Developing the students' autonomy in middle school: an exploratory study of French science teachers' points of view and the expectations of the school institution

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Abstract

We propose an exploratory study comparing the statements of 4 French science teachers to the expectations of the institution regarding the notion of autonomy with the speech of an inspector in science on: (1) what is an autonomous middle school student in science and (2) on the support a teacher can use to develop it. The analytical framework is mainly based on several dimensions of autonomy in science education. We distinguish between pedagogical autonomy and didactic autonomy and characterize the process of autonomisation a pupil according to different dimensions. The analysis of the 5 interviews involves two scales (mesoscopic and microscopic). The comparative analysis of our corpus reveals major differences between the interviewees in terms of pedagogical autonomy and didactic autonomy.

Keywords

Autonomy, didactics, physics-chemistry teacher, inspector, middle school

Résumé

Nous proposons ici une étude exploratoire comparant les propos de 4 enseignants français de physique-chimie avec les propos d'un représentant de l'institution concernant la notion d'autonomie. Plus précisément nous documentons la vision de l'autonomie en physique-chimie au collège ainsi que les condition/leviers sur lesquels un enseignant peut s'appuyer pour la développer. Le cadre théorique convoqué ici repose sur plusieurs dimensions de l'autonomie tout en distinguant l'autonomie pédagogique de l'autonomie didactique. L'analyse des 5 entretiens est réalisé selon 2 granularités différentes (mésoscopique et microscopique) ; elle met en évidence des éléments de convergences et de divergences entre les interviewés en termes d'autonomie pédagogique et didactique.

Mots-clés

Autonomie, didactique, enseignant de physique-chimie, inspecteur, collège

Introduction

We present here a research work that we conducted in France as part of the Digital Interactions for Teaching and Education project (IDEE project). In this project, the use of digital technology and the development of students' autonomy in different school subjects, particularly science, are central themes. This paper is in line with an exploratory work that aimed to study the points of view of French science teachers in middle school on what the autonomy of students would be (Boilevin et al., 2021; El Hage & Boilevin, submitted)

In the French institutional context, autonomy is explicitly introduced as part of the curriculum of cycle 4 (equivalent of grade 7, 8 & 9) in science. It is considered as a skill with a societal/social issue: "The knowledge and practice of these themes[1] help building the autonomy of the future citizen by developing his critical judgment and instill the values, essential in science, of respect of the facts, responsibility and cooperation" (MENESR, 2020, p. 96).

During the COVID-19 pandemic, in France and abroad, research in didactics on the development of the autonomy of students in science is gradually developing. They respond to an essential social challenge during a global health crisis where distance learning multiplies, most often leaving students on their own.

The research we present here aims to compare the statements of teachers with those of the expectations of the institution about autonomy through the speech of an

1 The topics are: « organization and transformation of matter », « movements and interactions », « Energy », « signals to observe and communicate ».

inspector in science. The results presented here will be used to collect a quantitative survey conducted with French science teachers and inspectors.

This type of questioning seems legitimate to us for several reasons. First, the term autonomy is mentioned in the official French texts (15 times for grade 7; 18 times for grade 8 to 10 and several times in the programs of the high school with variable occurrences according to the paths/areas). Secondly, research in didactics (Boilevin, 2013; Chevallard, 1991) show that there is always a gap, during each didactic transposition, between:

- What the institution (political) thinks and the translation of this concern/ideology into the school programs.
- The programs and their appropriation by the representatives of the institution (inspector, mission head).
- Curricula, institution representatives and reinterpretation/appropriation by the teachers.
- What happens in the classroom (what teachers make of this in their classroom teachings).

Thirdly, the results of our case study can be used to offer teacher's training to develop the learning autonomy of the students who follow a large part of their distance learning with the current Covid crisis.

In the first part, we develop the context and the problem of this study, then we present the methodological framework. Last, we develop the main results that we analyze and discuss.

Theoritical tools and related works

Autonomy: a question of terminology

Autonomy is a generic term which can refer to the autonomy of learning, autonomy in communication, relational autonomy, etc. The concept of autonomy is therefore a general and complex concept; it has been studied in several fields (psychology, philosophy, educational sciences, etc.) and has been defined in different ways. In many publications, the definition of autonomy goes along with different terms (autonomous learning, self-directed learning, self-regulated learning...). This allows a better understanding of what autonomy is but can lead to a confusion with similar terms such as independence, self-training, etc. It is important not to mistake autonomy with independence, withdrawal into oneself and individual functioning in the school setting (De Loof et al., 2019; Quintin, 2013).

Autonomy in education and training

Autonomy is associated with different theoretical perspectives in educational research. Some of these works refer to self-regulation or self-regulated learning (Beizhuizen & Steffens, 2011; Zimmermann, 1989). Other studies rely on the theory of self-determination derived from psychology and the theory of motivation (Deci & Ryan, 2000; Ryan & Deci, 2017) and generated numerous studies around the links between autonomy and learning, including Chirkov (2009) and Niemiec & Ryan (2009). We learn from this research on the theory of self-determination that students tend to learn better, feel autonomous and are more creative when they are intrinsically motivated, especially for tasks requiring conceptual understanding.

In the context of adult training, Guo (2019) postulates that the development of autonomy can be supported when a teacher-tutor is placed in the posture of the one who accompanies and helps the learner to take charge of his learning. Still in the context of adult training, Albero conceives autonomy as a process and "no longer as a global notion, but as a set of specific skills to which it is possible to prepare learners through activities and tasks that they must do" (Albero, 2004, p. 147). This author therefore does not consider autonomy as an entity but distinguishes several areas of autonomy required in a teaching and learning situation (technical, informational, methodological, social, cognitive, metacognitive, psycho-affective). Her work has been taken up in some didactic research aimed at developing the autonomy of students in different school disciplines (El Hage & Maigret, 2022; El Hage & Boilevin, submitted; Gueudet & Lebaud, 2019; Gueudet & Joffredo-Lebrun, 2021; Lebouil et al., 2019).

The autonomy in didactics of scientific disciplines

The emergence of publications shows the interest in questioning the autonomy in didactics of different disciplines, especially scientific (mathematics, physics, chemistry, etc.). Some work in the field of science didactics study the links between autonomy, as a component of motivation, and science learning based on the theory of self-determination (Basten et al., 2014; Black & Deci, 2000; Großmann & Wilde, 2020; Hofferber et al., 2016; Wang & Tsai, 2020; Zhang et al., 2020). The results of this research point to teaching practices that are not relevant to the students' motivation regarding science.

Other research focus on teaching practices, scientific inquiry's in the classroom and autonomy. Ramnarain (2010), for example, conducted a study in South Africa to understand how teachers and their students (13-14 years old) perceive the benefits of conducting independent scientific investigations. The analysis of the data reveals that both teachers and students believe that the active involvement of the learners in the investigations has a positive impact on the learning of science. Three advantages are perceived: it is motivating, it facilitates conceptual understanding, and it leads to the development of scientific skills. A complementary survey (Ramnarain & Hobden, 2015), in the same context, examines the opportunity to move from a teacher-centered to a student-centered approach in the field of scientific investigation.

In France, the research on the autonomy of pupils in scientific disciplines are quite recent. In the case of mathematics didactics, Gueudet & Lebaud (2019) aim to design didactic situations that promote the development of autonomy. This is why they put in contrast two types of autonomy:

- Pedagogical autonomy (PA) which concerns transversal elements of the student's work in all disciplines.
- Didactic autonomy (DA) which is linked to the knowledge at stake.

Science teachers' views on the issue of student autonomy

Robertson & Jones (2013) analyze, among other things, the views of Chinese and American Science teachers in middle school on what autonomy is. According to them, autonomy in science is related to the practical work necessary for the teaching and learning of the discipline. It therefore depends heavily on access to equipment and materials necessary for laboratory activities: "Teacher autonomy is particularly significant in science, because instruction is heavily dependent upon access to space, equipment, and materials needed for laboratory activities" (Robertson & Jones, 2013, p. 1462).

Some of these results can be found in the publication of Le Bouil et al. (2019) which conduct a series of semi-directive interviews with a dozen French Science teachers to analyze their comments on the notion of autonomy in middle school. The results highlight the existence of common points in their definition of the autonomous student such as teacher-learner interactions, as well as on the conditions to enhance this process such as work habits and the clarity of the instructions. The teachers interviewed also point to the specificities of the discipline such as the evaluation of autonomy, cooperation between pupils during practical work, the effects of the material constraints.

For their part, El Hage & Boilevin (submitted) analyze further the study of Le Bouil et al. (2019) by looking at the views of 4 French science teachers, working in different schools, on what is an autonomous middle school student. The results are presented in terms of pedagogical autonomy and didactic autonomy according to the 7 autonomy dimensions proposed by Albero (2004):

- Technical: dealing with technologies.
- Informational: knowledge of the tools of documentary research; searching, storing and restoring information etc.
- Methodology: capacity to organise his/her own-work according to the objectives set etc.
- Social: communicate to learn; cooperate, exchange and share information with others.

- Cognitive: identify clues, create links, compare, discriminate, synthesize, mobilising mental operations (induction, deduction, abduction), anticipate by formulating hypotheses, etc.
- Metacognitive: self-regulated leaning, self-assess the chosen learning process, regulate etc.
- Psycho-affective: regulate his/her own emotions, sharing a global responsibility in learning, etc.

The 7 dimensions of autonomy mentioned above is presented in El Hage & Boilevin (submitted) to analyse the discourse of 4 French science teachers on what an autonomous student is. They highlight the wide dispersion of points of view, whether on the PA or DA side:

- On the pedagogical side, the autonomy of the students seems to be focused and highlights a single invariant between the 4 teachers belonging to the social dimension according to which autonomy requires "cooperation between peers". One of these 4 teachers evoke the use of a word processor, the search for information in a document, the need for pedagogical ritual to understand the functioning of the teacher, the development of strategies to carry out a task as well as overcoming fear, discouragement and reassure him/herself.
- In terms of didactic autonomy, there is a divergence of points of view and any element is common to the 4 teachers. The results essentially highlight the role of research and sorting of information in the field of science (the point of convergence between 2 teachers) as well as cooperation between peers to solve a task in science (the point of convergence between 2 teachers).

Conditions and levers allowing teachers to develop students' autonomy

Little (2007) conducts a research to study the conditions enabling to develop the autonomy of the pupils. To achieve this, he relies on the theory of self-determination (Deci & Ryan, 2000) and finds that one of the levers consists in explaining to the pupil that he is co-responsible in the planning and evaluation of his learning. For their part, Reeve & Halusic (2009) identify other levers such as: adopting the students' point of view, showing patience to allow time to learn, feeding internal motivation resources, providing explanatory justifications, relying on non-controlling language, and recognizing and accepting expressions of negative effect. Furtak & Kunter (2012) classify the help for autonomy in science classes into two categories: support for procedural autonomy and support for cognitive autonomy where students can find multiple solutions to problems on their own. In fact, these categories separate the typical practical work and the "investigative approach" (IBSE)[2] activities, where students' cognitive engagement is more significant.

2 IBSE: Inquiry Based Sciences Education

As for Quintin, (2013) he highlights the essential role of teachers in the ability to provide relevant scaffolding in the pupil's proximal area of development. In the same vein, Berger (2016) distinguishes three levers to develop autonomy: organizational support, procedural support and cognitive support. We find the different levers mentioned in the various researches and quoted above as well as others in a recent synthesis conducted by Patall & Zambrano (2019) which presents and discusses different elements enhancing the development of autonomy such as: (1) letting the pupils make choices and taking into account their contributions; (2) provide explanations or justifications for the personal relevance of the learning; (3) be open and listen to the students' perspectives; (4) accept rather than suppress the negative affect and the resistance of the students; (5) use language to invite and inform, instead of control; and (6) stimulate and integrate the pupils' curiosity and interest in the content of learning.

Concerning El Hage & Boilevin (submitted), they make the distinction between two types of levers, pedagogical and didactic, analyzed according to the 7 dimensions of the process of autonomisation. The results of the analysis of the interviews show that the essential pedagogical levers are those related to the methodological dimension (such as the systematic presentation of the prescribed tasks with the same structuring) followed by 2 levers concerning the social dimension (the organization of heterogeneous groups of students) and the psycho-affective dimension such as the presentation of a usual working environment to reassure the pupils. As for the didactic levers, the main elements identified are:

- Methodological dimension, for instance the support on the spot during a science activity; the organization of activities such as a scientist approach several times a year;
- Social dimension in relation to the composition of the groups of pupils with different knowledge and skills in physics;
- Psycho-affective dimension, like resorting to extrinsic motivation by proceeding for example to the evaluation of the competence "to be autonomous and to show initiative".

In the continuation of this work, this text aims to look at the results found in this exploratory study based on the points of view of some French science teachers and to determine whether the results correspond or not to the expectations of the school institution.

Issues and research questions

We propose in this paper to think of autonomy in the same way as in our previously published texts on this subject to consider autonomy not as a state but as a series of dynamic relational processes taking shape at the interface of the subject and the social. Thus, "autonomy should be considered, in Candy's words, as a process rather than a product" (Candy, 1989 cited by Eneau, 2008, p. 232). This process of autonomisation is considered as a "process that allows the pupil, in a given context and within a system of interactions, to organize his work and mobilize resources (internal or external) to accomplish a given task by possibly developing new means" (IDEE Glossary, 2018). This definition essentially refers to the transversal forms of the process of autonomisation qualified as *pedagogical autonomy* (PA). Following the work of El Hage & Boilevin (submitted) and of Gueudet & Lebaud (2019), we distinguish it from the *didactic autonomy* (DA) which concerns the realization of tasks and the mobilization of specific internal and external resources of disciplinary knowledge. In addition, we use the different dimensions of application of autonomy (technical, informational, methodological, social, cognitive, metacognitive, psycho-affective) introduced by Albero (2004) either to characterize pedagogical autonomy or to characterize didactic autonomy. In Table 1 below, we give for information, for 2 dimensions, examples of conduct expected of autonomous students, distinguishing between pedagogical autonomy and didactic autonomy.

Table 1

Illustration of two dimensions of autonomy introduced by Albero (2004) while distinguishing between PA and DA

Autonomy dimensions	Pedagogical autonomy (PA)	Didactic autonomy (DA)
Technical	Control of the digital technologies and ability to adapt to the diversity of tools and media.	Control of the applications, software, or specific techniques for the acquisition and the processing of data in science.
Methodological	Organization of the work in the classroom and at home. Being able to take into account the different objectives and constraints.	Organization of the work: to be able to choose from different strategies while implementing IBSE.

This theoretical framework clarifying the possible meanings of the term autonomy allows us to study the following research questions:

- How does an inspector, who we consider as one of many representatives of the school institution, define autonomy? What dimensions of the autonomy are privileged?

- What are the pedagogical and didactic conditions & levers on which teachers can rely according to a representative of the institution?
- Are the expectations of the school shared by science teachers?

Methodology

Data collection

This study is based on 4 qualitative interviews with French science middle school volunteer teachers (we will call them: P1, P2, P3 & P4) and an inspector called "I". We note that every teacher works in a different middle school; they all have a minimum of 5 years' experience in teaching. In addition, "I" used to be a science teacher before becoming an inspector; he has been an inspector for 5 years at the time of the interview.

We elaborated the guidelines of the interviews dwelling upon: their university studies, their vision of the student's autonomy, the conditions on which a teacher can rely to develop the autonomy of his students in the classroom. The interviews lasted around an hour and were carried out in the schools expect for "I" (who was present via an online platform). All the interviews were recorded and conducted between January 2020 and December 2020.

Analysis of the data

The analysis of the interviews involves two scales: mesoscopic and microscopic. Different concepts (El Hage & Boilevin, submitted) are involved in the meso and microscopic analysis: facet and notional groups.

First step: treatment of a transcription at a mesoscopic level

All interviews were taped. The 5 transcripts were coded according to the 7 dimensions of autonomy as to whether it belonged to the:

- 'Student-tasks' related to the autonomy process that corresponds to the expectations of the teacher (here are 2 examples: the student should know how to mobilise the physics concepts; the student should be able to carry out a scientific investigation alone);
- 'Teacher-tasks' helping to develop the students' autonomy (here is an example: the teacher must verify prior to the activity involving a digital application in science if it is doable).

To do this, we proceeded by analyzing the content allowing the identification of what the students' tasks and what the teachers' tasks are.

Furthermore, the data were coded according to whether they belonged to a didactic[3] or pedagogical autonomy. Proceeding in this way, we built 2 tables of each interview around the 7 dimensions of PA and DA: table 2a corresponding to the expected behaviors and skills required to qualify a student as autonomous; table 2b showing the conditions on which teachers can rely on to develop the autonomy of their students

TABLE 2A

The expected behaviors and skills required to qualify a student as autonomous while crossing the 7 dimensions with PA and DA

Teachers' expectations behaviors and skills from an autonomous student «student-tasks»		
Autonomy dimensions	**Pedagogical autonomy (PA)**	**Didactic autonomy (DA)**
Technical	P3: «In IT the students used the tablets/Yes/ but not with me, and I wanted to see just how they are doing. How they deal with it by themselves.»	P3: «The student is using by himself the « sky map application », they were doing very well with the tool...»
...		

TABLE 2B

Table showing the conditions on which teachers can rely on to develop autonomy while crossing the 7 dimensions with PA and DA

Conditions on which teachers can rely on to develop the autonomy of their students « teacher-tasks »		
Autonomy dimensions	**Pedagogical autonomy (PA)**	**Didactic autonomy (DA)**
Psycho-affective	P4: «I think that teaching autonomy is also about making students aware of why it can be useful to them and why it can be fun to learn, right».	P1: In the evaluation grid there is a part, a science skill «to be autonomous and show initiative». When they ask me a question, they know that if the answer was given somewhere and that they could have found it without me, they know that they lose points.

Second step: The treatment of a transcription at a microscopic level

This coding at the mesoscopic level is followed by an analysis at the microscopic level

3 For information, the knowledges mentioned by the interviewees concerning physics and chemistry include "sky map application", "oscilloscope", "chemical transformation", "free falling objects", "IBSE", "modeling process in physics".

by defining elements of pedagogical or didactic autonomy; these elements are the size of a simple sentence. We relied on the concept of facet of knowledge (Minstrell, 1992) and named:

- Facet of the autonomy (pedagogical or didactic): any element in the teachers' speech related to the autonomy of the students. Concerning PA: an autonomous student works without asking questions to the teacher.
- Condition to develop autonomy: any element evoking elements on which they can rely to develop PA or DA of the students. Concerning DA: the teacher makes sure that in each group there is at least one student who can help the others in science.

This analysis at the microscopic level in terms of facets versus conditions completes the analysis at the mesoscopic level since the facets versus conditions, pedagogical and didactic, are located within each dimension studied.

Third step: grouping of facets versus conditions by notional group

Following Tiberghien (2012), we grouped facets versus conditions within the same autonomy dimension by notional groups (set of facets grouped around the same idea). In the same dimension, we can have one or more notional groups. Proceeding this way, we then obtained two kinds of tables according to the different dimensions of autonomy, notional groups, facets of autonomy versus conditions to develop autonomy:

TABLE 3A

Analysis of what the teacher expects from an autonomous student under the notional groups

Autonomy dimensions	Pedagogical autonomy (PA)		Didactic autonomy (DA)	
	Notional Groups	Facets	Notional Groups	Facets
Methodological	When and how to solicit the teacher	The student works alone without asking the teacher for help. The student carries out an activity prepared by the teacher soliciting the teacher's help occasionally. The student calls the teacher for help to begin the activity.	When and how to solicit the teacher	If blocked, the student requests a joker from the teacher during the implementation of IBSE.

TABLE 3B

Analysis of teacher-tasks in terms of conditions & levers allowing to develop the autonomy of the students under the notional groups

Autonomy dimensions	Pedagogical autonomy (PA)		Didactic autonomy (DA)	
	Notional Groups	Conditions & levers	Notional Groups	Conditions & levers

Finally, our method of analysis made it possible to answer our research questions relying on the identification of the notional groups evoked by each interviewee and according to the 7 dimensions of autonomy. In addition, to develop these notional groups, we mobilised the facets as a tool for analysing the teacher's discourse.

In the following section, we describe the results obtained by mobilizing our methodology consisting of 3 steps as described above.

RESULTS

There are 2 levels of analysis: the mesoscopic and the microscopic one. The analysis carried out at the mesoscopic level gives access to an overview of the inspector's point of view and makes it possible to compare it with the teachers (El Hage & Boilevin, submitted). We compared what both expect from an autonomous student and the conditions on which teachers can rely to develop students' autonomy in science class.

Then we present, the analysis of the common autonomy dimensions between the 5 interviewed. In another term, we carry out a focus analysis allowing us to look at what is common in terms of notional groups.

Mesoscopic level: what is expected from an autonomous student

To illustrate the results at the mesoscopic level analysis of what an autonomous student is "student task" according to the different PA dimensions, we grouped the results of the 5 interviewed in table 4a.

The analysis shows that pedagogical autonomy from the views of the inspector on student autonomy covers 5 dimensions: methodological, social, cognitive, metacognitive and psycho-affective.

We note that 2 dimensions of pedagogical autonomy (methodological and social) are shared by the inspector and the 4 teachers. This leads us to think_that for the 5 interviewed, from the pedagogical point of view, an autonomous student adopts a method of work and engaging in social interactions in his school life as well. In addition, the inspector shares 4 PA dimensions with P1/P4 and 3 PA dimensions with P2/P3.

TABLE 4A

Results of the analysis of the interviews on what the teacher expects from an autonomous student according to the PA dimensions

« Student-tasks » in terms of PA					
Autonomy dimensions	**Inspector**	**P1**	**P2**	**P3**	**P4**
Technical		x	x	x	
Informational		x	x		x
Methodological	x	x	x	x	x
Social	x	x	x	x	x
Cognitive	x	x		x	x
Metacognitive	x				x
Psycho-cognitive	x	x	x		

We note that P1 mentions more dimensions of PA than the inspector. We wonder if this is related to personal and/or professional experience. Indeed, P1 has a daughter in high school (15 years old) and he explicitly said during the interview that he does what is necessary to develop the « learning autonomy » of his daughter so that she does well in school like her father who prepared alone the CAPES[4]. He added that when he took the exam, there were a lot of candidates and a limited number of places for the competition; the selection among the candidates was tough compared to today.

Table 4b reports the results of the analysis of the 5 interviews according to the different dimensions of DA.

TABLE 4B

Results of the analysis of the interviews on what the teacher expects from an autonomous student according to the DA dimensions

« Student-tasks » in terms of DA					
Autonomy dimensions	**Inspector**	**P1**	**P2**	**P3**	**P4**
Technical	x			x	
Informational		x		x	
Methodological	x	x	x	x	
Social				x	x
Cognitive	x			x	
Metacognitive					
Psycho-affective		x			

4 CAPES: To teach in a middle or high school of public education in France, you must pass the competition of CAPES (Certificate of Aptitude to the Professorship of Second-Degree Education).

The results of this study show that the didactic autonomy according to the inspector covers only 3 dimensions: technical, methodological and cognitive. It appears that no dimension of didactic autonomy mentioned by "I" is common between the 5 interviews, even if P3 shares these 3 dimensions with the inspector.

However, the absence of the metacognitive dimension is common to the 5 interviewed. This absence in didactic autonomy leads us to wonder whether this is related to the fact that the students are still in middle school and that it is the teacher who is the only knowledge holder. If so, we wonder about the role of students: is it limited to memorization tasks and/or performing tasks without the need to have some distance from the knowledge produced and taught while the institutional prescriptions for cycle 3 & 4 highlights the importance of critical thinking.This in our opinion requires mobilizing the cognitive and meta-cognitive dimensions. Here is an extract from the institutional prescriptions published by the Ministry of Education: "They [teachers] are led to develop a sense of observation, curiosity, critical thinking and, more generally, autonomous thinking. (MENESR, 2020, p. 5). The curriculum of science education also mentions that the teacher must "contribute to the development in each student of a rational, autonomous and enlightened mind, capable of a critical analysis in the face of false information and rumors" (MENESR, 2020, p. 7)

We also note that the methodological DA is present in the verbatim of the inspector and 3 teachers (P1, P2 & P3). P3 mentions more dimensions of DA than the inspector.This finding could come from the fact that the interview took place immediately after a classroom observation of a digital-based astronomy session in which the teacher stated that this session allowed the development of student autonomy, among other things.

Mesoscopic level: The teachers' tasks to develop the students' autonomy process

The two tables (table 5a & 5b) present the result of the analysis of the 5 interviewees concerning the supports on which a science teacher can rely on to develop and foster the students' autonomy. We start with the pedagogical conditions (Table 5a) and continue with the didactic one (Table 5b).

The inspector mentions 4 conditions belonging to 4 dimensions of PA: methodological, social, cognitive and psycho-affective which is also the case of P1.

For P2, P3 & P4, we find very little presence of elements allowing developing autonomy which suggests that teachers, would have as their main mission to teach science knowledge without including the development of students' autonomy.

Only one dimension of PA (methodological) is shared by the inspector and the 4 teachers. Let us note the absence of the technical, informational and metacognitive dimensions in the result. It seems that those dimensions are not relevant, according to the teachers and the inspector, to develop students' PA.

TABLE 5A

Results of the viewpoints at a mesoscopic level in terms of conditions according to the PA dimensions

Teacher-tasks: Conditions & levers to develop PA					
Autonomy dimensions	**Inspector**	**P1**	**P2**	**P3**	**P4**
Technical					
Informational					
Methodological	x	x	x	x	x
Social	x	x			x
Cognitive	x	x	x		
Metacognitive					
Psycho-affective	x	x			x

TABLE 5B

Results of the viewpoints at a mesoscopic level in terms of conditions according to the DA dimensions

Teacher-tasks: conditions & levers to develop DA					
Autonomy dimensions	**Inspector**	**P1**	**P2**	**P3**	**P4**
Technical	x			x	x
Informational					
Methodological	x	x		x	x
Social		x			
Cognitive	x		x		
Metacognitive		x	x		
Psycho-affective		x		x	

Regarding teachers and the inspector's autonomy conditions, table 5b shows that the inspector's comments only concern 3 dimensions of DA: technical, methodological and cognitive. No dimension is common among the 5 interviewees. However, the methodological dimension was addressed by the inspector and 3 teachers (P1, P3 & P4).

P1 again presents more DA conditions than the inspector. Once again, we wonder whether this is related to his personal experience or his professional experience, even if it is only related to DA.

Analysis of the common dimensions in terms of notional groups

The analysis corresponds to a zoom on the common dimensions at the mesoscopic level between the 5 interviewees already presented in the previous sections (tables

4a, 4b, 5a & 5b). This analysis aims to go further in the search for convergences or divergences in terms of notional groups.

Just a reminder, according to the "student-tasks" the common dimensions in PA aspect are the following: methodological and social dimensions and there is no common dimension for DA.

As for the "teacher-tasks" and conditions for developing PA, only the methodological dimension is common between the 5 interviewees. However, there is no common dimension in DA between them. Therefore, we cannot conduct our analysis with a focus on notional groups in terms of DA. We believe that learning didactic autonomy does not seem to be a priority neither for the teachers interviewed nor for the inspector.

Table 6 focuses on the notional group associated with the methodological and social dimensions of pedagogical autonomy in terms of the "student-tasks."

TABLE 6

Results of the notional groups under the methodological & social dimensions of PA

Notional groups concerning PA on the student-task side					
Autonomy dimensions	**Inspector**	**P1**	**P2**	**P3**	**P4**
Methodological	Pedagogical rituals	Pedagogical rituals			
	When and how to solicit the teacher		when and how to solicit the teacher	when and how to solicit the teacher	when and how to solicit the teacher
			Organization of his activity according to the objectives set by the teacher	Organization of his activity according to the objectives set by the teacher	Organization of his activity according to the objectives set by the teacher
	Mobilization of external resources				
	Mobilization of internal resources				
	Rely on the planification of the task				

TABLE 6

Autonomy dimensions	Inspector	P1	P2	P3	P4
Social	Cooperation between peers	Cooperation between peers	Cooperation between peers	Cooperation between peers	Cooperation between peers
	Division of the tasks & confrontation of ideas between peers				
	Responsibilities of the groups				

Focus on the methodological dimension of PA on the student-tasks side
The inspector mentions 5 notional groups, P1 only mentions 1. As for P2, P3 & P4, they each mentioned the same 2 notional groups.

The comparison between the notional groups of the 5 interviewees indicates zero notional groups in common.

As for P1, he agrees with the inspector on the notional group "pedagogical ritual". For their part, P2, P3 & P4 share the notional group "when and how to solicit the teacher" with the inspector. We highlight that a notional group not mentioned by the inspector "organization of his activity according to the objectives set by the teacher" is shared by 3 teachers (P2, P3 & P4).

Focus on the social dimension of PA on the student-tasks side
The inspector mentions 3 notional groups among which "cooperation between peers". Also mentioned by P1, P2, P3 & P4 with less richness. There is thus a consensus on the importance of the "cooperation between peers" pointing the capacity of an autonomous student to discuss and to do cooperative activities.

Focus on the common dimension of PA on the teacher-tasks side
Table 7 presents the notional groups associated with the methodological dimension concerning PA in terms of "support offered by the teacher".

We note 7 notional groups in the inspector's case and far less for the 4 teachers (maximum 2 per teacher). The inspector only shares the notional group "scaffolding" with P2, P3 & P4.

The "alternation of individual and group work time" notional group is shared between the inspector and P4. The notional group "evaluation of student activity" is shared by the inspector and P3. Table 7 illustrates the absence of any common notional group between the inspector and P1. However, P1 is the only person who mentions "systematic presentation of prescribed tasks with the same structure" as a notional group.

The results of the multilevel analysis show that the development of pedagogical and didactical autonomy does not seem to be a priority for those 4 interviewed teachers. The teachers are obviously not equipped to carry out this type of task in the classroom. It is highly probable that they have not received any training on this topic for the moment.

TABLE 7

Results of the analysis of the notional groups under the conditions on a methodological dimension of PA

Notional groups related to the common dimension between the 5 interviewed and part of PA					
Autonomy dimensions	**Inspector**	**P1**	**P2**	**P3**	**P4**
Methodology	Scaffolding		Scaffolding	Scaffolding	Scaffolding
	Verification of the appropriation of the instructions				
		Systematic presentation of the prescribes tasks with the same structure			
	Oral presentation of the instructions as clear & explicit as possible				
	Alternate individual & collective time				Alternate individual & collective time
	Duration of the tasks				
			Identification of the students having troubles		
	Evaluation of the activity of the students			Evaluation of the activity of the students	
	Regulation of the activities of the students in groups				

Discussion and conclusion

The aim of this exploratory study was to compare from the perspective of an inspector who is a representative of the school institution with the points of view of science teachers on what is an autonomous middle school student and the means on which the teacher can rely on to develop this autonomy. To analyze our corpus, we mobilized a new framework and a method of analysis which we developed in a previous article (El Hage & Boilevin, submitted). This enables to take into account the different dimensions of the autonomy process while distinguishing between what is specific to PA and DA.

The data analysis illustrates that the teachers and the inspector, representative and prescriber/advisor of the school institution share some ideas on what an autonomous student is. However, those convergences only concern the pedagogical side.

At a mesoscopic level, we notice that for the inspector the PA covers 5 dimensions: methodological, social, cognitive, metacognitive and psycho-affective. Two of them (methodological and social) are common to the inspector and the teachers. In the case of the DA, it only covers 3 dimensions according to the inspector: technical, methodological and cognitive. The absence of a metacognitive dimension is the only converging element between them.

The emphasis on the common dimensions enabled to go further on the search for convergences through the notional groups extracted from the statements of the interviewed. We note that the methodological dimension shared by to the 5 interviewed, the results show abundant notional groups for the inspector in comparison to the 4 teachers. We wonder if this abundance is because the inspector, thanks to his function, can observe many teachers within a year. He therefore has a global vision of what is achievable in classroom practices. In fact, the inspector not only comes to observe what happens in science classrooms but also discusses with teachers, which would allow him to have a "toolkit" to develop students' autonomy.

The analysis of the interviews in terms of the conditions allowing teachers to develop students' PA in science according to the inspector and the 4 teachers only showed one lever in common. Despite the fact that the inspector mentions 4 conditions covering 4 dimensions of PA (methodological, social, cognitive and psycho-affective), only the methodological dimension is shared by the inspector and the 4 teachers. As for DA, no dimension is common to the 5 interviewees. Some notional groups emerge from our analysis as the need for evaluative feedback, either self-assessment or teacher evaluation or both (cognitive & meta cognitive dimensions).

Focusing on the only common dimension between the 5 interviewees in terms of pedagogical levers allows us to note the absence of notional groups in common between the 5 interviewees. However, only one group "when and how to solicit the teacher" is shared by 3 teachers. We believe that these results highlight the fact that the teachers are not well-equipped; as a matter of fact, they had no training in developing autonomy. The inspector is better equipped thanks to the numerous classrooms visits he does every year.

We would like to point out a limit in our work regarding the declarative data collected. Indeed, the research works as the one from Robert (2012) showed that they could be discrepancies between the statements of the interviewed and their actual practice. Moreover, the interviews were not led in the same conditions. In some cases, the classroom observation took place before which could explain the presence of didactic aspects in the speech of some of the teachers.

Despite the limits, the results of our study strengthen the current literature particularly on the means to develop the autonomy of the students. The framework suggested by Albero explores the notion of autonomy under a different perspective compared to the work led by other researches generally following the self-determination theory. Regarding autonomy as a process, the use of the 7 dimensions enabled to go further into the proposals of other researchers to develop the autonomy of students. Indeed Berger (2016) only identifies 3 conditions (organisational, procedural and cognitive). As for Furtak & Kunter (2012), they only use two categories to enhance autonomy in science classrooms (procedural autonomy and cognitive autonomy).

Furthermore, the criteria to analyse the discourse through the use of facets and notional groups is based on a precise categorisation by dimension where each facet of autonomy vs. levers cannot be assigned to more than one dimension. This method makes it possible to distinguish between what refers to PA and DA; it proposes a vision of the autonomy of students in science "finer" than Furtak & Kunter (2012), Robertson & Jones (2013) or Ramnarain & Hobden (2015). We believe that this may complete the work around IBSE by clarifying the central notion of autonomy in this practice of teaching and learning science.

Another element of interest about this research is the addition of the institutional perspective. The study of the discrepancy of viewpoints mentioned above on what the autonomy of the students and the ways to develop it, could be useful to offer the desired trainings by the science teachers. Thus, Gueudet & Joffredo-Lebrun (2021) had implemented an initial training for beginner mathematics teachers based on collective documentation work to combine the development of autonomy while using the scratch software. For their part, Le Bouil et al., (2021) rely on the theoretical framework used in our study to build and implement a training program for beginner science teachers. This system leads them to design and implement in their classroom scenarios to develop the autonomy of their students.

This exploratory study is the starting point of a research that we are currently pursuing with 2 directions: to go beyond the limits of the current methodological framework based on declarative information, we will proceed with observations and filmed data in the classroom. Also, to conduct a cross-disciplinary comparison of the teachers' views about student autonomy and the levers/conditions used to support its development. We expect that this comparison would allow us to identify invariants in teaching practices concerning pedagogical autonomy in various school disciplines. Therefore, it will be possible to draw up a "standard" portrait of what an autonomous student is. This standard portrait in terms of pedagogical autonomy could be enhanced by the specificity of each discipline concerning the didactic autonomy.

In addition, the case study presented here shows that the expectations of the educational institution in terms of developing of students' autonomy do not seem to be shared by science teachers. We are currently preparing a quantitative survey to test this hypothesis among teachers and inspectors of the field.

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