

The place of inquiry in mathematics taught within the International Baccalaureate

La place de l'enquête en mathématiques enseignées au sein du Baccalauréat International

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Abstract

Traditional teaching seems to prevail over problem-solving, and inquiry-based education struggles in finding a stable place in the classrooms. Our research questions the place of inquiry in a particular institutional context that places it in the heart of its educational philosophy, particularly when it becomes an institutionally recognized object, sanctioned by a summative assessment.

Keywords: Anthropological theory of didactics, Inquiry, international baccalaureate

Résumé

L'enseignement traditionnel semble prévaloir sur la résolution de problèmes, et la démarche d'investigation lutte pour trouver une place stable dans les classes. Notre recherche questionne la place de la démarche d'investigation dans un contexte institutionnel particulier qui la place au cœur de sa philosophie éducative, en particulier lorsqu'elle devient un objet institutionnellement reconnu, sanctionné par une évaluation sommative.

Mots-clés: Théorie anthropologique de la didactique, enquête, baccalauréat international

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In recent years, several European projects (Fibonacci, PRIMAS, S-Team, etc.) were conducted in order to promote inquiry-based mathematics and science education. Inquiry-based education (IBE) unlike transmissive instructional methods, aims to make students active in building knowledge by putting them in a research situation (Dorier & Maass, 2014). Because of its strong political promotion, Artigue and Blomhøj (2013, p. 798) emphasize the importance of research in mathematics and science education, especially when it comes to the pedagogical background and learning outcomes of IBE.

In our thesis, we question the place of inquiry in the context of the International Baccalaureate (IB) and focus on the place of IBE in mathematics classrooms when it becomes an institutionally recognized object, sanctioned by a summative assessment.

The institutional context

The IB is a non-profit educational foundation established in Geneva in 1968 to meet the needs of international schools and the international community. The IB offers four educational programs for students aged from 3 to 19, thus covering all levels of education. In this context, we chose to focus on the Diploma Program (DP) intended for students aged 16-19. Its successful achievement leads to a diploma that provides access to higher education.

The IB represents a particular institutional context that emphasizes the development of skills such as critical reflection or research skills through teaching that reflects pedagogical principles based on inquiry (IB, 2015). In addition, it is one of the few institutions that requires a summative assessment of inquiry-specific nature in mathematics, compulsory for all students and contributing to 20% of the final grade. The internal assessment (IA) is “a piece of written work that involves investigating an area of mathematics” (IBO, 2012, p. 43). Its main objective is to evaluate students’ performances

and skills that are impossible to assess through written examinations or tests. On top of that, it “should, as far as possible, be woven into normal classroom teaching and not be a separate activity conducted after a course has been taught” (ibid.). In our research we aim at identifying and analyzing the conditions and constraints of the implementation of inquiry-based activities in mathematics classrooms and in particular the influence of the IA in the integration of IBE in day-to-day teaching.

The institutional analysis

We will now provide an insight into the institution and interpret it in the light of Chevallard’s (2004) scale of didactic co-determination. Dorier and Garcia (2013) did not consider the level of the civilization, but for the four others they established a categorization aiming to draw up a table of the conditions and constraints of the diffusion of inquiry-based mathematics and science education (IBMSE) in the society:

1. Levels of society: Specific role of mathematics and sciences in society, tradition or recent changes in education relevant regarding IBMSE.
2. Level of school (global organization): Differentiation between primary, lower and upper secondary education, Pre-service and in-service teachers’ training structures, etc.
3. Level of pedagogy: Law of education, general statement on pedagogy, tradition in education (transmissive or constructivist tradition, place of the learner...), type and role of national assessments, etc.
4. Level of discipline: Links between mathematics and sciences in the curricula, integrated science or separate subjects, etc., place of mathematics and sciences in the curricula (number of hours), competence of teachers in mathematics and sciences (profile of teachers), type of curricula in mathematics and sciences (signs of IBMSE?), type of resources for teachers in mathematics and sciences (textbooks, web, etc.). Are mathematics and science teachers using IBMSE? Why? If it is a requisite in the curriculum, even in the textbooks, why not? (Dorier & García, 2013, pp. 839-840)

Changes in the life of the post-war society, such as the development of international trade and non-governmental organizations, have contributed to an increased international mobility. Places in universities have become more coveted and as a result, new educational needs for the children of the expatriate community appeared. In the

sixties, the prevailing educational model was the encyclopaedic approach of the German *Abitur* or the French *Baccalauréat*, characterized by the transmission of information over a wide range of subjects. The first General Guide to the International Baccalaureate states that “the weight of available information in each discipline is such that an encyclopaedic approach to education is not only out-dated but inappropriate: learning how to learn has now become the prime function of school education” (IBO, 1970, p.21-22, in Fox, 1985, p.58). The IB was facing a great challenge: to put together a curriculum and an examination that would “encourage the teaching of *minds well formed* rather than *minds well stuffed*” (Peterson, 2003, p. 43). According to Hill (2002), parents wanted their children to receive education that reflected the ideals of the international organizations that hired them. It was clear, as he points out,

[...] that a new pedagogical approach was needed to promote international understanding, [...]: critical inquiry coupled with an open mind willing to question established beliefs, willing to withdraw from conventional positions in the light of new evidence and experiences, willing to accept that being different does not mean being wrong » (ibid., p.19).

Fox (1985, p. 56), however, brings up that alongside the international ideals, parents were also concerned by the academic content on which depended the acceptance of their children to universities. Here, we can see how the happening at the society level of the didactic co-determination scale shaped the educational philosophy of IB and had “a profound effect on the planning of curricula and methods of assessment” (Peterson, 2003, p. 41).

Having analysed certain elements at the upper levels of didactic co-determination scale we consider the IB as an institution that carries the genetic code of IBE in its educational philosophy and expect it to have repercussion at the lower levels of this scale.

Research issues and research questions

1. Research issues

Despite numerous initiatives and projects over the last decade, traditional teaching seems to prevail over problem-solving, and IBE struggles in finding a stable place in the classrooms (Dorier & Maass, 2014). Tabulawa (2013) attempts to explain the failure of the school reform in sub-Saharan Africa, adapting an approach developed by Hoyle (1969) based on using medical terms such as tissue rejection and immunological condition transferred to the context of education. Hoyle (ibid.) advances that tissue rejection occurs “because the social system of the school is unable to absorb it into its normal functioning”(p.231). Tabulawa (2013) explains that the intended innovations often carry a radically new code and require a too radical shift from the values or past experiences of the host. However, if there was already some openness in the host, the confrontation would be less radical and the new code could get accepted. Chevillard (2013) points out that the paradigm currently dominating the school study is that of *visiting monuments* where the role of the teacher is to show the mathematical works designated to be taught to the students. Since IBE represents a paradigm of study that is radically opposed to visiting monuments, according to Wozniak (2015), the conditions relating to *topogenesis*, *mesogenesis* and *chronogenesis* convey a significant change, it is not a surprise that the implementation of IBE often encounters resistance of the host environment.

2. Research questions

From the institutional analysis and research issues, arise the following research questions:

Question 1: What are the institutional praxeologies concerning completing the IA requirement? How are these carried out by the teachers? Are there any personal praxeologies of teachers that foster inquiry in regular classes?

Question 2: To what extent does the IA requirement affect the regular classroom practices and contribute to sustaining inquiry in regular classes? What are the teachers' reactions towards the IA requirement? Do they execute it as a more-or-less tolerated constraint or do they appreciate its pedagogical value?

Question 3: How does prior experience with specific inquiry objectives of the teacher and/or the students affect their relation to the IA requirement?

The research design

According to Bosch and Gascon (2002), one cannot correctly interpret teaching practices without studying the institution in which the teacher practices her profession. For this reason our research began with an in-depth analysis of the institutional context of the IB based on official texts and interviews with the actors of the noosphere. In order to complete our vision of the institution, we will build a questionnaire to address the declared teaching practices of mathematics teachers working in different IB schools.

Afterwards we will conduct a case study considering two campuses of the International School of Geneva (Ecolint). We plan to collect data through semi-directed interviews with the department heads and the teachers in order to complete and clarify the information from the questionnaire and through video recorded observations of the intended teaching sequence for the completion of the IA requirement.

Theoretical approach

To describe the declared and observed teachers' practices in terms of praxeologies and identify those praxeologies that foster inquiry in the classroom, we need a tool that would enable us to identify the pro-inquiry praxeologies. With this tool we want to a priori estimate how much inquiry potential a suggested activity carries and measure the amount of inquiry actually present in the classroom. For this we decided to combine the five activity potentials developed by Georget (2009, p. 76) and the dialectics relative to the conditions on the chronogenesis, mesogenesis and topogenesis (Wozniak, 2015). The table 1 shows how each of the five potentials are linked to a given dialectics or a mathematical organization. This is obviously only a working version that needs further refinement.

Table 1

Analysis tool

<i>A priori analysis</i>				
Research potential	Resistance potential	Dynamic resistance potential	Debate potential	Didactic potential
Chronogenesis	Mesogenesis		Topogenesis	
question-answer dialectics	media-milieu dialectics		teacher-student roles dialectics	Local mathematical organisation
Observation grid				

Conclusion

After an informal visit and introductory interviews with the heads of the mathematics departments of Ecolint we realized that implementing IBE is not so obvious even for an institution such as IB. It seems that the dominant paradigm of the first campus is the one of visiting monuments and an important resistance of the teachers to any change was mentioned. The IA is considered as an inevitable evil that is executed because required. The second campus seems to be more open towards inquiry because of the prior experience of inquiry-based approach through the IB middle years programme without

the pressure of an approaching examination. The comparison of the praxeologies at the two campuses might help to explain the conditions and constraints that necessary accompany a successful implementation of IBE.

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