possibility and nature of knowledge is to understand the way in which the mind is able to construct such [internal] representations.
(Rorty, 1977, p 3 quoted in Cobb *et al*)

Cobb *et al* demonstrate that the application of this principle provides the basis for constructivist theories of learning in which students construct internal representations which match the mathematical relations inherent in external representations (p 17); and they note that such a formulation has "a certain explanatory power". However, the authors argue that since such theories lead to paradoxes in learning (Bereiter, 1985), have problems with an adequate theory of transfer, and ignore certain anthropological evidence they must, nevertheless, be rejected.

Thus the authors are lead to consider an alternative account in which the representational view of mind plays no part. A theory of social constructivism emerges in which both individual interpretation and the "taken-as-shared interpretations of mathematically acculturated members of the wider community" (p17) are taken into account. Teacher and student each construct individual interpretations which in principle, of course, they cannot share with each other; these, however, come to be taken as shared once a criterion of compatibility or fit for the purposes at hand is obtained. Note, finally, that the arguments of Cobb *et al* for the rejection of the representational view of mind amount only to a rejection of the hypothesis that mental representations can be known to be accurate; indeed, it would appear that individual cognitive representations play a tacit role in their theory, and that these enable the construction of individual interpretations. However, no account of the concept of representation, or of it's use by them in their theory, is provided by the authors. In the following section therefore, I will attempt to grapple with the question of the character and adequacy of their tacit formulation of this concept. I will also consider the efficacy of their application of teachers' and students' interpretations in order to construct mathematical relationships which, in their words, "have clout" (p25).

AN APPROACH THROUGH THEORIES OF PRACTICE AND REPRESENTATION

Theories of practice

In philosophical terms, the work of Cobb *et al* can be read as an attempt to counter a variant of an essentialist view of mathematics which holds that mathematical concepts exist in a reality separate from the minds and social space of the people who "discover" them and utilise them; and when concepts are to be utilised, so it is argued, they can be embodied in practical situations. An instance of this would be teaching mathematics itself, in which mathematical concepts are embodied by external representations in pedagogically transparent ways. In arguing against this position, known in philosophy as metaphysical realism, the authors embrace a positivist view of knowledge (*eg* privileging sense data as in the "experientially real scenario of the candy factory", p 22) and validate this by

advocating a theory of truth in which statements are judged true in so far as they help us move toward satisfactory relations with general experience (eg formation of "increasingly sophisticated mathematical conceptions", p 22).

But was sense experience *actually* fundamental for the subjects' learning in the situations observed? Were concluding propositions *actually* taken-as-shared by the participants in the manner the authors described? Little evidence/argument is provided by the researchers in support of their crucial presupposition that variability amongst these factors was critical to the learning outcomes of the students. Nor, indeed, is it clear on what basis evidence for such claims could be provided. Cobb *et al* argue that learner and teacher develop meanings which they take to be shared between them. But how does the researcher know this? Three possibilities will be considered: (1) The researcher has a way of knowing which can see this truth directly (and this essentialism would need to be explained); and (2), the researcher enters the learner/teacher relationship as a third element. On this view, the truth is formed as a taken-as-shared meaning developed in the concrete relations which hold between these three agents. However, review of the proposals put forward by Cobb *et al* reveals no evidence that either of these alternatives is intended. The remaining alternative must then be accepted, and this is that the key relation from the researcher's point of view is between himself/herself (as observer) and a repertoire of learner/teacher duads (as actors). On this view, researchers work by formulating the most plausible story abstractable from each of the learner/teacher duads investigated. But by what criteria are these stories abstracted? With what prejudices and blindnesses? For what audience are they meant to be plausible? To what extent does the condition of their plausibility depend on what an audience will accept? Entailed within the operations of this alternative is an agreement (amongst the observers) to privilege abstracted relations between learners and teachers (the actors) over concrete relations between the particular learners, teachers, and researchers. What justifies this asymmetrical treatment? Why have the authors not provided a reflective account of their method and its justification for obtaining abstracted relations? Why have the authors not critically reviewed the consequences of their choices? One response to the issues raised here is the suggestion that abstracted relations observed by the researchers exist in reality, and so are naturally privileged; moreover, on this view, abstracted relations are observed directly since they exist as separate elements within the system under review. Such an argument would, however, involve the paradoxical reinstatement of an essentialist epistemology, albeit at the level of the relation between the researcher and his/her subjects *ie* between observers and actors. A key question to be asked is: What are the epistemological implications of such a reinstatement for the theory which Cobb *et al* propose?

In conclusion, the arguments presented above demonstrate the need for Cobb *et al* to explicitly state their theory of practice (Bourdieu, 1977; Carr and Kemmis, 1986; Lave, 1991, pp 49-52). Such a theory would indicate by what processes and organisation researchers' interpretations of data are fashioned, and how their theoretical knowledge is formulated. A theory of practice formalises the distortions of theory, and provides research with a language in which to scrutinise, and assess the systematic (and necessary) failure of research to fully bring to light the character of what is being examined.

Theories of representation

I have already mentioned that Cobb *et al* do not explicitly analyse the notion of representation, although they extensively rely on it. In their hands it seems to be a simple duad: Two objects related in some way. Whether one or both of the objects are internal or external to the learner does not seem to matter - what is of importance is that the objects are similar (for/to the learner) in some important way, and that the tasks of construction ensure this. Indeed, in some instances Cobb *et al* seem prepared to go further and appear to have in mind some kind of equivalence between these elements (as in talk of "re-presentation", p 25, and the like). Thus, in these cases, it may be inferred that an idea of representation implies some kind of double presence for/to the learner in which an object (an identity) and its equivalent (a near identity) are present together (*cf* Boynes, 1990, p93). But if this is the case then it is not clear how representations can play the role in learning the tacit theory of Cobb *et al* gives them. For to learn by representation would be to simply renew or re-present a concept already present - in other words learning would have already have taken place. If, for representation to function in a learning context it is required from the start that the object of instruction be present, then it is clear learning is not possible. Clearly this *paradox of representation* is similar to Bereiter's learning paradox (1985), and it is therefore ironic that in order to avoid the latter, the theory of social constructivism seems to embrace the former.

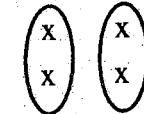
I believe an adequate treatment of the representation paradox shows one reason why we have to be most careful in how we approach thinking about how meaning is constructed for/to the learner in the process of learning. It would seem, for instance, that in order to avoid this paradox a second appearance of the social domain is required (*cf*

Lave and Wenger, 1991, p35). For Cobb *et al* the social domain appears as a domain of "acculturation", in contrast to the "cognitive aspect" of the aspiring individual (see p 28). In this, it's first appearance, it both constitutes and affirms the socially interactive component of learning as constructing taken-as-shared knowledge targets. Beyond this, however, I suggest that the social also appears intra-individually in order to allow for the personal construction of meaning. This second appearance, however, requires the promotion of the social domain as the third element of an adequate notion of individual representation. This would form what I shall call a *representational triad* consisting of object-representation-social. In the following sections, I will seek to further clarify and extend from perspectives in the philosophy of language, and general theory of signification (*semiosis*) the issues raised here. These lines of investigation will mark the boundaries of a second field of critical analysis of learning as social constructivism.

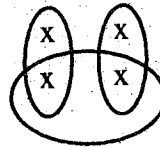
AN APPROACH THROUGH WITTGENSTEIN'S PHILOSOPHY OF LANGUAGE

Wittgenstein (1967, I-38) makes the following observation:

"You only need to look at the figure to see that $2 + 2 = 4$."



- Then I only need to look at the figure to see that $2 + 2 + 2$ are 4.



Wittgenstein's point succinctly reminds us that meanings are neither in the objects to which they refer, nor in the language which describes them, nor in the conventions which enable us to relate these two, but distributed amongst these domains, each one necessary but by itself insufficient. On one hand Cobb *et al* seem to endorse this observation, yet on the other, as my analysis of their tacit theory of representation has shown, they appear to reinstate assumptions consistent with mathematical essentialism by the demotion of the social within, or even its elimination from, the representational triad. As a consequence, individual interpretations in the theory of Cobb *et al* appear like movements in a private language. But is the idea of such a language intelligible? Wittgenstein himself struggled over this and related questions. In his early work (Wittgenstein, 1921/1974) for instance, he assumed that language was a perfect medium, it's operations did not distort as they painted to us a picture of the world. Later investigations (Wittgenstein, 1953/1991) however convinced him this view could not be sustained, language systematically distorts the world it reports; one instance for him of this view is the formulation of the notion of a private language, which he therefore rejects as unintelligible. Accepting Wittgenstein's argument would imply that individual interpretations are already social, and this throws into question the basis of the distinction between the social and the individual Cobb *et al* wish to preserve.

In studying the world, Wittgenstein came to insist it is necessary to also study the language in which it is represented. Such a study would need to focus on two related issues:

- Issue 1. Language is organised by structure (*grammar*). How do the workings of grammar entangle, structure, distort the sense I make? (Hunnings, 1988)
- Issue 2. Language is an act, a performance, a series of *language-games*. What is the purpose, and what are the particular circumstances of any given utterance? (Kanes, 1992)

These, together with the object world, form three elements in a triad of sense making involvements. Parallels with what above I have called the representational triad (object-representation-social domain) are to be noted: for instance, Issue 1 relates to a linguistic representation, Issue 2 the social domain. I suggest that future research into these (triads) and their interrelation within the multiple contexts of mathematical invention, application, and instruction could lead to the formulation of a learning theory alternative to the constructivist paradigm.

As Wittgenstein's later work testifies, finding a means to interrogate our language system, as it were, from the inside (Issue 1 above), is not a simple task either for the actor (the writer) or the observer *cum* actor (the reader). In

general two lines have been followed: the first is shown by Wittgenstein himself, and follows the operations of natural language; the second, starting from quite different perspectives but following a roughly parallel path, is currently practised in the form of poststructuralist /deconstructive analysis as developed by authors such as Jacques Derrida and Julia Kristeva. Understanding the relationship between these two paths (Norris, 1983; Staten, 1986) will be an important task in fully articulating a theory of learning foreshadowed here. My present, very much limited aim, is to provide something of the flavour of the deconstructive line in order to signal key points of departure from the constructivist paradigm.

AN APPROACH THROUGH SEMIOTICS

At the turn of the century the American philosopher, C. S. Peirce, and a Swiss linguist, F. de Saussure independently proposed the need for a "science that studies the life of signs within society" (Saussure, 1983, p 16). Focus on such a science (*semiotics*, from the Greek, *seimon* meaning 'sign') will enable us to reframe the formulations of Cobb *et al* in order to see more clearly their implications and begin the development of a counter view.

For Peirce (Hawkes, 1977), the sign is a triadic relation between an *object*; a sign or *representamen* which stands for it; and an *interpretant* for whom the sign, *grounded* in a way particular to circumstances, makes sense. For example, in the case quoted by Wittgenstein above, the object is the diagram, the representamen is the arithmetic symbolisation, and the interpretant is the set of arithmetic codes and conventions which enable sense to be elicited. In contrast, Saussure (1983) takes a sign to be an object within the mind of an individual. It has two parts: the sense-impression of the *referent* called the *signifier*, and a concept, called the *signified*, which provides unity to the triad of elements (referent-signifier-signified). Kristeva calls these combined elements a *matrix* or *pyramid* of the sign. To illustrate using the previous example: the actual marks on the page are the referent; the impression these marks make on the mind, the signifier; the arithmetic concept which gives the signifier meaning, the signified.

Putting aside any interest in the differences between these approaches, three key points relevant to the study of learning mathematics emerge.

Dichotomy of language and the world:

In Umberto Eco's words (1984)

The concept of the sign must be distinguished from its trivial identification with the idea of coded equivalence and identity; the semiotic process of interpretation is present at the very core of the concept of the sign. (p 1)

Kristeva (1989) notes the same thing when she says that signs

all *replace* or *represent* something that is absent, evoked by an intermediary, and, consequently, included in a system of exchange: in a communication. (p 13, italics in the original)

It is therefore clear that representation includes a separation, or at any rate problematises a separation between what is *present* and what is *absent* in the process of representing. Viewed in this way the sign constitutes and affirms a radical break between language and on the other side, an actual, concrete world. In setting up a learning theory, we have to understand how *both* these operations (constituting, affirming) function; our goal is to grasp and scrutinise their full epistemological significance.

Epistemology of the *constructive notion of the sign*:

As just hinted, the sign, an "evoking intermediary", is not epistemologically neutral: signs both constitute and structure knowledge, they do not merely transmit it as if through a transparent medium. At the level of language this concern parallels Wittgenstein's focus on the operation of grammar (correlate of the signifier) to both distort and make meaning possible (the signified). Partially, at least, Cobb *et al* seem in agreement with this notion of the incapacity of language - they do, after all, rule out the possibility of transparency in instructional representations, and this confirms the language/world duality. As a corrective, mathematics is treated as both an individual and a socially organised process of "constructive activity".

As we have seen, the purpose of constructive activity for the constructivists is successful communication. But what can be said of its character? This question, which corresponds to the switch from accenting functionalism in behaviourist psychology to accenting structure in cognitivism, has not, I believed received due attention. My approach will be to reframe constructivist notions within Saussure's semiotic domain: it is hoped to then more fully grasp the epistemological implications of constructivist theory. The views of Cobb *et al* could thus be restated: Learners act on both a set of referents and signifiers in order to produce in collaboration with teachers and others, a viable (*ie* taken-as-shared) set of signifieds. I shall call this characterisation, the *constructive notion of the sign*. Of immediate note is the immobility and stiffness of this production/construction *versus* the apparently inexhaustible, multivalent nature of the particular ground or context upon which the sign is built. Duality between language and the world is radically asserted by this process. But for Julia Kristeva (1971, p 24), the significance of this duality is that *sense*, the signified, is constituted by it (see also Lave and Wenger, p104). She argues that sense is the construction within language of a mediation between the signifier and the referent. Sense appears as "hidden in the sign". But such an appearance is actually an illusion based on the way a signifier "elides the plurality of the outside (out-of-sign) that it begins by posing [in the form of the referent]" (p 26). Illusion of content in the signifier is derived from the way it operates. Wittgenstein comes to a similar conclusion about the illusions language establishes for us when we attempt to use it in any other way than as a (rather flawed and problematic) tool. It remains to add that the illusory sense hidden in the sign, spoken of by Kristeva is, in this context, none other than the (re-)emergence of mathematical essentialism. The epistemological stance of the constructive notion of the sign, and therefore the social constructivist paradigm of Cobb *et al* privileges the operation of metaphysical realism within mathematics education, it does not deny it. Movement to the ideal, both endorsed and encouraged by the relatively immobile semiotic relation described here, is necessarily related to the elimination of differences and discrepancies - everything, in short, which is particular to the learner and the learning context. Kristeva aptly describes such a linguistic enterprise as "ideological": She does so because the elision of difference ultimately re-emerges on the political plane, as an expression of power (Lave and Wenger, 1991, p 38).

Under the mask of socialisation or of mechanistic realism, ideological linguistics, absorbed by the science of signs, turns the sign-subject into a centre. The sign-subject [the learner, the teacher] becomes the beginning and the end of all translinguistic activity; it becomes closed up in itself, located in its own word, which is conceived of by positivism as a kind of 'psychism' residing in the brain. (Kristeva, 1969, quoted in Eco, 1984, pp25-26)

Thus we see again that the tenor of the Cobb *et al* argument re-endorses rather than overcomes the Cartesian mind/body dualism. At the heart of the approach sketched here is the suggestion that poststructuralist perspectives offer an effective critique of the constructive notion of sign. This observation will be further developed below.

An alternative to the *constructive notion of the sign*:

In thinking about linguistic activity Saussure distinguishes between *langue* (language) and *parole* (speech). *Langue* emphasises the structural aspect of language, that which is anonymous in the sense that it "exists perfectly only within a collectivity" (Saussure, 1983). It is

the social part of language, external to the individual, who by himself is powerless to alter it or modify it. It exists only in virtue of a kind of contract agreed between the members of a community. (p 13)

Parole, on the other hand, being entirely a function of the speaker, belongs to the individual. Unlike *langue*, which "never requires premeditation", it is an "individual act of the will and the intelligence" (p 14), an active registration of the individual. Beyond these simple characterisations, including the suggestion of their duality, the question of the *langue/parole* relationship turns out to be of great significance to the questions of meaning, knowledge, and learning. Saussure argued that *langue*, viewed as "a fund accumulated by the members of the community through the practice of speech" (p 13), is an historical product constituted by *parole*; but the poststructuralists, in the tradition of Derrida and Kristeva, emphasise that an interplay operates on a deeper level, namely at every point the semiotic process is actualised, for example, when speaking, reading or writing. On the poststructuralist view, the distinctions implied by *langue* and *parole* (like those, also, between the signifier/signified itself) cannot be pinned down once and for all, they are constantly shifting ground. Making meaning is seen as an incorrigibly mobile

process; *langue* and *parole* are locked into a never ending struggle in which one never has a necessary privilege over the other. This view provides fresh meaning to the dictum: The individual is inscribed within the social, the social is inscribed within the individual.

Returning to the problem of learning, Saussure's *langue/parole* distinction provides a good framework to *redirect* the thrust of the constructivist paradigm. If *langue* were simply identified with the "taken-as-shared interpretations of mathematically acculturated members of the wider community" and *parole* as the "students interpretations of instructional materials" (Cobb *et al.*, p 17), then it becomes clear how germane to the debates about learning in mathematics, the issues at stake in the linguistic sphere are. Moves to postconstructivism are parallel to shifts towards poststructuralist thinking in other contexts. In each case, the kernel of the operation is the same: notions of identity are replaced with the notions of difference. From these perspectives, one problem with constructivism can be identified as the stiffness and immobility of 'construction' itself. Like *langue*, it is sensitive to the social collective, both in time and space; but as we have seen, *langue* is inextricably bound up with and entangled by *parole*, and therefore is unstable in every concrete instance. Likewise, the constructed artefacts of mathematics, what Cobb *et al* call mathematical knowledge, are locked into a permanent entanglement with instances of what I shall term *mathematical speech*, and this is the perpetually mobile and irreducible registration of the individual as one dealing in practice with mathematics.

In conclusion, my the aim has been to signal that an over-emphasis on mathematical *langue* currently exists both in theory and in practice; that the full consequences of this are anything but transparent; and that a new theory might favour the reorchestration of theory/practice in order to re-emphasise the importance, albeit problematic itself, of mathematical speech. At the level of *theory*, I have argued that emphasis on mathematical *langue*, leads to the endorsement of mathematical essentialism as an epistemological project, and that the work studied of Cobb *et al* is riddled with such a tendency. At the level of *teaching practice*, I argue that emphasis on *langue* leads to the algorithmisation of knowledge, in which "learning how to 'do' school becomes the object" (Scribner and Cole, 1981 quoted in Lave and Wenger, 1991, 107), not learning to participate meaningfully in a wide range of mathematics practices. As Lave and Wenger note

The didactic use of language, not itself the discourse of practice, creates a new linguistic practice, which has an existence of its own. [Learning] in such linguistic practice is a form of learning, but does not imply that [learners] learn the actual practice the language is supposed to be about. (p 108)

Mathematical *langue*, and mathematical *parole*, one abstract and the other concrete, are engaged in an endless struggle; in the terms of Lave and Wenger (pp113-117), each provides *continuity* for the other and yet, paradoxically, also threatens to *displace* its opposite. For this reason, postconstructivist theories of learning do not make an end of abstraction; they aim to make it merely a means. As Lave and Wenger's invocation of Marx (p 38) reminds us, the goal of theoretical knowledge is not abstraction in itself, but rather to "ascend (from the particular and the abstract) to the concrete". In so doing it is sought to revoke the privileges of abstraction current in both theories of learning and classroom practice.

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