

I2Geo quality assessment process: a tool for teacher professional development?

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Abstract

We focus on the means to support the use of ICT by math teachers. Despite the availability and accessibility of ICT tools and the recommendations in the curricula in many countries to use it, teachers are reluctant to use technologies. In the case of dynamic geometry systems (DGS), several reasons explain this resistance. The multiplicity of DGS and resources makes it difficult to identify relevant and quality resources. Moreover, the availability of resources does not solve the problem of their appropriation by teachers, which requires an evolution of teachers' competencies and their conceptions about the role of technology in teaching and learning of mathematics. These considerations have led to one of the goals of I2Geo project, which is at the core of this contribution: a quality assessment process for dynamic geometry resources based on an evaluation of resources by users. In order to frame the resource evaluation, we have designed a questionnaire addressing aspects that contribute to the mathematical, instrumental, didactical, pedagogical and ergonomic quality of a resource. The aim is to collect users' opinions reflecting the use of resources in a classroom and thus stimulate their reuse by others and their improvement. Several experiments that have been carried out with groups of teachers allowed analysing strengths and limitations of resource quality assessment. It turns out that the questionnaire is a helpful tool for the appropriation of resources since it prompts teachers to analyse in detail main aspects of a resource that each criterion of the questionnaire addresses.

1. Introduction

This contribution raises the issue of teacher professional development as far as the integration of ICT tools by math teachers into their practices is concerned. Considering the meaning of professional development in the technological age, Grant [1] claims that:

“Professional development... goes beyond the term 'training' with its implications of learning skills, and encompasses a definition that includes formal and informal means of helping teachers not only learn new skills but also develop new insights into pedagogy and their own practice, and explore new or advanced understandings of content and resources. [This] definition of professional development includes support for teachers as they encounter the challenges that come with putting into practice their

evolving understandings about the use of technology to support inquiry-based learning...”.

Then the author questions what teachers need from a professional development program to support technology use in their classroom:

“They need to become comfortable enough with technologies to grasp their potential for teaching and learning, to navigate changes in practice and pedagogy to meet that potential, to evaluate and make choices among myriad options, and to manage the enormous quantities of information that come their way as a result of increased access to primary sources and to a much more extensive audience. They need to position themselves to become continual learners, from one another, from their students, and from the broader world "out there". Most important, they need to make technology tools their own”.

This paper explores the idea of involving teachers in a quality assessment process concerned with dynamic geometry (DG) resources as a means of their professional development supporting the integration of dynamic geometry systems (DGS) into their teaching practices. The research addressing this issue has been carried out in the framework of the I2Geo European project¹ aimed at (1) making the main existing DGS interoperable, i.e., enabling the exploitation with any DGS of a file created with another one thanks to the development of a common file format [2], (2) sharing DG resources well-described by a set of international metadata through a dedicated platform² (ibid.), and (3) developing an online quality assessment process on the platform concerned with DG resources. In this paper we attempt to show that teachers’ work with resources on the platform contributes to the development of professional skills enabling them to evaluate and make choices among myriad of available resources, to broaden their understanding of possibilities offered by DG in mathematics teaching and learning, and to make DG resources “their own”, which is a necessary condition for an efficient use of DGS in classrooms. In the following section, we briefly present the motivations and objectives of the I2Geo project, focusing on the quality assessment process. Sections 3 and 4 present respectively theoretical approaches that ground our research and how they are used to enable us observing and studying teachers’ involvement in the quality process and its impact on their professional development. Section 5 presents several empirical studies and their main outcomes. Concluding remarks and new perspectives this research opens are provided in the last section.

2. I2Geo project and resource quality assessment process

In contrast to the training paradigm, consisting in “*short-term, standardized sessions designed to impart discrete skills and techniques*” [1.], Little [3] claims that

“the most promising forms of professional development engage teachers in the pursuit of genuine questions, problems, and curiosities, over time, in ways that leave a mark on perspectives, policy, and practice. They communicate a view of teachers not only as classroom experts, but also as productive and responsible members of a broader professional community”.

¹ <http://www.inter2geo.eu>

² <http://i2geo.net>

The I2Geo project arised from the idea to develop a Pan-European mathematics teacher community around a platform enabling sharing dynamic geometry resources and teaching practices related to the use of DGS. However, making resources available is not sufficient, as pointed out by Robertson [4]:

“Finding useful and credible resources, educational content of good quality and regularly updated very often comes close to being a utopia. Indeed, the user often faces a lack of support in searching (metadata versus keywords), a need of confidence regarding the quality of information. [...] we would claim that appropriation by teachers of pedagogical and didactical materials, favouring students’ learning and complementary to printed resources (school textbooks in particular) remains difficult, although technologies have been available in schools for about twenty years.” (p. 13, authors’ translation).

The author stresses three main obstacles: (1) finding resources fitting to a specific educational context due to the lack of metadata providing an accurate description of the resource content, (2) absence of quality guarantee concerning available resources, which makes it difficult for a teacher to foresee the adequacy of a resource to her/his specific context and its potential effects on the students’ learning, and (3) lack of resource appropriation by teachers, which is deemed as one of the main obstacles for the exploitation of existing pedagogical resources. For these reasons, tools for indexing resources as well as for evaluating their quality appear essential.

The quality assessment of DG resources in I2Geo project, described in detail in Trgalová *et al.* [5], and Soury-Lavergne *et al.* [6], relies on both a priori analyses (prior to test in a classroom) and a posteriori analyses (after a test in a classroom). It involves all users of the platform, provided they are logged in, be they teachers, researchers or teacher educators.

The main tool supporting DG resource quality assessment on the platform is a questionnaire organized around nine dimensions of a resource considered as relevant with respect to its mathematical, didactical, pedagogical, technical and ergonomic quality: (1) metadata, (2) technical aspect, (3) mathematical dimension of the content, (4) instrumental dimension of the content, (5) added-value of the DG, (6) didactical implementation, (7) pedagogical implementation, (8) integration into an ongoing teaching sequence, and (9) ergonomic aspect. A set of criteria is associated to each dimension. A first item refers to the dimension from a general point of view. The list of criteria, accessible by clicking on the blue triangle (cf. Fig. 1), allows a more detailed analysis of the corresponding dimension of the resource.

▶ ○ ○ ○ ○ ○	I found easily the resource, the audience, competencies and themes are adequate
▶ ○ ○ ○ ○ ○	The files are technically sound and easy to open
▶ ○ ○ ○ ○ ○	The content is mathematically sound and usable in the classroom
▼ ○ ○ ○ ○ ○	Translation of the mathematical activity into interactive geometry is coherent
○ ○ ○ ○ ○	The math and the figures are related
○ ○ ○ ○ ○	The figure is behaving consistently within the activity
○ ○ ○ ○ ○	The figure shows no ill effect
○ ○ ○ ○ ○	The numerical values (angles, lengths) are consistent
○ ○ ○ ○ ○	Functionalities and specific behaviors like sliders, keyboard interaction or macros are well described
Comments: <input type="text"/>	
▶ ○ ○ ○ ○ ○	In this resource, Interactive Geometry adds value to the learning experience
▶ ○ ○ ○ ○ ○	This activity helps me teach mathematics
▶ ○ ○ ○ ○ ○	I know how to set my class for this activity
▶ ○ ○ ○ ○ ○	I found easily a way to use this activity in my curriculum progression
▶ ○ ○ ○ ○ ○	The resource is user friendly and adaptable

Figure 1: Quality questionnaire allowing to review any DG resource on I2Geo platform

All items (general and more precise criteria) are formulated as statements that a reviewer is supposed to answer by giving her/his opinion in terms of a four-level range of agreement. These quantitative answers can be complemented by qualitative comments, which are crucial for the resource improvement. Indeed, they allow identifying strengths and weaknesses of a resource, or of its description by metadata, enabling the resource to be subsequently improved either by its author or by any other user, which is the purpose of the quality assessment process.

In what follows, we present the theoretical frameworks we use to analyse teachers' usages of the resource quality assessment tool and its impact on the evolution of their professional knowledge and skills.

3. Theoretical frameworks: instrumental and documentational approaches

Resource selection and analysis are part of the usual teachers' activity [7], especially while preparing their lessons. I2Geo platform's ambition is to support this activity when preparing lessons involving the use of a DGS is at stake. For this, it offers services allowing the teachers to identify resources, understand what the resource content is about and help them planning a possible use in a classroom. Thus, by using the platform, and in particular its resource collection and the quality assessment tools, teachers should be helped in this part of their activities. But like for any tool, teachers have to learn how to use it and make it "their own". Our main question was therefore to understand how teachers can make use of the platform content and services.

Rabardel's *instrumental approach* [8] provides a theoretical framework to understand this process, explaining by which mechanisms a user, the teacher in our case, transforms an *artifact*, that may be the i2geo platform or any of its component, into an *instrument* enabling her/him to achieve her/his goals. In this approach, the instrument is a dual thing that evolves during the activity. It is composed of the initial artifact (or a part of it), that may have been transformed throughout its use,

and *utilization schemes* developed by the user while using the artifact in a class of situations. Two kinds of utilization schemes are developed in the process called *instrumental genesis*. On the one hand, *schemes of usage* are directly related to the activation of the artifact. They are elementary elements developed as adaptations to the characteristics of the artifact, to its constraints and to the required part of the activity. On the other hand, *schemes of instrument-mediated action* are built to achieve the aim of the activity. They combine more elementary schemes of usage to perform the global action toward the object of the activity. This construction of schemes is a key process of the user's conceptualization and knowledge construction. Thus appropriation and usage by a teacher of the I2Geo platform tools, such as the quality questionnaire, will generate new schemes and as a consequence nurture her/his professional development.

The instrumental genesis of the resource collection by the teachers and its exploitation for their professional activity is at the heart of the *documentational approach to didactics*, recently developed by Gueudet and Trouche [9]. As an extension of the instrumental approach, it specifically addresses the issue of teachers' work with resources. In the documentational approach, the considered artifact is a teaching *resource*, or a set of resources, that needs to be transformed into a *document* by a teacher in the process of its use in and outside the classroom. Teachers interact with sets of resources: they modify, adapt, organize them in a process closely articulating design and implementation; this process, called *documentational work*, underpins a *documentational genesis* that develops a document, i.e., a new resource, consisting of selected, modified and recombined resources-artifacts, together with schemes of utilization of this resource. The documentational approach is appropriate to study and analyze teachers' activity with the resource collection of I2Geo, and in particular to investigate which schemes are developed by teachers allowing them to select resources and to adapt them to their particular educational context. We refer to these two complementary frameworks to understand the complexity of the teachers' activity with the I2Geo platform and to address the issue of appropriation and use of the I2Geo collection of resources and the quality questionnaire.

Two intertwined processes supporting each other occur in this activity: a documentational genesis concerning teachers' work with the collection of resources, which is the aim of the I2Geo project, and an instrumental genesis concerning the process of transforming the quality tools into an instrument to support teachers' documentational work with DG resources. Teachers' professional development supported by I2Geo platform results from these two processes.

4. I2Geo quality assessment process and teachers' professional development

Referring to the instrumental approach, quality questionnaire and comments have to be transformed by teachers into instruments enabling them to analyze resources, this analysis being an essential part of their documentational work. The instrumental genesis of the quality questionnaire is a process going on when teachers review resources by using the online tool. The utilization schemes that may be developed by teachers when using it will thus be a major contribution to their professional development.

Considering the instrumental genesis of the questionnaire, the two kinds of utilization schemes presented in part 3 can be developed. Schemes of usage will rather concern the way of using the artifact, such as where to click to display the questionnaire, how to fill it in, how to save the review (i.e., filled questionnaire). Schemes of instrument-mediated action will depend more directly on the goal of the teacher's action. It is therefore important to identify the teacher's goals when using the

quality questionnaire. One of his/her goal can be using it to attribute quality values to resources and to impact resources ranking on the platform, without considering a possible use in a classroom. In this case, s/he may use the quality questionnaire to obtain a positive or negative review and answering correspondingly to each, or most of, general items, avoiding detailed items and comments. On the contrary, if a teacher aims at understanding the learning potential of a resource in view of its classroom implementation, s/he will analyze more deeply some of its dimensions according specific criteria of the questionnaire corresponding to these dimensions. Another goal can also be to make a resource evolve along some of its dimensions, leading the user to provide qualitative comments as clues for the resource improvement. In the last two cases, the schemes of instrument-mediated action will draw on several detailed criteria to achieve the analysis of the resource. Therefore, a resource analysis performed by the teacher will be instrumented by the questionnaire and the emerging schemes of instrument-mediated action will impact his/her documentational work.

Considering the documentational work with the I2Geo collection of resources, if teachers want to find a resource related to a specific topic, they will develop schemes of usage corresponding to writing and validating a query. But the teachers' aim is not just getting a list of resources, but rather getting a list of relevant resources with respect to their teaching project. Thus, teachers need to know how to formulate queries, how to choose between searching by plain text or through the ontology, how to deal with multilingualism, all being combined in order to quickly obtain a more significant response from the platform. When a teacher's documentational work consists in selecting a resource for a classroom implementation, the corresponding schemes of instrument-mediated action may be the ones generated by the resource analysis with the questionnaire or their adaptation.

Without ignoring the importance of schemes of usage, which are strongly linked to the artifact, and in our case to the I2Geo platform and its tools, we focus on the development of schemes of instrument-mediated action as key production of the teachers' activity with the platform and elements of their professional development that may be transferred to other resource collections. Thus it was necessary to elaborate an observation tool, enabling us to have access to elements of teachers' instrumental and documentational geneses.

5. Experiments

The questionnaire aiming at framing users' analysis of DG resources has been elaborated in a cyclical process combining design of successive versions and their subsequent tests with ordinary and expert teachers leading to a refinement of the questionnaire. Moreover, the design of the questionnaire has been carried out in close collaboration of math education researchers with a group of experienced teachers³, which was a key feature of the design methodology ensuring that the formulations of items and criteria would be accessible to ordinary teachers. In what follows, we present three empirical studies we have carried out with teachers using the questionnaire and analyze the impact of teachers' involvement in resource analysis on their professional development.

³ These teachers are associated to the National Institute for Pedagogical Research (INRP), which is an associate partner of the Intergeo project. The possibility for education researchers to work with in-service teachers is an asset of the INRP, which enables developing research in close relation with the reality of classrooms and teachers' practices.

5.1. Short-term experiments

In this section, we present two short-term experiments that were part of the questionnaire design-test cycles. Their purpose was twofold: (1) analyze the relevance and clarity of the questionnaire items by observing teachers' uses of the questionnaire, and (2) identify what "good quality" resources are for teachers, in particular which dimensions of resources inform their selection and/or appropriation by the teachers for a potential use in their classrooms. The first purpose is related to the instrumental genesis concerned with the questionnaire while the second is related to the documentational genesis concerned with resources.

5.1.1. First experiment: 22 Brazilian teachers

During this pilot experiment, some selected criteria of the initial questionnaire [10] have been tested within an in-service teacher training course. A few open questions have been added with the objective to make teachers explicit their views of a quality DG resource, as well as to identify elements of a resource teachers consider as helpful in order to appropriate and use the resource in their classrooms (cf. Fig. 2). A DG resource to be analyzed by the teachers has also been specifically designed to control some of its aspects for the experiment purposes and to be relevant for a teacher training. The resource addressed the "quadrilaterals" topic and made use of a DGS. It was constituted of a student worksheet, a teacher file and three DG files: two dynamic figures and one macro-construction. The teacher file provided a description of the resource (topic, school level, educational goals, prerequisites and required material) and a brief presentation of the suggested organization of the sessions: classroom setting and roles of teacher and students.

<p>Regarding the pupil's worksheet:</p> <ol style="list-style-type: none"> 1. Are the texts of the activities: <ol style="list-style-type: none"> a. Clearly formulated? b. Mathematically correct? 2. Are mathematics tasks proposed to pupils easily identifiable? 3. Are DG figures provided with the resource: <ol style="list-style-type: none"> a. Easily accessible? b. In adequacy with the proposed activities? c. Do the figures behave as expected? 4. Would you use this kind of resource with your pupils? With or without modifications? Which ones? <p>Regarding the dynamic geometry:</p> <ol style="list-style-type: none"> 1. What do you think about the role of dynamic geometry in the resource? Do you think this sequence could be proposed in paper-and-pencil environment? 2. If not, what aspects justify the use of the software? 3. Does the use of drag mode contribute to the achievement of the declared educational goals? <p>Regarding the teacher document:</p> <ol style="list-style-type: none"> 1. What elements of the teacher documents do you consider as essential and the most relevant for a pedagogical use of the resource? 2. Do you think this document is sufficient for an easy appropriation of the proposed teaching sequence? Do you miss some information? Which? 3. Would you like to have other types of material or documents? Which ones? 4. Suppose that some of your colleagues have tested the resource in their class. What information do you consider important to be shared their experience?
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Figure 2. Questionnaire used during the first experiment.

The experimentation consisted in one 2h30 training session with 22 secondary mathematics teachers, who had, in average, six years of experience in teaching and most were "beginners" in

DG. The training session was organized in three phases: (1) solving tasks presented in the student worksheet, (2) analyzing these tasks, and (3) analyzing the resource according to the questionnaire.

In phase 3, regarding the teacher file, the participants particularly appreciated the brief description of the sequence considered as the resource “calling card”, so to speak, as well as the synthetic description of the sequence organization: “*very well like that, one gets directly all essential information*”; “*one understands immediately how to organize the sequence*”. As regards the student worksheet, the teachers have found the tasks easily identifiable, mathematically correct and clearly formulated. The teachers used these worksheets also to understand the sequence organization: “*student sheets allow us to easily understand the whole sequence and to spot contents and objectives*”. Regarding elements helpful for resource appropriation but missing in the resource, the teachers expressed a need to understand how the macro had been constructed and how it works. They would also have liked to have more information about the teacher’s role: what interventions and when, particularly during the institutionalization phases; how to assist students’ work. Some teachers pointed out that a document with reports of use, containing expected solutions and answers, but also possible students’ difficulties accompanied with advices how to cope with them (e.g., student worksheet with commentaries for a teacher) would be helpful for a better appropriation of the resource.

From the documental approach perspective, both teacher file and student worksheet played a significant role in teachers’ documentation work by providing them with tools helping them envisage a possible classroom implementation of the resource. However, the teachers expressed the need for other tools enabling them to manage a classroom in an efficient way, such as when and how to intervene or how to assist students’ work. It is worth noticing that the student worksheet has also been used to understand the organization of the teaching sequence in a classroom and to extract the intended learning objectives, which is not its usual function. This is a clear example of the instrumentalization of the student worksheet in the teachers’ documentary geneses. An associated scheme of instrument-mediated action could be: “when a student worksheet is available, I use it to understand the teaching objectives of the sequence and its general organization”.

Regarding DG, all teachers found unquestionable its contribution to the resource: “*activities specific to Cabri*”; “*the software is essential*”; “*impossible without Cabri*”. This is not surprising since the resource has been designed for it. The teachers mentioned more precisely that “*the software favors checking properties*”; “*without drag mode and possibility to modify diagrams, properties wouldn’t be visualized*”. They mentioned that dragging enables manipulating the figure and thus identifying its properties; checking properties; easily obtaining many different cases of a same figure; constructing figures easily, quickly and more precisely; making conjectures.

It is important to note that the role of DG in the task was analyzed in response to an explicit open question related to the added-value of DG in comparison with the paper and pencil environment. The teachers admitted that they would not have paid attention to this dimension, though essential in a DG resource. Thus the questionnaire helped teachers analyze efficiently the resource and identify what is the benefit of DG in the students’ tasks. An associated scheme of instrument-mediated action would be: to analyze a DG activity, I need to identify the role of drag mode to be sure that it takes a real benefit from DG.

In conclusion, the criteria set up for the questionnaire proved to be understandable by teachers, but what’s more, they helped them analyze important aspects of the resource and thus get a deeper insight into the proposed tasks and their didactical intentions. The teachers could transform the

questionnaire into an instrument enabling them to realize a deep and efficient analysis of the resource, which constitutes an important part of their documentational genesis. Thus, the questionnaire appeared both as a tool for highlighting aspects to be improved (e.g., add missing information about the teacher's role), and as a possible means of training teachers to be able to identify positive and negative aspects of a resource and understand its goals and content. Performing such analysis can therefore contribute to the development of teachers' professional skills necessary for a sound usage of resources.

5.1.2. Second experiment: 6 French teachers

The purpose of this experiment⁴ was to test a refined version of the questionnaire, which, at that time, addressed the first 8 dimensions, the ninth, ergonomic dimension, having been included later on. Three resources were proposed to teachers, addressing a same mathematical notion (quadrilaterals) but having different characteristics. The resources were retrieved from the Internet, they were thus representative of the content teachers can usually find if they search for teaching resources on the web. The resources had the same form consisting of a text associated with a DG file; the text addressed either a teacher, a student or both. In addition, the resources suggested the same type of DGS use: students solving proposed tasks in a computer lab. An "expert" analysis of the resources was done by the researcher prior to the experiment for the purpose of its comparison with the participants' responses.

Six French secondary school math teachers volunteered in the experiment. They had a professional experience ranging from five to fifteen years, with a very heterogeneous level of ICT integration. The resources have been proposed to the teachers according to the following protocol: first, every teacher had to become individually acquainted with each resource. Next, the teachers had to fill in the questionnaire in pairs. Finally, each teacher had to decide individually whether s/he would plan using the resources in her/his classroom or not, explain her/his choice and possibly suggest modifications allowing to improve the resources. The whole experiment lasted approximately three hours. While working with the questionnaire, the teachers were grouped in pairs, allowing the exchange and confrontation of different points of view. An observer was present to conduct debates when appropriate or to help teachers overcome potential ambiguities arising while answering the questionnaire.

The analysis of the data gathered during the experiment showed that some teacher pairs had difficulty sticking to the strict content of the resources during the analysis. Indeed, their answers to several items did not correspond to the information provided by the resource, but they rather reflected teachers' attempts to interpret the proposed tasks according to their own experiences, which resulted in bypassing authors' didactical intentions (instrumentalization of resources). Regarding the criteria determining whether the teachers would choose or not a given resource, it turned out that valid mathematical content is a necessary condition for a resource to be eligible. Moreover, the tasks proposed in the resource must take a real benefit from dynamic geometry, otherwise the resource is rejected. Teachers who were not familiar enough with using ICT in a classroom considered also the dimension addressing the didactical implementation of the resource as one of the most important.

⁴ This experiment was carried out by J.-M. Baudoin in the framework of his Master thesis, under the supervision of one of the authors of this paper <<http://educmath.inrp.fr/Educmath/recherche/projets/intergeo>>.

The questionnaire itself was used differently by the teacher pairs. One pair used it from the very beginning in order to eliminate the less suitable resources. Their analysis framed by the questionnaire aimed at highlighting the unsatisfactory dimensions of the resources. Once these were identified, they stopped analysing the resources without attempting to analyse the other dimensions that could have constituted strengths of the resources. For example, one of the resources included a DG file with a quadrilateral supposed to be a parallelogram, but in fact it was just any quadrilateral in the form of a parallelogram at the time when the file had been opened (Fig. 3a); as soon as its vertices were dragged around, it did not remain a parallelogram (Fig. 3b).

This pair of teachers have found irrelevant to continue the analysis after having identified the weakness of the resource residing in the erroneous DG file, as they claimed "*the first thing is the DG figure*".

Unlikely, the two other pairs provided a detailed analysis of all dimensions of the resource. When asked if they would choose the resource or not for a possible implementation in their classrooms, some of them were able to envisage even the usage of resources presenting some weaknesses provided that they would improve the corresponding dimensions. They seem to have bypassed this inconsistency, as they mentioned "*we are going to do as if the figure were correct*".

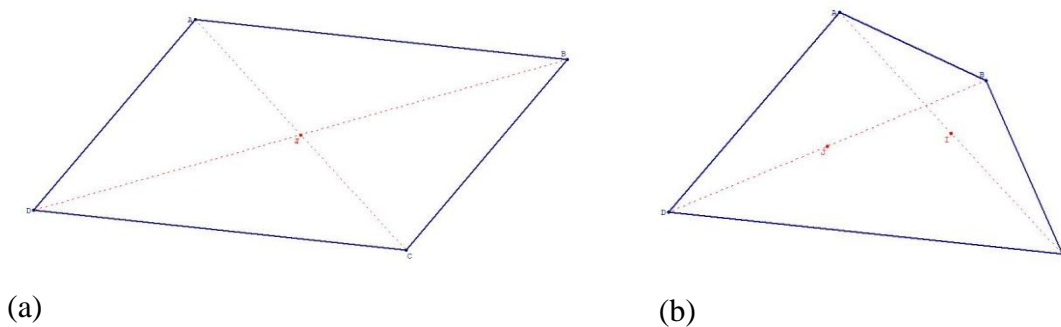


Figure 3. (a) When opened, the DG file displays a parallelogram ABCD, but as soon as its vertices are dragged around (b), one realizes that ABCD is "any" quadrilateral.

Thus, although all pairs considered this weakness as unacceptable, some of them suggested to improve the resource by "*modifying the figure itself so that the parallelogram resists dragging*".

These results allow to foresee various possible usages of the questionnaire. They correspond to different instrumental geneses leading to the development of different schemes of instrument-mediated action and associated instruments of resource analysis, such as the following:

- focusing on a few essential dimensions, using detailed criteria to analyse these and only general items to evaluate the others;
- starting by analysing in detail one important dimension: if it is satisfactory, analyse an other one, if not stop the analysis and conclude with a "poor quality" resource;
- using only general items to analyse the resource;
- using detailed criteria to perform a deep analysis of all dimensions of the resource.

The way the questionnaire is used (or in other words, the nature of the questionnaire as an instrument for resource analysis) is shaped by the user's experience. However, the purpose of the resource analysis also plays an important role in the instrumental genesis. For example, if the analysis aims at improving the resource quality, one would perform a detailed analysis of all (or most of) dimensions of the resource to highlight its weaknesses. If the aim is to get a deeper insight into the resource content prior to its implementation in a classroom, one would analyse in detail the dimensions s/he considers the most important and let aside the other ones. If the aim is to choose a resource among a set of similar resources, one would focus the analysis on important dimensions and reject resources for which any of these dimensions is unsatisfactory.

The outcomes of this experiment show that the two processes, instrumental genesis concerned with the questionnaire and documentational genesis concerned with resources, are intertwined since, on the one hand, using the questionnaire is supposed to frame the resource analysis and to help teachers choose the most appropriate ones, and on the other hand, the resource analysis contributes to shaping the questionnaire usage.

5.2. Long-term observation of the i2geo platform usages

The short-term experiments focused on the quality assessment tool: its utility to evaluate quality of DG resources and its usability by teachers. We could thus observe only a part of teachers' documentational work with resources corresponding to their selection (among a restricted number of resources) and analysis. As soon as the questionnaire was implemented on the platform, we wished to observe, analyse and understand the documentational work from the moment a teacher logs in on the platform until the implementation of the chosen resource in a classroom and its subsequent improvement (if any). For this reason, we have set up a long-term experiment (still in progress) involving seven teachers who have been collaborating with us on the design of the quality assessment process. In order to be able to gather as many information as possible about their platform usages, we have designed a methodological tool, called a "log book", the teachers are asked to fill in whenever they use the platform. The log book addresses the following phases:

- Searching for resources: What tools are used (browsing all resources, browsing recent resources, browsing reviewed resources; using the search engine)? What terms or keywords are entered in the query? What is the platform response? How the relevance of the search engine is judged?
- Exploiting relevant resources: According to what criteria are the resources to be reviewed chosen?
- Resource review using the questionnaire: After an online review of a resource, is this resource considered for a classroom implementation? Are there any modifications suggested?
- Classroom implementation of the reviewed resource and a posteriori review: Based on the outcomes of the test, are there any modifications to be done in the a priori review? In the resource?

We have gathered 12 log books so far. Their analysis is still in progress, nevertheless we can provide a few preliminary results related to the search for resources on the platform and their selection for a review.

Concerning the search for resources, the teachers use the search engine in the majority of cases, browsing all resources was used once and one teacher browsed resources deposited in his “My favorites”. A first selection of resources, that will possibly be reviewed, among those proposed by the search engine, is based on the following criteria, used in this order:

- the place in the list of resources: usually the first 10 or so resources are quickly looked through, the other ones are let aside;
- the author of the resource: the teachers have already noticed authors whose resources they appreciate, as well as those whose resources they consider non appropriate (e.g., because they are created with a DGS the teachers do not have at their disposal or simply do not master), the author’s name is therefore an important selection criterion.
- the title of the resource: a resource with an “*evocative*” or “*attractive*” title, or a title “*that corresponds exactly to the expectations*” is likely to be selected for a further analysis;
- the description of a resource: if, according to the description, teachers think that the resource corresponds to what they are looking for, they will consider it for a review;
- the attached text files: if a teacher file or a student worksheet are available, teachers look through to have information about the teaching sequence;
- the attached DG files: teachers usually try to understand the tasks through manipulating the dynamic figure when available;

These criteria are underpinned by schemes the teachers have developed (instrumentation of sets of resources) allowing them to quickly reduce the set of available resources to a manageable number.

The next step of the teachers’ documentational work consists in choosing resources, among those selected in the previous phase, that will be reviewed by using the online questionnaire. The analysis of this phase allowed highlighting reasons for rejecting resources, which are the following:

- language and/or DGS barrier: indeed, resources in French, Spanish, Czech, German and English co-exist on the platform. In the majority of cases, the resources contain a text file accompanying a GD figure, which is hard to understand if one does not read the language in which it is written. Similarly, a DG figure is created with one of the many existing DGS. If one does not possess or master this system, it is difficult for her/him to exploit the resource;
- “animation type” resource: the teachers are not interested in resources whose aim is to display a dynamic diagram illustrating a property or a theorem, i.e. the dragging of some points of the diagram shows the invariant property, independently from the user’s decision. According to these teachers, resources of this type propose tasks that are not challenging enough for the students. This criterion may be specific to this group of teachers who are “experts” in using ICT in their classrooms and who prefer innovative and motivating tasks for their students. Indeed, they consider that manipulation by students of DG figures is essential in the learning process;
- resource requiring too many modifications to adapt it to one’s expectations: a resource, which seems interesting at the first glance but turns out to require important modifications to adapt it to a given educational context is finally rejected by the teachers;
- added-value of DG not perceived: when the teachers do not perceive the benefits of using DG to solve the proposed tasks (e.g., when the task is a simple “translation” of a paper and pencil task into a DG environment), they reject the resource. This is in line with the outcomes of the short-

term experiments showing that DG added-value dimension is one of the most important in teachers' eyes;

- tasks not adapted to the students' level or too far from the ongoing teaching sequence: in these cases the resource is considered not usable and is therefore rejected;
- lack of information about the proposed tasks, their objectives and possible exploitation: in this case, the teachers would face a difficulty with the appropriation of the resource, they thus prefer to reject it.

Some of these criteria seem to be general, applying to most of the users (e.g., the usability of the resource or its appropriation potential), other may be specific to a given type of users (e.g., preference or rejection of certain types of resources, such as animation).

Further analysis is necessary in order to be able to detect patterns of teachers' behavior when using the platform and to identify possible impact of their documental work on their professional development. Moreover, we are aware that our group of teachers does not constitute a representative sample and other such studies are necessary with "ordinary" teachers to obtain results, which would apply to general teacher population.

Beyond the data gathered by the means of log books, we witnessed evolutions of practices of the teachers involved in this experiment. A long-term work with the I2Geo platform has in particular impacted their teaching practices concerned with the lessons preparation, as they say themselves:

"Before our involvement in the project, we used official websites with a few resources in relation with DGS, or various personal websites, without necessarily finding what we were looking for. As a consequence, we often ended up by building an activity from scratch including the DGS file if needed.

Since then our habits have changed as regards to our practices. The search program becoming efficient, I2Geo has become a tool for the design of our teaching. We first look for resources matching the subject that interests us. If we do not have any precise idea about the activity, the proposed resources can provide us with an activity we want to test or at least give us some ideas or make us discover unknown software potentialities. [...] In any case, we begin to get familiarized with the first resources related to our request, we analyze them and fill in [...] the questionnaire [...] If needed, we modify it according to our specific classroom context or take inspiration from them according to our aims. Once tested, we deposit the modified resource on the platform."
(Bourgeat et al. 2010, p. 4).

In addition, their usage of the questionnaire has also significantly evolved as they produce the more and more expert reviews of resources, providing both a detailed analysis of all resource dimensions and relevant qualitative comments with the view of the resource improvement. This shows that the questionnaire itself as instrument for resource analysis is in a continuous evolution; its usage is shaped during the teachers' documental work.

6. Conclusions

The purpose of this paper was to explore the I2Geo quality assessment process as a means to foster teachers' professional development. Our analysis of the teachers' documental work with the I2Geo collection of resources and of their instrumental genesis related to the quality questionnaire

shows some evidence of a positive impact of the teachers' involvement into the quality process on their practices.

A first conclusion concerns the intertwining of instrumental and documentational geneses in teachers working with I2Geo. Initially, the quality questionnaire was supposed to help teachers to analyze resources in order to assist them to select suitable ones for a classroom implementation. From this point of view, the instrumental genesis of the questionnaire for DG resource analysis is supporting the documentational genesis. Yet, the quality questionnaire has been used differently, producing different instruments enabling various analyses of DG resources. Thus, the resource analysis and its different possible purposes have shaped the use of the questionnaire and therefore the resulting instrument for DG resource analysis. From this other point of view, the documentational genesis is also impacting the instrumental genesis of the questionnaire. Finally, this tight interconnection between documentational and instrumental geneses is one of the keys of professional development, but at the same time, it presents a high complexity for the teachers.

Empirical studies carried out with teachers have produced many significant results. For instance, it is now clear that the student worksheet and the teacher file are crucial components of a resource facilitating its appropriation. They play a more important role in the documentational genesis than thought by the designers. The metadata are also significant for the teachers, who focus especially on the title and authors of a resource. These results may be of importance for resource designers.

We have observed several different instrumental geneses of the questionnaire and some associated utilization schemes. We have also identified evolutions in the questionnaire usages and in characteristics of the produced reviews. For instance, DG resource analysis goes through an explicit check of DG added-value in comparison with paper and pencil and a special attention is paid to the role of the drag mode. This is a professional skill needed for an efficient DG resource analysis. The development of this skill was obviously aimed at when designing the questionnaire, and the results of the experiments show that the questionnaire indeed helps to achieve this aim.

Although this work shows that quality assessment of DG resources can support teachers' professional development, it also appears that the complexity of such activity for teachers requires specific and long-term support. The teachers participating to the long-term experiment are not only experts in using DG, but they have been involved in the I2Geo project and have thus collaborated with researchers and questionnaire designers. They could benefit from assistance in the stage of their work with the platform. Clearly, all I2Geo users will not have the same opportunity. New means and tools of accompanying instrumental and documentation geneses in the platform users have therefore to be invented, which opens a route for further projects.

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