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# The question of students' autonomy in academic learning when using ICT: Case study in analysing help interactions involving two 9th graders with a visual impairment

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**ABSTRACT**

Research on help-seeking and tutoring has mostly been experimental. Still, identified categories can be found in natural learning situations. The use of Information and communication technologies (ICT) by students with a visual impairment (VI) modifies learning conditions and brings students' autonomy into play. This article aims to present a pilot study involving several research domains: academic help; ICT; visual impairment. New categories associated to help strategies, ICT and visual impairment have been identified using a new methodological approach.

## 1. INTRODUCTION

Research on ICT efficiency for academic learning has demonstrated the complexity of the subject, and that there is no equivocal answer regarding the benefits of ICT in learning. For example, Amadieu and Tricot [3] went over some presumed properties of ICT such as ICT helping learners become autonomous, or ICT enabling to tailor teaching contents to students' needs. They highlighted that these presumed benefits can be observed under specific conditions. Lewi-Dumont [17] brings up the risk of using ICT for every task and stresses that the use of ICT by students with a VI should not be the same as for their sighted counterparts, in inclusive classroom environments. In other words, even if ICT are supposed to enhance autonomy in students with a VI when included in mainstream settings, the presumed advantages of ICT are not automatic.

In this context, after introducing the potential limits and risks of using ICT for students with a VI, we will present a "natural" data collection from students with a VI who are included in 9th grade mathematics lessons. This way, we aim to lay the foundations for an in-depth reflection on the link between autonomy and the use of ICT. First, this work focuses on social interactions in middle school classrooms, but it also contributes to this refection by focusing on learning situations in mathematics lessons.

## 2. LIMITATIONS IN THE USE OF ICT FOR STUDENTS WITH A VI

ICT provide different types of help in mathematics for users with a VI. For example, in middle school, students with a VI use their computer or braille notetaker (braille computer with an integrated refreshable braille displayer) to access, process, exchange information (using USB storage device for example) and to write and produce results (for example when collecting data; using calculator; cut, copy and paste results). Besides, reading functions for navigation in mathematical formulas provide audio access to mathematical expressions. The refreshable braille displayer improves access to information in addition to audio functions (see for example [2]). However, the efficiency of such functions decreases as the complexity of mathematical formulas increases.

Students may need help to complete a task at school using their ICT – help on the task itself. They may also need help using their ICT tools efficiently when processing the task. In both situations, there is always a human behind the tool [30]. For example, on help forums or online encyclopaedia – Wikipedia for example – humans are either processing information implementation or website administration. Indeed, help is always provided by humans when programming the tool, implementing the content or providing postponed answers to questions (e-mails, forums).

### 2.1 Prior knowledge

One of the limitating factors of mediated help-seeking one can use (for history of mediated communication, see [23-24]) is the incapacity to use one's prior knowledge in a specific task [1, 9-10]. This prior knowledge constitutes a first level of intellectual solicitation, which is essential for the acquisition of autonomy in learning with ICT on a notional level. A second level stands for prior knowledge on the tool itself [8, 35, 39], that is on a technical level. Rouet [32] considers that a critical mind-related skill constitutes a third level of prior knowledge. To him, the third level is needed for a rational and independent information search when using ICT. These three levels of prior knowledge (notional, technical and critical) are essential for an independent help-seeker.

### 2.2 Skill belief

Skill belief is considered as another potential limit to academic learning when using ICT. Amadieu and Tricot [3] observed that the new generation which was born in the era of new technologies is not more competent ("digital natives" vs previous generations) in using ICT for academic purposes. To them, students need to be aware that the use of ICT is different in school tasks and in everyday tasks, and therefore, that strategies are different.

### 2.3 Control of ICT skills

The present limit leads students to consider that the skills they have gained when using ICT are sufficient to be autonomous in academic learning. However, the continuous evolution of information sources and the content of these sources make them permanent beginners. The increasing number of ICT devices leads to increasing uncertainty [39]. Regarding learners with a VI, Soiffer [35] highlights the persisting work habits which refrain learners from objectively evaluating the positive interest of new systems.

### 2.4 Utility, usability and availability

On the data content level, the expert student may be led to consider that the piece of information he/she has just obtained using an ICT is useful when it enables him/her to access other pieces of information. Therefore, he/she is aware of the network organisation of data [7]. As far as the inexperienced student is concerned, the piece of information is considered relevant when found in a short time period (ibid.).

Available information from ICT (from internet or local storage devices) does not meet standards regarding its presentation [32]. Consequently, the lack of presentation standards obligates learners to constantly re-learn. This phenomenon creates a lack of usability which might make some information sources unusable, because too much effort would be needed to get the best of them.

And then, Ruf and Ploetzner [33] investigated help availability in a helping system dedicated to academic learning. They observed that visible but not intrusive help significantly increases its use.

### 2.5 Cognitive load

The third levels of mental mobilization for prior knowledge (notional, technical and critical) imply an important cognitive load when learning with ICT. Thus, for example, intelligent tutoring systems (ITS) may divert the student's attention from the task itself – when the task does not consist in learning how to use the tutor itself – and focus it on the use of the tutor itself [11, 31, 34].

When comparing several research projects on distance helping systems, Pélissier [25] points out the need to limit the cognitive load by selecting relevant pieces of information – vs useless information. The use of help would increase if the real task needs were clearly identified. For example, for students with a VI, complex mathematical formulas are difficult to build mentally (fractions among others). The difficulty first creates an important limitation to access this type of content (for a review, see [5]). Second, audio systems, sometimes associated with the students' lack of experience, create an important short-term memory overload [4].

### 2.6 Technical limitations

From a technical point of view, and against the students' will, ICT fallibility is at the heart of students and teachers' concerns. When interviewing students with a VI (from middle school to university), Lewi-Dumont [16] observed that ICT failures may prevent the students from working efficiently (but also among teachers; [18]).

Furthermore, braille computers or notetakers require more manipulation between applications (vs mechanical braille typewriter, like Perkins typewriter). This manipulation creates a cognitive overload (manipulation, memorization of tasks and subtasks) and reduces the tactile access to content when writing and reading (refreshable braille displayers – in both braille computer and notetakers – are, most of the time, limited to 40 characters, and even 32 on one line only).

And then, audio and tactile feedback demands a lot of students' attention [4] so students may not always be attentive during lessons.

### 2.7 Attention limitations

The use of ICT, their complexity and the memorization and organization skills they require have an impact on the students' capacity to remain focused on lessons. Thus, they have to select their focus point (for example, paying attention to the teacher's instructions rather than read them on their ICT). Tricot and Boubée [39] incriminate the lack of usability of ICT and say, for example, that the abundance of applications the students need in order to complete a task may be the reason for their possible distraction during academic tasks.

Despite the technical considerations and the limits we brought up, it is important to note that ICT provide many advantages. For example, the weight and the volume of books is considerably reduced; when mastered, information search is made easier; production, modification and transmission of digital documents is facilitated (vs paper documents); control by a human helper is possible with a control screen. Thus, the balance between the learning project, behavioural aspects, academic and ICT skills and knowledge, and the relation between students and ICT have an impact on students' autonomy when using ICT.

## 3. HELP IN CLASSROOM

### 3.1 Help provided by teachers

At the beginning of the 1980s, there was a turning point regarding help in academic learning. Bruner [6, 41] focused on help provided (or help offerings) to children when learning, and more specifically on tutoring. In parallel to this, Nelson-Le Gall [20-21] introduced a new reflection on help-seeking which was therefore considered as a learning strategy. It was no more seen as a sign of dependency on the helper. The two researchers theorized tutoring functions and help-seeking categories and contributed to drawing a frame concerning help interactions in classrooms.

In the research on tutoring processes, Bruner identified six functions produced by the tutor: *recruitment* (motivation); *reduction in degrees of freedom* (simplification of the task);

*direction maintenance* (keeping the learner "in the field"); *marking critical features* (accentuation of specific features); *frustration control* (putting errors into perspective); *demonstration* (modelling). These functions, chronologically marked on a cognitive level, help the tutee in understanding the task. They have been updated by Topping [36-38] in a model organized into five categories of sub-processes which make tutoring more efficient. These five categories include Bruner's functions of tutoring in the following sub-processes: organisation and engagement, cognitive conflict, scaffolding and error management. Other new sub-processes are associated with communication and affects. Topping's model includes Bruner's functions of tutoring as well as self-regulated components in learning.

### 3.2 Help sought by students

Nelson-Le Gall proposed two help-seeking categories (*instrumental* and *executive*) and considered that only *instrumental* help (aiming to understand the task) is adaptive, permanent and transferrable (vs *executive* help which aims to request the answer). Many studies on the topic support this point of view (see for example [12, 22, 28]. Instrumental help-seeking enables the student to be more independent in academic learning. A third category of help-seeking has been theorised by Puustinen [27]: *confirmation* help-seeking consists in having one's result or strategy confirmed by a helper. This aims at reassuring the learner.

### 3.3 Help in classroom and ICT

Karabenick and Puustinen [14] dealt with help-seeking together with ICT. ICT-mediated help-seeking is now considered a self-regulated learning strategy (including ICT, intelligent learning environments and online learning systems).

The introduction of digital technologies for academic learning modified habits in the sense that information is always available and that access to information is facilitated [13]. Thus, the dichotomy between information search, previously considered as interaction with a non-human source, and help-seeking, previously considered as interaction with a human source [42] is no longer sustainable when considering the ever-growing use of ICT in learning situations. Indeed, it seems more acceptable to replace the non-human/human dichotomy by a continuum regarding the way the help source can adapt to the learner's need, from non-existent to excellent [30]. If research on self-regulation enabled us, at least partly, to identify factors of efficacy in help-seeking, research on ICT requires to re-evaluate these factors. The capacity to identify and mobilise the appropriate source of help is an important feature for a self-regulated help-seeker [19]. For example, the Internet enables learners to access many more sources of information with better flexibility (time, location, affordable, for example) when attempting to use them [7] than traditional sources (paper).

## 4. METHOD

### 4.1 Choices in data collecting method

In a research on students' help-seeking, Puustinen [28] recommends collecting data from real learning environments. When analysing help sources (both human and non-human), Makara and Karabenick [19] highlight the efficiency of real situations analysis and the limits of exclusive self-report-based methods. Young students (6th and 7th graders) find it hard to express their internal judgments about their learning activities into objective reports [26]. Learners' reports and self-evaluations do not always correspond to their real actions [40]. Regarding students with autistic disorders, Koegel and her colleagues [15] stress the need for varying information sources – when collecting data – including real situation observation and interviews.

So, our study consists in filming the activity of 9th graders during mathematics lessons in a mainstream French middle school. In the same classroom, four students with a VI studied alongside sighted students (24 students in total). The study focused on two of the students with a VI (two were excluded from the research: one of them worked with a teacher assistant, and the other's parents refused the participation of their child). A tutor student was designated by the mathematics teacher to help the two students with a VI (blind and working in braille) who participated to the study. The tutor had this occupation from the beginning of the year, even before the study was organized. She was seated between the two students with a VI. Three video cameras were used to film two mathematics lessons (with individual lapel-microphones and a wide-spectrum microphone to record the classroom activity). One of the video cameras recorded the whole classroom while the other focused on the students with a VI. In this study, we focus on first speaking turns (help offering and help seeking) initiating help interactions. And then, semi-structured interviews were organised with the two students with a VI, the mathematics teacher and the tutor.

During the first mathematics lesson (trigonometry), students were asked to use the sine, cosine and tangent relations using triangles' dimensions. During the second mathematics lesson (geometrics), students were asked to find the nature of a triangle (the dimensions of which could include unknown values) using the Pythagorean theorem and remarkable identities. The students with a VI had the instructions in their ICT but also on paper in braille/tactile pictures (text/drawings).

### 4.2 Limits and bias

Though the small number of participants in this study does not allow us to generalise our results, the qualitative analysis of the data provides interesting results on this small sample.

The mathematics lessons focused on (1) a new concept (trigonometry) and (2) the collective correction (Geometrics; associating the Pythagorean theorem and remarkable identities). We are aware that the help interactions we observed were specific to these learning situations.

## 5. RESULTS

Help-offering is distributed into Bruner's six functions of tutoring (*recruitment; reduction in degrees of freedom; direction maintenance; marking critical features; frustration control; demonstration*). Help-seeking is distributed into three forms (those presented before: *instrumental, executive, confirmation*). Regarding help-offering, we mainly focus on Bruner's functions of tutoring updated by Topping (without including sub-processes of self-regulation – chronologically

viewable after the first speaking turn). Occurrences classified as "other function" (for help-offering) or "other form" (for help-seeking) correspond with help interactions which so far have not been identified in the literature.

The major part of observed help interactions corresponds with categories which have already been identified in the literature – help-offering and help-seeking episodes, respectively being 27 out of 45 and 42 out of 60. Even if functions and forms have been almost exclusively observed in experimental settings in the literature (vs natural learning situations in the present study), it is relevant to underline that identified categories have been also spotted in our study. However, we also need to stress that 18 help-offering episodes out of 60 and 18 help-seeking episodes out of 45 do not correspond to identified categories.

The analysis of data sheds light on other specificities of help interactions. Some functions of help-offering episodes and some forms of help-seeking episodes identified in the literature do not appear in our study. For example, *executive* help-seeking episodes have not been observed. Since *executive* help aims at requesting the answer to a question or a problem without trying to reach the solution on one's own and without effort, we are aware that the presence of video-cameras and microphones may have had an impact on this result.

| **Forms of help-seeking** | **Number of occurrences** |
|---|---|
| Instrumental | 15 |
| Confirmation | 12 |
| Executive | 0 |
| Other | 18 |
| Total | 45 |
| **Functions of tutoring** | **Number of occurrences** |
| Reduction in degrees of freedom | 17 |
| Direction maintenance | 11 |
| Demonstration | 8 |
| Marking critical features | 6 |
| Frustration control | 0 |
| Recruitment | 0 |
| Other | 18 |
| Total | 60 |

**Figure 1.** Occurrences of forms and functions

Regarding help-offering functions, *recruitment* and *frustration control* have not been observed in our study although they have been identified in the literature. Interviews confirm that the two students with a VI were motivated and happy about the mathematics lessons (at least those which were filmed). Also, they said they were aware that errors are part of the learning process and they had no problem admitting it. Relationships between students in the classroom seemed to be friendly and not competition oriented.

The analysis of help-offering episodes in the study shows how involved the helpers were in helping the learners understand the resolution principle (help was provided almost exclusively by the tutor student – 90% of the help episodes were handled by the student vs 10% by the teacher). The help-offering episodes which were proposed by the helpers (*reduction in degrees of freedom; direction maintenance; marking critical features; demonstration*) mainly affect cognitive and metacognitive levels (vs surface level as in *recruitment* for example)

The important level of instrumental help-seeking episodes shows that the students tried to understand the resolution principle of the tasks (probably in order to be able to work by themselves in similar future tasks). However, the significant level of confirmation help-seeking episodes probably highlights a lack self-confidence [29]. The combination of the analysis of help-seeking attitudes with the analysis of the interviews shows that one of the two students with a VI expressed an attitude of impulsivity and lack of self-confidence.

In both types of help interactions (help-offering and help-seeking), the category named "other", which corresponds to non-identified help interactions initiatives, is the most important regarding the number of occurrences. Detailed analysis of these interactions reveals, for both types, that the interactions were associated with information about the resolution principle, organisation in the task or task instructions. It was observed several times that the students with a VI could not access information written on the blackboard (for example, the teacher's correction or sighted students' propositions). So, trouble accessing data made the students with a VI dependent on their sighted peers. For example, one of the students with a VI asked the tutor to read the correction on the blackboard for him, but also, the tutor took the initiative to help him by comparing his result to the answer on the blackboard. During the two filmed lessons, no help-seeking nor help offering was formulated by sighted students in the classroom regarding displayed information. Thus, the proportion of help interactions related to information access is potentially linked to the difficulty, and even incapacity to visually access information. Visual impairment is obviously responsible for the loss of autonomy.

Nevertheless, other non-identified help interactions refer to other subjects; for example, the functioning and use of ICT, the problems when using it, accessibility via visual feedback on a control screen (for the helpers), identification of the task or the way to access it in the ICT, loss of objects. Help-offering and help-seeking episodes classified as "other" in the present study seem to be associated with tools and strategies to access data. For example, a braille notetaker that started very slowly during a mathematics lesson refrained one of the two students with a VI from answering the teacher's question. Students with a VI's limitations in autonomy when organising their work and accessing information sources and data seem to be linked, at least partly, to the use of ICT. Limitations identified in part 2 are confirmed.

## 6. CONCLUSION

Some limitations of help with and by ICT (that is, help in using ICT and help generated by the ICT) have been observed in the present study, which has been undertaken in real learning contexts.

Interviewing the teacher was helpful to understand that the two students with a VI had different prior knowledge. Although they both belong to the "digital natives" generation, skills in ICT were different. Interviewing the students with a VI showed us that the gap between the supposed control of ICT and the effective control in an academic learning

environment may create a limitation of autonomy.

Regarding the utility, usability and availability of information, the presence of a human helper (mainly the tutor) does not enable us to evaluate the autonomy of the students with a VI because some tasks were managed by the tutor. However, it proves the significance of human help in specific learning situations.

The tutor provided the students with a VI with organisational and informational help, but also with technical help. Doing so, she reduced their cognitive load. The help provided is a response to the identified difficulties in using ICT, and to the loss of autonomy.

Although solutions were provided, the technical problems which occurred during the mathematics lessons showed how the use of ICT can restrict autonomy, even for a limited time.

The attention required by ICT, operation problems and difficulties using them show that ICT may also restrict autonomy in learning as long as they are not properly controlled by the user and fully operational.

Theoretical limitations displayed in part 2 were evaluated in the present study. Observations show that a complementary human help is necessary for the students with a VI when using ICT.

The help-offering and help-seeking episodes we filmed highlight some of the concerns and difficulties that students with a VI encounter in mathematics lessons. Results show that we have observed identified help categories. In the meantime, however, we have shown that every help episode does not systematically fit into identified categories.

Few studies have focused on help interactions and disability. Considering the use of ICT in the help process enables to widen this field of inquiry. Yet, so far, research on help interactions has focused on identified categories since the beginning of the 1980's using experimental methods and self-reports but has not involved new categories when using ICT and considering VI.

The diversification of data-collecting methods shows that identified categories do meet every help interaction when students with a VI are involved in mainstream classes. The other categories we suggest in the present study reveal that other types of interaction exist in the classroom, such as those related to data access or ICT management. In other words, help does not only affect the task comprehension level (such as *instrumental* help), but also prior components (data access, organisation help, etc.). Comprehension level together with prior components contribute to the development of autonomy for students with a VI when using ICT for academic learning.

The results of this pilot study need to be confirmed with a larger sample in the future. It would enable the researchers to identify some difficulties encountered by students with a VI when using ICT in mathematics by observing their help offers and requests. These difficulties have an impact on the acquisition of autonomy in academic learning. In spite of the small size of our sample, results suggest several future directions: the awareness of students' ICT skill (and training) levels; the level of autonomy in accessing and processing data; the missions and training of human help.

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