The influence of word processing on the cognitive functions of young EFL learners

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The experiment described in the article has been carried out with young learners of English so as to determine the effects of using word processing on the cognitive and metacognitive activity of these children. The research is based on a collaborative approach in which pairs of pupils had to carry out a writing task in English as a Foreign Language. The verbalizations of the two children involved in the task with only one child using the keyboard and the mouse were recorded during their work, and the performance of the child holding the mouse and typing was compared to the other child. The analysis of the variations made it possible to estimate the degree of cognitive overload in relation to the use of the computer and the benefits of a cognitive tool for weaker children. The study first focused on the control of the mouse and how this control was established. It then examined the relation between the technical management of the mouse and the degree of cognitive and metacognitive activity. The experiment suggests that manipulating the mouse does not create a particular cognitive overload but that it impairs collaboration and sociocognitive conflicts favourable to reflection.

KEYWORDS: young EFL learners, word processing, cognitive overload, mouse control, collaborative task
Introduction

Research on collaborative writing conducted with EFL learners has proved positive. It has shown that, when engaged in explaining and defending their ideas to their peers, learners develop reflective thinking. This process may even be enhanced by the kind of pairs formed. Collaborative writing may encourage what Donato (1994) terms “collective scaffolding”. Furthermore in such tasks, technologies are recognized as having potential to support writing. Past and recent research has studied the way the writing process (planning, transcribing and editing) can be modified and facilitated by the use of word processing. Computer-aided writing may ease text production, a scaffolding process which is called “procedural facilitation” (Bereiter & Scardamalia, 1987). Nevertheless, there are great differences between the abilities and skills of expert and novice writers and using the computer may not be felt as a support by the latter. The aim of our study is to focus on the technical aspect of writing so as to measure the effect of cognitive overload brought about by the technical manipulation of the mouse and typing on the keyboard at an early stage of EFL learning.

1. Theoretical background and hypotheses

Our research is based on Vygotsky’s sociocultural theory. Cohen (1994) quoted by Bourgeois & Nizet (1997, p. 172) builds upon this theory to explain that peer interaction will favour strong working relations and develop a sense of responsibility among pupils. The aim of collaborative work is to make learners work in groups small enough so that each one is given the possibility of participating in a collective task that has been clearly defined. Moreover, the learners are supposed to carry out the task without the direct and immediate supervision of the teacher”. (our translation)

According to Lebrun (2002, p. 151), peer interactions lead to cognitive progress as long as they allow for a social opposition of answers or points of view around a common task. This improvement can be explained through three main arguments (Mugny & Carugati, 1991). Cooperation is a source of change of perspective which allows each participant to realise that answers or points of view may differ from his/her own. Each one provides a different piece of information that can be put together and form a different answer. Cooperation engages each subject in a social relation with others. The problem is first and foremost social and sociocognitive instruments are only developed in so far as they allow the participants to establish a social balance.

Thus the conflict is twofold: it is social because it is a disagreement between individuals, it is also cognitive because the disagreement concerns the way to solve

1 “[...] faire travailler les apprenants en groupes suffisamment restreints pour que chacun ait la possibilité de participer à une tâche collective qui a été clairement assignée. De plus, les apprenants sont censés réaliser la tâche sans la supervision directe et immédiate de l’enseignant”.
the cognitive task. Several methods for collaborative and cooperative work have been developed during the last twenty years. We have chosen Cohen’s model (1994) because it was developed as an answer to heterogeneous classes. Its aim is to introduce team work to stimulate individual involvement and responsibility. Her method, Complex Instruction, is efficient to facilitate the understanding of abstract concepts, develop high-level cognitive skills (hypothesizing, categorizing, deducing skills ...), help the pupil process information and finally improve oral communication.

All cooperative methods work along the same principles which were applied in our research. The teams must be composed of heterogeneous groups of 3 to 5 pupils (in our case, we formed pairs because of the age of the pupils), the members of the group have to work together to carry out a common task, direct communication is necessary and the task cannot be carried out by one pupil.

The technical aspect of collaborative work is based upon the use of word processing in writing tasks. Researchers such as Anis (1998) or Crinon & Gautellier (2001) have described the positive impact of word processing on the quality of texts as much as on the cognitive processes and more psychological aspects like motivation. They unburden the cognitive process by taking on certain functions such as calligraphy. As a consequence, the writer may concentrate on more complex tasks. It also improves the layout and visual presentation. The good quality of the produced document provides a positive image of his/her work and helps build his/her self-esteem and confidence. This feature, inherent to word processing, has made it a valuable tool in school writings, poems, posters or school journal.

It has become the most commonly used software in education because it also helps pupils sort and sequence their thoughts and ideas thanks to its copy/paste function. In addition, it is particularly useful when it comes to organizing notes into final texts, and it allows young learners to engage in the revising and improvement of their work throughout the writing process. These characteristics make it a helpful means for an introduction to the written language. “Writing is not only a graphic competence, it is first and foremost a language competence. We write in order to remember, to sort out our ideas, think or hold an asynchronous communication. [...] Besides the use of the computer would allow young learners to explore written language just as they explore oral language, by trial and error [...]”. (Crinon, 2001, p. 108, our translation).2

This may be contradicted by the concept of cognitive load related to the structure of cognitive architecture as developed by Sweller (1988). According to his studies, human cognitive architecture is composed of a long-term memory which can hold a large quantity of information and a working memory which has a limited capacity. “Human cognitive architecture includes a large store of information held in long-term memory that coordinates our cognitive activities. A very limited

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2 “Car écrire n’est pas seulement une compétence graphique, c’est aussi et surtout une compétence langagière. On écrit pour se souvenir, mettre de l’ordre dans ses idées, réfléchir ou entretenir une communication différée. [...] Utiliser ainsi l’ordinateur permettrait en outre aux jeunes enfants d’explorer le langage écrit tout comme ils explorent la parole [...]”.
working memory tests the effectiveness of small variations to long-term memory with effective variations altering long-term memory while ineffective variations are lost. Both an existing genetic code and information in long-term memory provide a central executive that guides behaviour” (Sweller, 2004, p. 9).

The long-term memory contains among others a great number of automated schemas. The essential factor determining expert performance appears to be schemas. “A schema is defined as a mental construct permitting problem solvers to categorise problems according to solution modes” (Sweller, Chandler, Tierney, and Cooper, 1990, p. 176). Schemas enable experts to categorise problems and consequently to solve them. Novices, on the contrary, do not possess schemas which makes them unable to categorise problems. Consequently they have to engage in general search techniques which overload their working memory. Besides, recent research (Bétrancourt, 2005) shows that some technologies used do not favor learning, in fact they may represent an obstacle to learning. Indeed, during complex activities, the amount of information processed may overload the capacity of the working memory and slow down the learning process.

Thus, the use of word processing, especially by weaker children considered as novices, i.e. children who have not yet developed low-level routine procedures, may induce a cognitive load for these learners when engaged in a writing task in a foreign language. The experiment is based on the hypothesis that controlling the mouse in a writing task may impair cognitive and metacognitive activities. It focuses on the relation between the technical aspects of word processing and the degree of cognitive and metacognitive activity. The question the study posits is whether young children are capable of developing linguistic skills, social skills and technical skills simultaneously when carrying out a task.

2. Research questions and methodology

In order to test our hypothesis, we conducted an experiment in a French primary school in winter 2009 using qualitative methodology. Three sessions of EFL writing were conducted with one CM1 class corresponding to year 5 in the French primary school system (a total of 30 children between 9 and 10 years old). The children had to write a recipe of their own in English, as part of the final task involved in a webquest. In order to carry out this task, the children were first categorised according to their personal and social skills, their linguistic skills and their more general skills. The three categories were then labelled level 1, 2 and 3, 3 being the lowest skill level. Pair composition was monitored so as to include equal-ability pairs and different-ability pairs. As Hooper & Hannafin (1991) point out, pair composition should avoid putting together two level 3 children or one level 1 + one level 3 children because such combinations do not generate enough interactions to have an effect on learning. This is the reason why such pairs were not made up.

The task the children had to carry out was a webquest, adapted to their age and divided into two different phases: first, during a reading task, they had to find the food vocabulary on a preselected website; they then had to use this vocabulary to write a recipe of their own in English. Their written production was prepared by the reading task and the writing was done on the computer. The writing
task required using pictures to illustrate the recipe, so some technical problems arose when they tried to copy/paste the pictures. Each pair of children shared one computer and it was left to the pupils to decide who should use the mouse and keyboard. Their interactions in front of the computer were recorded and analysed so as to verify whether the typing activity was compatible with reflexion and metacognitive activity in a collaborative task.

3. Analysis of interactions

3.1 The control of the mouse

The first part of our study focused on the control of the mouse. We wanted to find out if there was a direct relation between the level of the pupil and the control of the mouse. Who took control of the mouse? What did this control imply on the relations between the children and decision-making?

In all cases, i.e. 15 pairs, except one, there were no negotiations as to who was going to hold the mouse. Holding the mouse was decided without open discussion, and this decision couldn’t be explained by the children when interviewed at the end of the sessions.

In the last pair, the decision was made quickly as can be seen in the following short conversation:

Thomas: She is 7.
Valentin: 7, will you write it or shall I?
Thomas: Ok, go ahead.

Notwithstanding, we tried to find a regular pattern to explain this phenomenon. The following table indicates who took hold of the mouse (name underlined).

The skill level is indicated by H = higher level, L = lower level.

<table>
<thead>
<tr>
<th>Same sex, different level</th>
<th>Same level, different sex</th>
<th>Different sex and level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pierre (H) and Grégory Audo (H) and Léa</td>
<td>Alban and Cindy Jamel and Marlène</td>
<td>Lucile (H) and Mathieu Quentin (H) and Lisa</td>
</tr>
<tr>
<td>Margot and Fiona (L) Thomas and Valentin (L)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Children holding the mouse

We didn’t include the same sex and same level pairs as no criterion could be determined and the conversations didn’t give any clue as to the choice of the mouse holder. Physical proximity is not an explanation as several took hold of the mouse despite the fact they were seated far from it. Among different ability pairs, we had hypothesized that the mouse would be controlled by the four higher-level children. Four pairs fitted this pattern; two of them gave the mouse to
the lower level child. Among same ability and different sex pairs, the mouse was controlled by the girl. When both levels and sex were different, the higher level child took hold of the mouse, respectively a boy and a girl. Holding the mouse was in some cases felt as a privilege and sharing it became a source of discussion, sometimes quite harsh. Alban, for example, is concentrated on counting the words they have to type:

Alban: I know, I have done this, this and that. You will do this, this and this one at the bottom. You still have a lot to do. (later on): For the verbs, you will do the other two, because I have done (he starts counting them up).

Diana and Adeline have done the same in a very precise way:

Diana: Ok, so you’ll do three, because I have done three.
Adeline: Ok, this is my last one, I don’t care, I counted them up.

In some cases, sharing the mouse is not accepted by the partner, and keeping count is hard:

Benjamin: Right, then you can do ... that’s it, you can do... but from here, I’ll do it.
Hugo: No, please wait, not yet.
Benjamin: One, two, three, I’ll only have three!
Hugo: Ok, go ahead.
Benjamin: One, two, three, four. One, two, three.
Hugo: Ok, your turn.
Benjamin: Apple, you did that one too. Four!
Hugo: Ok.

The recordings allowed us to understand that the holder of the mouse feels entitled to hold it and he will make his partner fight for the mouse all the time. For example, in the end, Hugo will have held the mouse 76% of the time. Aggressiveness develops throughout the exchanges and prevents useful discussions on linguistic matters.

When the children have a different level, the tension is even perceptible especially among boys. Girls share the mouse in a little more pacific way.

3.2 Cognitive load linked to the handling of the mouse

Our next question focused on the relation between typing and the degree of cognitive and metacognitive activity. We wanted to know whether the cognitive load linked to typing or copy/pasting could be perceived in the amount of cognitive and metacognitive actions. In other words, did typing impair any other high-level activity? The cognitive category included utterances about reading, reasoning and control of technology, and the metacognitive category included linguistic, procedural and general utterances. Utterances about collaborative work are not included.
The cognitive and metacognitive utterances of the pairs in front of the computer screen were numbered and cross-checked with the activity of the mouse holder (considered as “writer”). These were then sorted out according to the child level. The following bar chart shows the results.

![Cognitive and metacognitive activity for writer and non writer according to the level](image)

**Figure 1:** Cognitive and metacognitive activity for writer and non writer according to the level

Holding the mouse does not impair the cognitive and metacognitive activity of the writer. It is even surprising to note that the technical manipulation of the mouse seems to foster reflection as if the tool becomes a support to the thinking activity. Besides, there is no sensible difference according to the level of the children which could corroborate the idea that this task is not too difficult at this stage of language learning.

We cross-checked these results with the number of requests for help uttered by the children to know whether holding the mouse would bring cognitive load and prevent the writer from asking for help when necessary. The following chart shows the correlation between the number of requests for help and the writer / non writer position.

![Requests for help by writer and non writer](image)

**Figure 2:** Requests for help by writer and non writer (all children considered)
We had hypothesized that the requests for help would be made by the non-writer who would be liberated from this task and free to think about the difficulties encountered during the exercise. If this hypothesis is confirmed for higher level children, we can notice the low-level children manage to both hold the mouse and reflect. The writer can combine both roles and holding the mouse does not make him/her a mere executor of the task, obeying the non-writer. A more refined analysis allows us to differentiate between cognitive activity and collaboration. Even if the writer can maintain an important level of reflection, it does not imply that he will express his thoughts and discuss with his partner. We could identify a meaningful number of instances when the writer kept control over the task and excluded his/her partner from reflection and thus from deciding on linguistic aspects. This, for us, is the sign of a cognitive overload which prevents the writer from voicing his thoughts and sharing the task with the non-writer. The technical load induced by the IT tool and the cognitive activity induce a high cognitive cost which cannot be taken on by the writer. As a consequence, the non-writer will be rejected from the co-construction of the task. This situation may make them lose interest in the task, this case being most certainly more important among lower level children for whom the cognitive cost is already very high.

We will present the case of pairs composed of level 1 and 2 pupils, then concentrate on the three pairs including a level 3 pupil. The child whose name is underlined holds the mouse and the level is indicated between brackets.

3.3 Link between cognitive load and collaboration

Paul-Simon and Killian (both level 1)

In this high-level pair, Paul-Simon, who is busy browsing through the website and solving technical problems, finds it difficult to impose his views onto his partner. This high cognitive cost prevents him from listening to his partner’s suggestions. That is why he cannot have a high-level reflection and even makes mistakes that have to be corrected by the teacher who confirms that Killian was right. As Killian is constantly excluded from decision-making he turns to the teacher to be listened to and confirmed in his point of view. Quite a large part of the reflection takes place during interactions with the teacher as can be seen in the extract below.

Paul-S. (1): The verb, “mix your salad up”… “mix your”...
Killian (1): Here, it’s “mix”.
Paul-S. (1): No, it’s not the verb, it’s not the verb, this is not the one...
Killian (1): Yes, it’s the verb.
Paul-S. (1): No, Teacher, the verb here, it’s “mix”? It means mix, doesn’t it?
Killian (1): No, it means “blend”.
Teacher: That’s right, it means “blend”.
Paul-S. (1): Well, it’s the same.
Killian (1): Oh, well, not really the same, is it! (he guffaws)
Adeline and Diana (both level 2)

Adeline, as seen throughout the recording, cannot take Diana’s suggestions into account, for two reasons: first she has decided to ignore Diana and interacts with Marjorie, another child next to them, and secondly, she monopolizes writing on the screen. Once again, Diana refers to the teacher to be listened to and find support for what she thinks.

Marjorie I’m not sure about this one. I’m not sure it is the right one. Well, I can tell you this: it isn’t the right one.

Diana (2): So, it’s the other one.
Adeline (2): That’s because there are two words.
Diana (2): We have to go back to... (there is a lot of noise nearby) these guys are really too much... ! Stop, stop, no. Teacher ! (she calls the teacher and tries to prevent Adeline from doing something at the same time). No, click there. Click, nooo, nooo,... That’s not right.

Diana would like to examine the problem of choosing between two terms more in depth, but Adeline who is holding the mouse does not give her time to think.

Adeline (2): That’s the correct word, oh s....

Adeline who is caught up in the writing task does not take time to listen to Diana and think about the meaning of the words. We can suppose that her only care is to finish the worksheet as fast as possible.

Diana (2): There were two identical pictures.
Adeline (2): No, there weren’t!
Diana (2): Teacher, yes, because we can’t find this word, and we don’t know if it’s ... because I think that...
Marjorie: You know, beat, a blow, you know, (she pretends to slap Diana on the face). Adeline (2): No, no...
Diana (2): Oh, what did I do? The picture, we need to find the picture. (Diana erased the picture while she was trying to prevent Adeline from holding the mouse.
Adeline (2): Teacher, we have a big problem, she lost the picture. She lost the picture.
Diana (2): So we don’t know what it is any more.

The technical problem disturbs the reflection and both pupils are concentrated on the loss of the picture. During the rest of the exchanges, we notice that the linguistic problem linked to the choice of the verbs is not evoked anymore; the decision follows what Marjorie said. So, the cognitive overload is also to be felt when the writer does not take his/her partner’s suggestions into consideration.
Quentin C (level 1) et Lisa (level 2)

In this last example, Lisa, who is in charge of typing, cannot answer Quentin’s requests and suggestions. She goes on with her work without paying any attention to her partner’s ideas. This, to our opinion, constitutes a patent case of cognitive overload.

Lisa (2): Don’t touch.
Quentin C (1): Absolutely. She put capital letters? Oh Lisa! Wait, how do we spell this?
Lisa (2): So there...
Quentin C (1): OK? So you’ll use this model because, I think you are going to make a ... You’re a real pain in the neck, Lisa, no capital letter.
Lisa (2): There is one!
Quentin C (1): We didn’t put one there, so why would we put one here?
Lisa (2): Because.
Quentin C (1): Stop, Lisa. You’re a pain in the neck, Lisa, really. OK, I’m writing (Lisa is still laughing).
Lisa (2): No, capital letter, “fruit”.
Quentin C (1): Right, so I’ll write “salad”, oh no, Lisa (Lisa is making strange noises), Lisa! Teacher! I’ve lost two points because of her.

Pairs including a level 3 child

In the four pairs including a level 3 pupil (name underlined), we cannot speak of cognitive overload because, in these four cases, level 2 children verbalize most about cognitive and metacognitive aspects and type on the keyboard. Level 3 children do not show any high level reflexive activity, most of their verbalizations concern quantitative aspects of their work. As can be seen in Jennifer’s case below, they are more focused on the quantity of information to be placed into their worksheet than on the comprehension of what they are copying.

Jennifer (3): I want to add it, we never know, then we’ll have to look at the thing there, right?
Marina (2): OK?
Jennifer (3): But why did she put (muttered word) “family”? We didn’t have to put it, right?
Marina (2): Yes, we had to, because, look, “family”, her family likes that, not her. Here it’s her family, here it’s her. (she points at the screen). […]
Jennifer (3): We put everything, we put everything. […] I feel like putting all this. […] because I haven’t finished.

It can also be noticed that in these pairs, level 2 pupils working with a slower partner have taken their leading role with great seriousness, and have never re-
fused to answer their questions. There is a very high degree of collaboration and tutoring in these pairs. From the following chart differentiating the number of cognitive and metacognitive verbalizations according to the levels, we can notice that the higher level children present the higher percentage of utterances of such reflection.

![Figure 3: Utterances linked to cognitive and metacognitive activity according to the level (all children considered)](chart)

On the contrary, the final record concerning the number of requests for help shows that level 1 children have a strong demand for help, while we could have thought that they would be able to work alone. Here numbers of utterances are used because percentages are too low to show differences.

![Figure 4: Number of requests for help according to the child level (all children considered)](chart)
This is not the case. The requests for help are much more numerous from higher level children. In fact, we can put forward the fact that they have a higher degree of concern for the completion of the task. They try to understand what they are doing, their metacognitive reflection if more important, which is why they need more explanations. They also ask for more technical help. We have extracted some examples that corroborate this.

- **Level 1 pupils:**

  Killian (1): “add” Teacher, “add”, is it a verb?
  Paul-S. (1): “add” no, no, it isn’t a verb.
  Killian (1): What do you know? “include...” Here it is, “cover the blender”.
  Paul-S. (1): Teacher! “add”, “add” is it a verb?

  **Alexandre** (1): *(to the teacher)* Because just now, it was doing the mouse, you know, and then it was doing the hourglass, so ...!
  Quentin (1): We didn’t know what was happening.

- **Level 2 pupils:**

  Léa B (2): *(she left to ask the teacher what is a bagel)* Bagel is a sort of doughnut. [...] But, how do we select the photographs?
  Cindy (2): I had one, two, three. Teacher, we only put the verb.
  Alban (2): The verb, isn’t it?

- **Level 3 pupils:**

  Lastly, we analyzed more precisely the nature of the requests for help among level 3 pupils to venture a comment.

  **Marina** (2) and Jennifer (3):

  Jennifer does not ask for help at all. She only turns to the teacher when she is surprised by the presence of the tape recorder in front of her. Marina is the writer, which would tend to prove that the requests for help are motivated by the level of knowledge and the absence of help her partner can provide.

  **Margot** (2) and **Fiona** (3):

  Fiona formulates only one request for help about the meaning of a word (she is the writer at that time):

  **Fiona** (3): What is, “nd”?
  Teacher: What?
  **Fiona** (3): This, here?
  Teacher: Ah, “second”! the second. It’s her class.
Lucile (2) and **Mathieu** (3):

Mathieu often asks for confirmation that he is on the right track. In fact, he does not have any reflexive activity on his work but only tries to be reassured. He is always the writer when he asks for help:

**Mathieu:** Teacher, we have finished. [...] It’s OK, Teacher, we have finished saving! [...] Teacher, is “oil” spelt like that? [...] Oil, oil, Teacher, we have found oil! [...] Is this good?

Thomas (2) and **Valentin** (3):

It is the same with Valentin who is the writer in half the utterances recorded:

**Miss,** we found it! [...] “Grade”. **Miss!** ... **We found it!** [...] How do we manage with the mis... er... the spelling? and all that? [...] Wait, I’ll call the teacher, if we do this. Anyway, I’ll do this.

The analysis of the requests for help issue by level 1 and 2 pupils showed that they were mostly dictated by cognitive and metacognitive reflection and by technical problems. The small number of requests for help issued by level 3 children does not allow us to correlate both factors. We can only suggest that, as their work is not cognitively demanding, the load is not important. This allows them to call the teacher while they carry out the task.

**Conclusion**

The mouse is taken hold of by any member of the pair, whatever level or sex. The possession of the mouse is the subject of negotiations and discussions all through the task. This indicates that holding the mouse is taking power, which may induce consequences on the collaborative dimension of the task. The different overviews of the verbal data have made it possible to notice that holding the mouse and typing on the keyboard do not facilitate reflection, and consequently hinders collaborative work. The writers keep working but they find it more and more difficult to share their reflection with their partner. There is a real addiction to the tool: it seems impossible for the writer to put down the mouse and think carefully before resuming typing. Many cases of cognitive overload would have been avoided if the writer had accepted this. However, we could also observe that the cognitive reflection of the writer seems to be enhanced by the writing task. It looks as if the writer became the tool used to express the collective thought and that this active role stimulated his/her own reflection. Of course the children who were recorded had a limited practice of word processing and this lack of practice has certainly had an impact on the interactions. To measure more precisely the influence of writing on the screen, a second experiment was conducted with two groups, one using word processing and one using paper and pen. Even with this experiment, we cannot be certain that word processing constitutes a help or a hindrance at this level of cognitive
and linguistic development in such a writing task. What we can say is that written
productions did not benefit from the copy/paste function and that writing with
paper and pen greatly reduced collaboration for spatial reasons. It is obvious
that the computer screen focuses both pupils on the same text whereas writing
on paper prevents the non-writer from seeing properly what the other one is
writing. This certainly does not help the non-writer get involved in the task. This
question of cognitive overload needs to be investigated further, which is in keep-
ing with current research.

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