

Knowledge and question asking

Rafael Ibáñez Molinero and Juan Antonio García-Madruga
Universidad Nacional de Educación a Distancia

The ability and the motivation for question asking are, or should be, some of the most important aims of education. Unfortunately, students neither ask many questions, nor good ones. The present paper is about the capacity of secondary school pupils for asking questions and how this activity depends on prior knowledge. To examine this, we use texts containing different levels of information about a specific topic: biodiversity. We found a positive relationship between the amount of information provided and the number of questions asked about the texts, supporting the idea that more knowledgeable people ask more questions. Some students were warned that there would be an exam after the reading, and this led to a diminishing number of questions asked, and yet this still did not significantly improve their exam scores. In such a case, it seems that reading was more concerned with immediacy, hindering critical thinking and the dialog between their previous ideas and the new information. Thus, question asking seems to be influenced not only by the amount of knowledge, but also by the reader's attitude towards the information.

Conocimiento y formulación de preguntas. La capacidad y la motivación para preguntar son, o deberían ser, algunas de las metas más importantes de la educación. Por desgracia, los estudiantes no suelen hacer muchas ni buenas preguntas. El presente trabajo analiza la capacidad para preguntar en alumnos y alumnas de Educación Secundaria y su dependencia del conocimiento previo, utilizando para ello textos con diferentes niveles de información sobre un tema específico: la biodiversidad. Hemos encontrado una relación positiva entre la cantidad de información proporcionada y el número de preguntas realizado sobre los textos, apoyando este resultado la idea de que las personas con más conocimiento preguntan más. Algunos estudiantes fueron advertidos de que habría un examen después de la lectura de los textos, y esto llevó a una disminución del número de preguntas que hicieron, aunque no tuvo influencia en su desempeño en ese examen. Parece que la lectura en ese caso estuvo más orientada a lo inmediato, dificultando el pensamiento crítico y el diálogo entre sus ideas previas y la nueva información. Por tanto, la formulación de preguntas parece estar influenciada, tanto por la cantidad de conocimiento, como por la actitud del lector hacia la información.

Asking questions is one of the most characteristic expressions of curiosity and creativity. It requires finding a problem, determining the information that you need and verbalizing that necessity to another person. This phenomenon has been studied from different fields: creativity (Corbalán et al., 2003; Shumakova, 1992), comprehension (Graesser, Lu, Olde, Cooper-Pye, & Whitten, 2005; Pascual & Goicoetxea, 2003), social development (Baldwin & Moses, 1996), reasoning (Graesser, Baggett, & Williams, 1996), education (Pedrosa de Jesús, Almeida, Teixeira-Dias, & Watts, 2006; Van der Meij, 1990), etc., as well as its connections to intelligence, socioeconomic status and academic achievement (Berlyne & Frommer, 1966; Zimmerman & Pike, 1972).

There are two points of view regarding this topic in education (Graesser & McMahan, 1993). The first, more optimistic but with weak empirical support, maintains that students are good question

askers, and use questions to overcome gaps and inconsistencies in their knowledge. The second one draws a more negative conclusion: Teachers have the monopoly of questions in class, and students don't ask frequently enough, posing an average of one question every six hours, which means one question a school day (Dillon, 1988). Moreover, they are usually *shallow* questions (for instance: What does that word mean? or Who discovered America?) rather than high-level questions that involve inferences, quests for a deeper understanding of problems and explanations of how things work (Flammer, 1981).

One reason for this deficit is social obstacles. Asking questions implies a price, like showing one's own ignorance and laying oneself open to ridicule if the question is not appropriate. Moreover, the teacher is usually not regarded by the student as a good source of information when compared to classmates and textbooks. Therefore, it only takes a few months of school for an inquisitive child to stop asking questions. However, this decrease of spontaneous question asking contrasts with the increasing capacity to pose them if it's explicitly required (Shumakova, 1992). It has long been known that older children can ask more and better questions (Stirling, 1937, cited in Berlyne & Frommer, 1966). We think this result may extend to adults, as inquisitive ability is

based on the amount of knowledge people have, not simply age. That is our first hypothesis: more knowledgeable people can and do ask more, according to the claim that knowledge, curiosity and creativity are closely related (Ibáñez, 2007).

The research with adults supports two additional views concerning the connection between knowledge and question asking. The first poses a negative linear relationship; that is, ignorant people ask more (Flammer, Grob, Leuthardt, & Lüthi, 1984; Fuhrer, 1989; Smith, Tykodi, & Mynatt, 1988, cited in Van der Meij, 1990). How is that possible? A few answers to this question have been attempted. For example, someone with sufficient amount of knowledge is probably able to deduce the rest of the information required (Loewenstein, 1994). Furthermore, when knowledge in a field is sufficient, it is hard to find someone who deserves being the target of our questions.

The second line of thought proposes an inverted U-shaped relationship, with an optimal amount of knowledge required for question asking. Miyake and Norman (1979) in a classic field experiment endorsed this view, arguing that knowing too much can be as counter-productive as knowing too little.

We have tried to modify the amount of knowledge in order to see its influence on the number of questions asked, instead of assessing the knowledge of subjects in a certain topic, or developing a formative task (as Miyake and Norman did). In the present study, we used texts with different levels of information about a subject that the students had not seen in early courses: biodiversity. We have assessed, not spontaneous questions, but the capacity of asking and its dependence on prior knowledge.

In addition to previous knowledge, we wanted to test the effect of the instructions on memory and question asking. With this aim, some groups were told just to understand what they were reading, while the other group was advised that after reading the text they would have to pass an exam about the presented material. The hypothesis was that the latter condition would lead the students to face the text with the intention of remembering it as it was presented, with a less critical eye, without posing doubts and without looking for problems within the text. Learning in this way would be more concerned with immediacy and, thus, would hinder the rising of questions.

But it was possible that, though the group warned about the impending exam made fewer questions, they would be better ones. In order to rule out this possibility we performed a qualitative analysis. Instead of using a more complex taxonomy of questions like those shown in Van der Meij (1990) or Guilford (1956, cited by Arlin, 1977), two simple criteria were used: depth and whether the answers were in the text or not.

In summary, we propose that question asking is affected, by both the amount of knowledge and the attitude towards information.

Method

Participants

The experiment was carried out with 109 students in the fourth grade in Obligatory Secondary School, with an average age of 15.4 years old (from 14.2 to 17). All of them studied in high schools at the province of Córdoba, Spain.

Design, materials and procedure

The chosen topic of the texts was biodiversity, which participants had never studied before, and therefore they had little or no

previous knowledge at all. Participants were randomly assigned to four groups. Groups 1 to 3 received different kind of texts. Group 1's text (group with irrelevant information) was about Cervantes' life. Group 2 (group with partially relevant information) read two texts, each one was half the length of those of the other groups: one was about biodiversity, and the other about Charles Darwin's life. Group 3 (group with fully relevant information) read the complete text about biodiversity. All texts were approximately 800 words long, whereas the two texts of group 2 were each about 400 words long (texts are available at reader's request to the authors).

There was also a fourth group in which participants received the same text as group 3 but a different kind of instruction: In addition to the directions that one should carefully read the text, as in group 3, group 4's participants were informed that they were going to take an exam on the content of the text after the reading. That is, subjects in group 4 were the only ones to know about the exam even though all groups passed it.

Groups 1, 2 and 3 received the following instructions:

Read carefully the following text in order to fully understand it.

Instructions for the group 4 were:

Read carefully the following text in order to fully understand it.

After the reading, you will answer some questions about it.

After reading the texts, which took about 10-15 minutes, they were removed and students were asked to write as many questions as possible on biodiversity.

Once this phase was finished (it took 10 minutes), the sheets of paper with their questions were removed and an exam about biodiversity was distributed. It consisted of 12 multiple-choice questions (the exam is available at reader's request to the authors). Instructions warned that wrong answers would reduce their score.

The whole process took about 50 minutes.

Data analysis

All analyses were performed using the SPSS version 17.0 for Windows software package. One-way ANOVAs were used to compare groups 1 to 3, with the HSD Tuckey for post-hoc comparisons. Groups 3 and 4 were compared using the Student's t test for independent samples.

Results

Figure 1 shows the means and standard deviations of the number of questions asked and the exam score, assessed with the usual formula for multiple-choice tests: correct answers minus the number of (mistakes / number of alternatives), and this was converted into a 0 to 10 scale.

Two analyses of variance were carried out in order to test the significance of the differences in knowledge between the three first groups (amount of relevant information of the texts). The effect of knowledge was statistically significant in exam scores, $F(2,78)=8.08$, $p<0.001$, $\eta^2=.17$. The significant differences were between groups 1 and 2 (Mean difference, 1.51; HSD Tuckey, $p=.03$) and

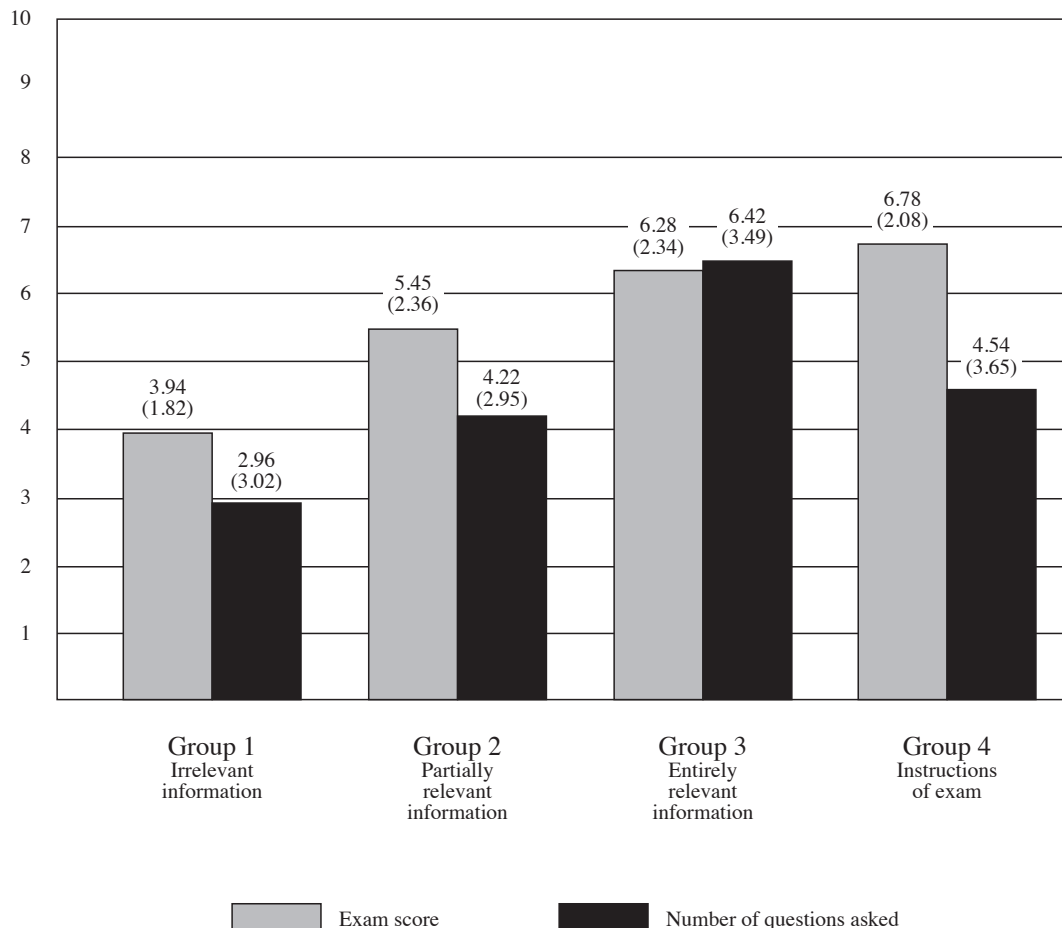


Figure 1. Means and standard deviations (in brackets) of the exam score and the number of questions asked

between groups 1 and 3 (Mean difference, 2.34; HSD Tuckey, $p < .001$). The effect of knowledge was statistically significant too in the number of questions asked, $F(2,78) = 8.23$, $p < 0.001$, $\eta^2 = .17$. The significant differences were between groups 1 and 3 (Mean difference, 3.46; HSD Tuckey, $p < .001$) and between groups 2 and 3 (Mean difference, 2.20; HSD Tuckey, $p = .03$). Apart from confirming the obvious finding that a previous reading of a text improves the learning, the results support the claim that the amount of information on a topic, at least at low levels, is positively correlated to the ability to ask questions about it.

In order to evaluate the effects of the instructions on exam and question asking scores we carried out two t-tests. With regard to the exam, although group 4 scores are slightly higher than those of group 3 (6.78 and 6.28, respectively), there were no significant differences between them ($t = -.82$, $p = .42$, $\eta^2 = .01$). However, the questions asked by subjects of group 4 were significantly fewer than those posed by subjects of group 3 (4.54 and 6.42, respectively, $t = 1.94$, $p < .03$, one tailed, $\eta^2 = .07$). It seems that knowing that they had to answer some questions about the text inhibit, to some degree, their own ability to ask.

But, is it possible that, although the students of group 4 asked fewer questions, were the questions they did ask better and more meaningful? In order to answer this, we analysed the questions in a qualitative way.

Two criteria were used to assess the qualitative difference of questions: depth and whether the answers were in the text or not. With regard to the first criterion, we distinguished between superficial and deep questions, in the same vein as Chin and Brown (2000) and Pedrosa de Jesus et al. (2006). The first relates to information about the meaning of a concept (for instance, What does biodiversity mean? or What is a starling?), or about certain data (for instance What is the percentage of birds threatened by extinction in Europe? or Is the FAO part of the UN?). Deep questions, on the other hand, ask for information about the relationship between concepts or facts, like cause and effect (for instance, Why is the number of crops declining in Spain? or Do weather changes affect biodiversity?) and hypothetical situations (like Why don't states work together to solve this problem? or What would happen if more species became extinct?).

The second criterion considered whether or not the questions were already answered in the text. For instance, «Which European country has more biodiversity?» is a question answered within the text, whereas «Are reptiles also in danger?» is not presented.

Table 1 displays the differences between groups using the percentages of deep questions and questions answered within the text with respect to the total amount of questions posed

Two analyses of variance were carried out in order to test the significance of the differences in the percentages between the first

three groups. There were no significant differences neither in the percentage of deep questions: $F(2,78) = .65, p = .53, \eta^2 = .02$, nor in the percentage of questions answered within the text between groups 2 and 3 (remember that group 1 had no access to the text about biodiversity): $t = -.35, p = .73, \eta^2 = .002$. Therefore, it seems that the amount of information given didn't affect the quality of questions asked.

In order to check the effects of the instructions on the types of questions, we carried out two t-tests. There were no significant differences between groups 3 and 4 neither in the percentage of deep questions ($t = .06, p = .95, \eta^2 < .001$), nor in the percentage of questions answered within the text ($t = -.78, p = .44, \eta^2 = .01$). Thus, the instructions affected the total number of questions asked, but they didn't affect their quality.

Table 1
Percentages of deep questions and questions answered within the text for each group

	Deep questions	Questions answered within the text
Group 1. Irrelevant information	45	-
Group 2. Partially relevant information	66	18
Group 3. Entirely relevant information	54	21
Group 4. Entirely relevant information with instructions of exam	54	28

Discussion

The method of presenting texts with different levels of relevant information in order to manipulate the subjects' knowledge about a topic has led to interesting outcomes. We have found a positive relationship between knowledge and question asking, supporting the view behind the claim that the more knowledge people have, the more questions they ask. There is a minimum amount of information needed to be sensitive to gaps, incoherencies, ambiguities, etc. in it. And it seems that this sensitivity increases with knowledge. This relationship may be the expression of a more general one, between knowledge and curiosity. Loewenstein (1994), due to his gap theory about curiosity, claims that as people become more informed about a certain field their attention is attracted to gaps in the information. For instance, if someone knows the name of only three of the fifty American states, his attention is focused on what he knows. But if one knows the name of forty-seven states, it's more probable that he focuses on what he ignores, labelling his state as «ignorance of three states».

However, we can't conclude with too ambitious a generalization because the levels of knowledge we have assessed are quite low. It may be that, in this case, an increase in knowledge leads to an increase in the number of questions asked, but this cannot be assured when subjects become more knowledgeable. There may be a maximum point within the function after which the ability to ask decreases after knowledge surpasses a critical point. It is possible that the levels we have studied were part of the initial rising zone of this inverted U-shaped function.

The hypothesis about the optimum point of knowledge has been presented in the fields of creativity (Runco, 1994) and curiosity

(Berlyne, 1976), two of the main fields where question asking has been studied. And taking for granted that creativity and curiosity are expressions of mental plasticity, we could pose a more general question about the relationship between the amount of knowledge and its flexibility and openness to change. Can knowledge, to a certain point, hinder the ability to discover new possibilities or to inquire into that which one does not know? It is well known that too much knowledge can cause a «tunnel effect» in problem finding, and can lead to stereotyped strategies in problem solving (Basadur, cited in Runco & Nemiro, 1994, p. 238). Our prior knowledge, necessary in one sense, can limit and blind us in other ways. In this sense, there seems to be a pair of opposed tendencies. One needs a complex knowledge in order to find out anomalies and gaps in it, which favours question asking, but, on the other hand, as this complexity grows, the structure could become more rigid.

We can't answer these abstract problems from the results of this study because, as we have said, the levels of knowledge employed may have been too low. Moreover, it seems that the amount of knowledge is not the only factor that affects question asking. Another important factor is one's attitude towards information. An interesting result has come from the comparison between the groups that were given different instructions. It seems that the students of group 4, who were advised that they had to take an exam after reading the text changed their way of facing it, and therefore seems to have led them to ask fewer questions. Why? Our explanation is that the instructions in this group guided the reading toward a literal assimilation of the content, where the aim was just to remember it as well as possible. This leads to an acceptance of the information as it is presented, with a lower level of criticism and questioning. In order to raise doubt, contradiction or reflection, it is necessary that the reader link what he/she is reading with his/her previous assumptions or preconceptions. In fact, without that dialectical relationship between the reader and the text, it is hard to talk about real understanding (García-Madruga, 2006). The mere knowledge of the impending exam reduced the number of possible idea associations, hindering the awareness of deficits, ambiguities and contradictions, leading to the inhibition of counterfactual thinking, which overcomes the actual, confronted with the possible. Of course, this explanation doesn't derive directly from the data obtained and should be assessed in further studies.

The analysis of the types of questions asked aimed to rule out the possibility that the subjects of group 4 asked fewer but better questions, that is, deeper ones and questions not explicitly answered in the text. We didn't find that trend, regardless of how much information given might have had an influence (groups 1 to 3): there was no difference in the quality of questions asked. Therefore the number of questions posed proves to be sufficient criterion for analysis.

We can find some limitations in the present study, and also possible improvements. We have taken for granted that the students' knowledge on the topic, biodiversity, was scarce if not null before the experiment. Their previous knowledge was not assessed here, however, which may have biased the results, even though the random placement into the groups certainly weakens this effect. Previous interest on the subject may have also affected the results, and this was not evaluated either.

The narrow range of the amount of the information given is another issue that prevents the extraction of more significant conclusions.

Moreover, we must remind ourselves that we have assessed the ability for asking, not the intrinsic motivation to pose questions that stem from actual curiosity, which would presumably result in quite valuable information.

The test made up of twelve questions was given just after participants stopped reading and writing questions. It would be very interesting to repeat the learning assessment after a longer period of time to see the effect of the amount of information and whether the instructions had an effect on long term memory. It is plausible that the instructions that advise the students of an impending exam could result in worse learning in the long run.

In summary, in this paper we have seen how the quantity of knowledge and the attitude towards information affects the ability of question asking. We have taken for granted that this is a positive aptitude that we should cultivate in our students if we regard education as an improvement of thinking abilities, rather than a simple dispensing of information.

The effect of instructions on inquisitive behaviour found in this experiment, though weak, seems to warn about the risks of the bad use of evaluation in education. Orienting the attention of the students to exams, tests and grades, could lead to more rigid and less critical learning.

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