

Research Needed on Critical Thinking

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The teaching of critical thinking, long held an important goal of education, is finally being taken seriously in schools, colleges, and universities. However, much research remains to be done on questions that Robert Ennis said over two decades ago were in need of answer. This paper discusses two issues in need of research, the generalizability of critical thinking, and the evaluation of critical thinking ability. Some of the conceptual and empirical work required on these topics is indicated, and it is argued that the combined expertise of philosophers, psychologists, and subject matter specialists is needed to do the work well.

L'enseignement de la pensée critique, longtemps considéré comme un but important de l'éducation, est finalement pris au sérieux dans les écoles, les collèges et les universités. Toutefois, une bonne partie de la recherche sur la pensée critique, que Robert Ennis jugeait encore nécessaire il y a plus de deux décennies, reste encore à faire. Cet article met en relief deux questions qui méritent d'être étudiées: les possibilités de la généralisation inhérentes à la pensée critique, et l'évaluation de l'aptitude à la pensée critique. Certaines recherches de nature conceptuelle et empirique qu'il faudrait effectuer sont expliquées; l'auteur invite en outre les philosophes, les psychologues et les spécialistes d'autres disciplines à s'intéresser à cette facette de l'éducation.

Research on critical thinking has not traditionally been given a high priority in education. However, two and one-half decades after Robert Ennis (1963) bemoaned the lack of knowledge about critical thinking, the education field now seems to be taking the issue seriously. Entire journals and special issues of journals are devoted to the topic. There is a society of scholars interested in furthering critical thinking instruction in schools and colleges. There are regular international conferences on critical thinking. California requires that all undergraduates in its university system take two courses in critical thinking in order to graduate, and items that test for critical thinking ability are appearing more frequently on college entrance examinations. At least one Canadian university offers a master's degree in critical thinking, and one American university will soon offer a doctorate in the area.

Nevertheless, since the appearance of Ennis's article there has been little progress on many of the topics he found most in need of research, including the development of critical thinking tests, the critical thinking capabilities of children at various levels of development, the effectiveness of various methods of instruction in critical thinking, and the development of a testable

theory of critical thinking ability (Norris, 1985b). Each of these topics raises intriguing basic and applied research problems. The main purpose of this paper is to inform researchers who have some interest in critical thinking about some questions in need of exploration and to encourage them to consider contributing their insights to this important area.

Since 1963, much of Ennis's own work has been devoted to elaborating the definition of critical thinking, and this consequently is one area where progress is noteworthy (Ennis, 1981; 1987). This article discusses two areas where progress has been slower: the study of the generalizability of critical thinking and the evaluation of critical thinking ability. These topics are central to theory and instruction in critical thinking and require considerable research in order to sort out the many conceptual and empirical problems they raise. However, it is not here possible to treat the generalizability and evaluation of all aspects of critical thinking, so some delimitation of the discussion is required.

I adopt for purposes of this paper the broad concept of critical thinking recently offered by Ennis: "Critical thinking is reflective and reasonable thinking that is focused on deciding what to believe or do" (1985a, p. 45). Thus defined, critical thinking is a practical activity concerned with making decisions. It is quite natural to conceive of such decisions as proceeding from some *bases* (previously accepted conclusions and information from others and from observation) to *conclusions about beliefs or actions*. These conclusions are *inferred* from the bases, thus giving the process of inference a pivotal role in critical thinking.

Inference can proceed through deduction, induction, or value judging, but for the purposes of this discussion I choose to concentrate on inductive inference. Inductive inferences are of two types: inferences that generalize information and those that explain information. I shall further restrict the discussion to the latter type. This paper will thus concentrate on the generalizability of inferential thinking and the evaluation of inference ability. It does so because of the central role of inferring in thinking critically. More specifically still, I shall place emphasis on inductive inference with special attention to inductively reached explanations.

THE GENERALIZABILITY OF INDUCTIVE INFERENCE

The question of the generalizability of inductive inference has both an *epistemological* and a *psychological* interpretation (Norris, 1985a). On the epistemological interpretation, the question is whether there are *general principles and strategies* of inductive inference "that bridge subjects, [or] have application to many subjects" (Ennis, 1985b, p. 29). That is, are there general principles and strategies for appraising and making inductive inferences

which are applicable to the various subjects or contexts in which such inferences are made? On the psychological interpretation, the question concerns *transfer*. Do students transfer their knowledge of inductive inference learned in one area to others? That is, would teaching students to make and appraise inferences well in science, say, make them good at making and appraising inferences in, say, choosing a life insurance policy?

General Principles and Strategies of Inductive Inference

Are there general strategies and principles for making and appraising inferences that lead to explanations? One general principle proposed by Ennis is as follows: "An explanatory hypothesis is justified to the extent that ...it is not inconsistent with any evidence" (1981, p. 174). This does seem to have wide applicability. In a court of law, the explanation that the defendant killed the victim for the money is less justified if it can be shown that the defendant believed that the victim possessed no money. In research on teaching effectiveness, the explanatory hypothesis that the new program caused the increase in the students' critical thinking ability is less justified if it can be shown that a similar increase in critical thinking ability was experienced by a group of students alike in all relevant respects to the first except that they did not receive the new program. In the field of physics, the hypothesis that the ether is the medium of transmission for light through seemingly empty space is less justified when it is discovered that to be a medium for light transmission the ether has to be both an extremely rigid substance and at the same time allow free movement of the earth and other heavenly bodies. In the field of economics, the explanation that high interest rates cause high unemployment is less justified when the interest rates fall and the unemployment rate remains high. In comprehending textual material, the explanation that the sentence "The men are going to the bay" means they are going shopping at the Hudson Bay Company is less justified when the men are later portrayed as fishermen hauling a catch in a net.

The general applicability of certain strategies of inductive inference is likewise plausible. Consider the following strategy: *Seek alternative explanations of information to be explained*. In the court case, the strategy could lead to the derivation of the alternative explanations that the defendant killed the victim in self-defense or in a fit of rage, rather than for the money. In research on teaching effectiveness, the alternative explanations can be proposed that the increase in students' critical thinking ability was really a halo effect or caused by the new teacher, rather than the new program. In physics, the explanation that light does not require a medium of transmission is an alternative to the ether hypothesis. Finally, the explanation in economics that unemployment is caused by high interest rates can face the

alternatives that the cause is low business confidence or inordinately high worker salaries.

Thus, a case can be made that certain principles and strategies of inductive inference can be applied to a wide variety of contexts in which such inferences are made. However, this view does not go unchallenged. Some argue such widely applicable principles and strategies are merely maxims that have lost all their practical import, rendering them next to useless as guides to decision making about what to do or believe. There is, on this account, a generalizability-utility trade off. McPeck has put the point this way:

The general skills approach to critical thinking represents a classical trade-off. In its effort to maximize the number of areas its general principles apply to, this approach must sacrifice genuine effectiveness in all of them. While its prescriptions are generally true, they are also hollow. (1984, p. 39)

McPeck has offered only weak arguments for his claim, maintaining that the promotion of general principles of critical thinking is like a baseball coach promoting good pitching solely by urging the pitcher to throw strikes. I have argued elsewhere (Norris, 1985a) that this analogy is inappropriate, and others (Ennis, 1985b; Siegel, 1986) have argued that there are both useful and general principles and strategies of critical thinking.

Nevertheless, there is room for the type of questions McPeck has raised. Are both the principle of inference appraisal and the strategy of inference making outlined above hollow, or can they be guides for action? Are there people who violate the principle and fail to employ the strategy, and who could thus profit from knowing them in their explicit form? If this principle and this strategy are hollow, are there *any* general principles and strategies of inference which are not? Questions like these need to be answered to determine whether critical thinking instruction which is aimed at teaching general principles and strategies of thinking can be placed upon a firm foundation. This work is clearly within the interest and competence of philosophers of education, but educational researchers other than philosophers can also contribute. For illustration, consider some of the ways to investigate whether the principle of inference appraisal outlined above is a hollow standard or can be a guide for action.

Recall that the principle is as follows: An explanatory hypothesis is justified to the extent that it is not inconsistent with any evidence. Of what use as a guide to practice can this principle be? First, in order to apply the principle, many issues must be considered. When is a hypothesis inconsistent with the evidence? What evidence must be examined to determine this? Is *anything* considered evidence? Is some evidence more important than other

evidence? Answering these questions requires background knowledge in the area in which the hypothesis is proposed.

In the example above concerning the effectiveness of a new program in increasing the critical thinking ability of students, one would need to rely on background knowledge from several sources. Knowledge of the nature of critical thinking ability and of its measurement would be needed to decide whether the evidence on levels of critical thinking ability is to be believed. In addition, it would be necessary to know how to determine whether groups of students are to be taken as equal in all relevant respects, for otherwise the evidence from the control group might be evaluated inappropriately. These are sophisticated pieces of knowledge. Given that application of the inference principle requires them, one might indeed wonder whether teaching the principle would be either superfluous or useless. It might be superfluous to those with the required background knowledge, because to them such a principle might, as McPeck suggests, seem a truism. On the other hand, for those without the requisite knowledge, the principle might be useless because they might not be able to apply it. Experiments studying the separate and combined effects on performance of relevant background knowledge and knowledge of the principle of inference appraisal are suggested by these considerations.

Another approach to these questions is to examine the relationship between the philosophy of science and the practice of science. Can the philosophy of science, which contains many general principles for making and appraising inferences, provide guidance to practicing scientists? Although this question requires informed and diligent appraisal and has a long and contentious history, my intuitions suggest that the philosophy of science can be of only limited value to scientists. On the other hand, can the principles of good scientific practice found in the philosophy of science be of any guidance for teaching young children to make and appraise inferences well? The authors of many school science curricula over the past 20 years have likely assumed a positive answer to this question when they have incorporated into their teaching materials insights about the nature of scientific thinking found in the philosophy of science. However, little is really known about the extent to which such general principles have assisted children to understand and perform better in science. Greater knowledge of such matters would assist in evaluating claims about the usefulness of general principles of inference making. Thus, science classrooms can provide strategic sites for this aspect of critical thinking research.

Another issue concerns whether all general principles of critical thinking would fare similarly under the type of analysis suggested above. Ennis has proposed several principles of inference beyond the one discussed, and I have proposed an extensive set of principles of observation appraisal (Norris, 1984b). Are all of these principles truisms? Let us consider one example

of a general principle of observation appraisal: An observation report is believable to the extent that it is not about an emotionally loaded event. One sort of emotionally loaded event is one in which violence occurs. Considerable research in the field of eyewitness testimony (Loftus, 1979; Yarmey, 1979) has shown that observers' recollections of such events are less accurate than their recollections of nonemotional events. This large body of evidence suggests that the above principle is true. However, if one considers the amount of research necessary to establish the principle, it is clearly not a truism. The principle is also useful and has general applicability. It would be a useful principle for jurors in assessing eyewitness testimony, for social scientists in studying violence in societies, and for people in general in dealing with interpersonal situations requiring an accurate description of an emotional occurrence. It may thus be possible that some *extremely* general principles, such as the one about the consistency of an explanation with the evidence, may be of little use but that some less general principles, such as the one about the believability of reports of emotionally loaded events, may be very useful in situations requiring critical thinking. Considerable investigation is needed before we can reach dependable conclusions on these issues.

THE TRANSFER OF PRINCIPLES AND STRATEGIES OF INFERENCE

If, after analysis such as that proposed above, a justified and useful set of general strategies and principles of inference making and appraisal can be found, the question would remain whether knowledge of the principles and strategies, and their application, transfer to areas other than those where they are taught. An answer to this question would be worthwhile because of its implications for instruction. For example, Phillips (1987, in press) has shown that strategies and principles of inference making and appraisal are used by proficient readers to comprehend textual material. Effective comprehension of textual material requires, among other things, inferring explanations of meanings contained in the text. Proficient readers can infer alternative explanations when having alternatives is appropriate and adjudicate these alternatives for their relative consistency with the information which the text contains. Proficient readers thus use the general strategy of inference making and the general principle of inference appraisal discussed in the previous section.

The questions are whether effective use of this principle and strategy in comprehending textual material requires that they be taught in the context of reading comprehension and whether effective use in other areas requires that they be taught in those areas. A general belief in educational circles is that transfer does not occur on its own but that one must teach for it. This

implies that a course in critical thinking would not lead very dependably to transfer effects if it focussed on general principles and strategies without emphasis as well on practicing the strategies and principles in varied contexts, and without helping students to abstract the general principles and strategies from the specific contexts in which they were practiced.

However, the transfer question requires work of both a conceptual and an empirical nature. First, the very idea of the transfer of knowledge from one area to another is unclear. What is it that demarcates areas? Are questions of inference in comprehending narrative text in a different area from questions of inference in expository text? Both are information in print. Are questions of inference in physics in a different area from questions of inference in biology? Both are in the area of natural science. Are questions of inference in poetry in a different area from questions of inference in short stories? Both are in the area of literature. There are no obvious criteria for demarcating one area from another, and thus it cannot be clear whether transfer of knowledge has occurred from one area to another. I see no easy way to clarify this issue, but there is considerable conceptual work to be done for those so inclined, including philosophers of education and empirical researchers with theoretical interests.

If these conceptual issues can be resolved satisfactorily, then certain empirical questions can be posed. One important one is whether transfer is enhanced by teaching general principles and strategies of critical thinking through the use of examples from diverse fields. For example, in a critical thinking course intended to teach general strategies and principles of inference making and appraisal, there might be examples of the use of the strategies and principles in many areas: economics, home buying, politics, poetry, and so on. Does teaching in this manner, without emphasis on any one particular area, enhance effective use of the strategies and principles in the areas exemplified as well as those not considered? A positive answer to this question would point to a more manageable way to teach critical thinking strategies and principles than teaching them in all areas. Indeed, this latter project is at any rate impossible, since there is no limit to the possible number of areas of human endeavour which could be imagined. Thus, in some sense transfer *must* be possible. Indeed, research reported by Holland, Holyoak, Nisbett, and Thagard (1986, pp. 259–262) suggests that, at least when teaching principles of statistical inference making, the use of examples in a given domain (notwithstanding the problems with the domain notion) transfers to a very great degree to the use of the principles in other domains.

THE EVALUATION OF INDUCTIVE INFERENCE ABILITY

Inductive inference ability is one of the most important and most trouble-

some areas of critical thinking to evaluate (Norris, 1986a), and this is a reason for choosing the evaluation of this aspect of critical thinking as a focus for discussion. In this section, I wish to highlight some of these problems, and to suggest possible research.

The best known accounts of critical thinking are *process*-not product-oriented (Paul, 1985). The emphasis is on the process of reflectively and reasonably deciding what to do or believe. However, the reference of *inference* is ambiguous: inferences can be thought of as the *products* of thinking processes, the conclusions reached through reasoning, or the *process* of thinking itself, the inferring. Evaluation of inference ability in the critical thinking field is more concerned typically with whether sound thinking processes are employed than with whether the correct conclusion is drawn.

Other factors to consider in evaluating inductive inference ability are the ways in which students' background knowledge of a problem and the assumptions they make influence the conclusions reached. If a subject possesses different background knowledge or makes assumptions different from those of the evaluator, then that subject may possibly arrive at different conclusions. If the evaluator examines only those conclusions in making an assessment of inference ability, then the subject may possibly be penalized, not because of a lack of inference ability, but because of the failure to have the same background knowledge or to make the same assumptions as the evaluator.

The above factors create problems in any attempt to evaluate inductive inference ability. The Cornell Critical Thinking Test, Level X (Ennis and Millman, 1985) consists of questions about the story of a group of space explorers searching for some comrades lost on a newly discovered planet. In the first part of the test, one explorer infers that the comrades are all dead because everything in their hut is covered with a thick layer of dust. The remainder of the section provides additional information which the explorers discover, and examinees must judge whether the information is evidence for, evidence against, or not evidence either for or against the inference that the comrades are all dead. The problem is that judgements of the direction of evidence can vary depending upon the background knowledge and assumptions of examinees. Examinees with different experience and sophistication will tend to operate from different assumptions and, since it is impossible to constrain completely the assumptions which can be made, different examinees can arrive at different answers using equally justifiable processes of inference making. For this reason the results of this section of the Cornell Test must be interpreted cautiously, as must induction items on any critical thinking test.

The Watson-Glaser Critical Thinking Appraisal (Watson and Glaser, 1980) raises similar problems in its inference and interpretation sections. These

problems can be illustrated by examining the following three questions from the interpretation section of the test. Examinees are to decide whether the given statements follow beyond reasonable doubt from the information given.

Pat had poor posture, had very few friends, was ill at ease in company, and in general was very unhappy. Then a close friend recommended that Pat visit Dr. Baldwin, a reputed expert on helping people improve their personalities. Pat took this recommendation and, after three months of treatment by Dr. Baldwin, developed more friendships, was more at ease, and in general felt happier.

55. Without Dr. Baldwin's treatment, Pat would not have improved.

56. Improvements in Pat's life occurred after Dr. Baldwin's treatment started.

57. Without a friend's advice, Pat would not have heard of Dr. Baldwin.

The keyed answers are that 56 follows beyond reasonable doubt from the information and that the other two statements do not follow. However, examinees could reach different decisions depending upon the assumptions they were willing to make. For example, an examinee might ponder 55 as follows:

The statement does not say that Pat would not have improved *ever* or would not have improved *during the three month period*. I suppose they do not mean the former, because that would make the question too easy. It is obvious that one cannot say beyond reasonable doubt that he would never have improved without Dr. Baldwin's help. But, is it beyond reasonable doubt that he would not have improved during this three month period? Well, from the description it seems that Pat is suffering from some long-standing malady. Though it is possible, such problems typically do not go away by themselves in short periods of time without professional treatment. In any case, I am given no reason to believe that Pat's is the sort of problem that would go away on its own. Given this, the most plausible explanation of Pat's improvement is that Dr. Baldwin's treatment caused it and that without that treatment Pat would have remained the same. Thus, while not a certainty, it seems from the information to be beyond reasonable doubt that the improvement in Pat's condition would not have occurred without the doctor's help.

This reasoning justifiably leads to a conclusion other than that keyed as correct, and the examinee thinking critically in this manner would be penalized. In addition, it is not clear that the keyed answers for this section of the test are based on a criterion of following beyond a reasonable doubt. For example, item 56 follows beyond *all* doubt from the information given. Following beyond all doubt is following with certainty, but following beyond a reasonable doubt does not demand certainty. According to theoretical analyses of good critical thinking dispositions (Norris, 1984a) it is problematic to demand certainty where reasonable doubt is specified and appropriate. One risks penalizing the student who is thinking critically.

A number of important researchable issues arise from these problems in testing for inference ability. One concerns whether the responses of examinees which are anticipated above actually occur a significant number of

times. It is one thing to speculate that people with different background knowledge *might* make different assumptions in answering questions and another to know how prevalent this phenomenon is among those tested. Do significant numbers of examinees who take the Cornell and Watson-Glaser tests and other tests of inference ability make assumptions different from those people designing the tests? Maybe it is unjustifiable speculation that they do, but this will not be known until the issue has been studied.

Another researchable issue concerns the extent and nature of the role that background knowledge plays in inductive inference making. Everyone seriously interested in the issue of inference seems to concede that background knowledge is important. But how important, and in what way? And if there is inevitably influence of background knowledge in testing for inductive inference ability, then is there any means of controlling for it, or, if not, any way to take it into account in interpreting people's performances?

I have tried to take into account the issues of differing assumptions and background knowledge in test design methodologies that I am developing and using. For example, in the design of multiple-choice tests, information on the sorts of assumptions that examinees make while answering items can be gained by interviewing a sample of subjects and asking them to think aloud while they work through the items. Items can be modified or discarded on the basis of whether adequate correspondence of assumptions exists across the sample to warrant sufficiently trustworthy interpretations in actual testing where all that is available are examinees' choices of answers. This technique has been applied in the design of a multiple-choice test of observation appraisal (Norris & King, 1984), and the validity of the information gathered in the interview format to the actual testing format has been demonstrated (Norris, 1985c, in press).

We are currently also dealing with the matter of background knowledge in the design of an essay test of inductive inference. Two constraints are being imposed. First, we are seeking tasks to which students bring considerable common background knowledge. Second, we are attempting to devise a scoring scheme that will evaluate examinees' inductive inferences *given what the examinees know* and *given what they can reasonably be expected to know*. Thus, there is an explicit attempt not to penalize students for their background knowledge when it is their ability to think well that is supposedly being tested.

A further important issue arises from the process orientation of inference ability mentioned toward the beginning of this section. If it is the process of inference making which is to be evaluated, then what are effective means for doing this? Are objective tests to be ruled out in principle because they display only the products of thinking? I have argued elsewhere (Norris, 1986b) that objective tests *properly designed* can provide insight into the thinking pro-

cesses which determine performance on them. However, for really satisfactory evaluation of critical thinking ability must one employ such techniques as essay testing, naturalistic observation, and one-on-one oral testing? In a clear sense, such methods provide the most direct evidence about the process of thinking, and the latter method allows for that process to be probed for even deeper and more detailed insights. Nevertheless, no technique for gathering information about thinking ability is infallible, and each has limitations which must be explored and understood.

Finally, the very assumption on which are built many current theories of critical thinking ability, and the ability to make inferences in particular, needs to be examined. That assumption is that a useful distinction can be drawn between the process and the product of thinking. It is not clear whether rationally good processes of thinking can be identified independently of the products they yield, or whether the quality of thinking processes must be judged by the propensity of the processes to yield good products. If the former is the case, then what are identified as good processes and how are these identifications justified? If the latter is the case, how can the propensity for a process to yield good products be estimated?

These questions are clearly contentious. For example, one might turn to theories of scientific method or theories of moral reasoning to find models of good thinking processes. However, no clear answers are to be found in these sources. There is a debate in the philosophy of science over the extent to which the products of science result from scientific thinking, as portrayed in models of the scientific method, or result from psychological and sociological factors stemming from the desires of scientists to hold relentlessly to pet ideas and to require conversion to new forms of thinking. Similarly, in the field of moral reasoning, there is debate over whether dominant theories of the development of moral reasoning are contaminated by a male cognitive perspective (Gilligan, 1979), with *male* in this context intended to be a sociological as much as a biological construct. In the case of science, there seems to be a high degree of consensus that the products are good but much debate over how they are produced. In the case of moral reasoning, the quality of both the products and the processes is questioned.

SUMMARY

This paper has described two issues in the area of critical thinking in need of research: the generalizability of critical thinking principles and strategies, and the evaluation of critical thinking ability. Questions surrounding both issues are diverse and difficult. Researchers with widely varying interests should be able to find something challenging and stimulating to study. I have emphasized inductive inference ability in this paper because of its central role in thinking critically, and because of the difficulty and diversity of the problems surrounding it. Specifically, I have addressed two

major topics, the generalizability of strategies and principles of inductive inference making and appraisal, and the evaluation of inductive inference ability. Progress in each area requires considerable conceptual and empirical research, suggesting roles for philosophers, psychologists, and subject matter specialists. Cooperative research work could hardly be focused on a more pressing educational concern than the teaching of critical thinking.

NOTE

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Das Erlernen des kritischen Denkens, seit Langem schon als ein wichtiges Ziel der Erziehung anerkannt, wird endlich in Schulen, höheren Lehranstalten und Universitäten ernst genommen. Gemäß den Aussagen von Robert Ennis schon vor zwei Jahrzehnten, sollten dennoch weitere Untersuchungen durchgeführt werden über Fragen die noch der Antwort warten. Diese Abhandlung konzentriert sich auf zwei Bereiche die noch untersucht werden müssen; erstens auf die allgemeine Anwendbarkeit des kritischen Denkens und zweitens auf die Bewertung der Fähigkeit kritisch zu denken. Einige der begrifflichen und auf Erfahrung beruhenden Untersuchungen die auf diesem Gebiet durchgeführt warum das Wissen von Philosophen, Psychologen und Experten auf diesem Gebiet nötig ist um diese Arbeit zum Erfolg zu führen.

La enseñanza del pensamiento crítico, considerada en el pasado como una de las importantes metas de la educación, empieza finalmente a considerarse seriamente en las escuelas, los colegios y las universidades. Sin embargo queda mucha investigación por llevarse a cabo acerca de los puntos a los que, hace veinte años, Robert Ennis hubiera querido tener contestación. Este artículo estudia las dos cuestiones sobre las que la investigación debería volcarse: la posibilidad de generalizar el pensamiento crítico, y la evaluación de la habilidad a pensar de manera crítica. El autor indica algunos de los trabajos teóricos y empíricos que el estudio de estos temas requiere, y cree que se necesita la competencia de filósofos, psicólogos, y especialistas del tema para llevar a cabo un trabajo bien hecho.

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