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Quality Assessment Plan

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Contents

1 Scope

This document is part of the WP6 Quality Assessment production. It is intended to be used freely, in particular by the members of the project in order to implement the ideas described in it, into questionnaires to be taken online, methods to assess and use the results of these questionnaires, a set of documents to accompany the services and processes.

2 Executive Summary

Quality assessment of e-Learning has slowly evolved into a clear necessity. Yet its implementation is difficult and its acceptance by the community is not always straightforward.

In this document we describe how the quality assessment is implemented in the INTERGEO project. There are two levels in it, the quality assessment of the e-Learning content in itself by user's evaluation reports which is the main point we will focus on and the quality assessment of the processes that enter the use of the services.

The main outputs of this work are

- a questionnaire to be taken by teachers that plan to use or used a resource, to evaluate different aspects of the quality of their planned or passed teaching experience, in order to give a ranking score to resources and to identify directions of possible improvements;
- the implementation of a quality approach based on a set of best practices, rules of work, incident reports and quality steps, to be used in the quality management of the processes during the use of the services the project provide. These documents are the result of a light adaptation from the e-Quality project [34] and only the life-cycle of the two main roles, namely the teacher role and the tutor role, are included for completeness.

This work is based on didactical analysis as well as the work of previous projects, namely the SFoDEM project [12] for their resource model, the JEM network [5] for their analysis of evaluation criteria for quality assessment in eLearning mathematics and the e-Quality project [34] for their model of workflows through the definition of activities, roles and artifacts in a Unified Modeling Language.

We won't address specifically the quality assessment of the different Dynamic Geometry Software (DGS) that are used to manipulate the resources, but only its effect on the service and the resources themselves, although the former does influence the teaching experience and the evaluation of the latter in more ways than simply an interoperability issue.

3 Methodology

Quality evaluation is now accepted in the e-Learning community as a requirement; but the implications of quality management and the understanding of the associated processes have not yet percolated into the community of users [10], although its need is clearly identified as was shown in the survey we conducted at the proposal stage, and in the INTERGEO report D5.1 on Dynamic Geometry Usage [35, 16].

Our methodology stems from previous European projects namely the JEM and the e-Quality projects, together with a didactical analysis of the users' evaluation report by the Institut National de Recherche Pédagogique (INRP) authors and the IREM project SFoDEM (see Sec. 4.3).

- JEM: Joining Educational Mathematics is an eContenPlus Thematic Network that began in 2006 and will last for 3 years. The JEM network delivered guidelines and best practices regarding evaluation criteria for eContent quality in mathematics [5].
- e-Quality: Experienced-based Quality in European Open and Distance Learning is a European project within the action MINERVA of the programme SOCRATES that ended in 2006. The project delivered guidelines, process charts and a software to model the processes that take place in the creation and delivery of Open and Distance Learning courses to university students [10, 25, 19]. We adapt this methodology and the contents to our present situation which is different but related, of the delivery of eContent to secondary math teachers. The adaptation is relatively light and the core of the material was developed by the e-Quality consortium. The authors would like to thank Pr. Michelle Joab for her valuable help.
- SFoDEM: a training program that was created by the IREM (*Institut de Recherche sur l'Enseignement des Mathématiques*) of the Université Montpellier 2 in Sept. 2000 and lasted for six years. It stands for *Suivi de Formation à Distance pour les Enseignants de Mathématiques*, meaning "progress assessment of distance learning for mathematics teachers" [18, 13, 12]. It constitutes the genesis of the INTERGEO project.

These projects synthesize and generalize previous methodologies on the issue of quality management that we will not summarize here.

3.1 Objectives

Quality assessment of eContent and of the processes linked to its delivery is necessary for several reasons, the two principal being the quality insurance of service, and the ranking of material by users' evaluation.

Quality assurance of the **processes** linked to the use of the services is a clear objective: seen from the teacher's perspective, best practices should be used in order for the services to be delivered in the most efficient way and quality steps to be taken when incident reports are filed in order to improve the quality of service. This means that fewer failures take place, fewer resources are diverted to address them, and the overall satisfaction of the user is not impaired, her/his trust in the project is built through a feeling of confidence.

We address this view of quality assurance through adopting the **model of processes** defined by the e-Quality project, adapting the definitions of activities, roles, artifacts and workflows that may take place in the use of the services from the teacher's perspective, and issuing best practices, charts, incident forms and methodological guidelines.

Quality evaluation of **resources** themselves, mainly based on users' reports, has more complex objectives. The first one is **usability** and especially searchability: we want the "good" resources to be ranked first by a *search engine*, the score of a given resource will be weighted by the overall quality evaluated by users, providing a sense of confidence for the teacher to use the resources. The second one is **reusability** by improvement of resources and their metadata through *quality cycles* based on users' feedback. And this quality steps can be taken in different directions, namely improving the intrinsic quality of the resource or repositionning its pedagogical metadata asserting its objectives. That is to say a resource may be rich and improve teaching in some given situations and may not be adapted in other situations, the narrowing of the associated metadata to specific situations is part of the quality steps encompassed by the project. Adaptation to the teacher's needs, without authoring a new version is a well a desirable feature made easier by the quality approach.

The metadata will consist in a subset of the LOM metadata, together with an annotation by elements belonging to the INTERGEO ontology, which allows for the definition of competencies, whether prerequisite, trained or aimed at, associated with interactive geometry.

In Fig.3.1, we give an example of a search query that results in the competencies [Identify parallel lines in intercept theorem] and the topic [Enlargement]. Every resource is annotated with such competencies and topics, with a difference between prerequisite competencies, trained competencies and aimed competencies.

Therefore a (fuzzy) distance can be computed between a query and each resource, leading to a first ranking of resources. The quality of each resource and the user's settings then weights differently each found resource and leads to the final ranking.

The quality evaluation bears not only on the intrinsic quality of the resource but as well on its adequation to the pedagogical context described by the metadata, among which the level of education of the learners (Keystage 3 Scottish level in the example).

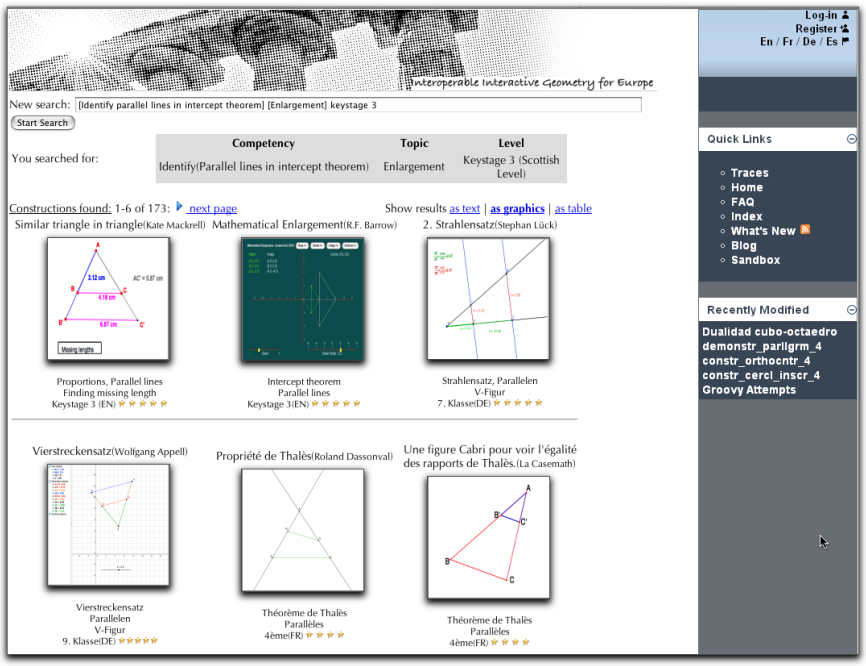

Figure 1: Prototype of the result of searching for `[Identify parallel lines in intercept theorem] [Enlargement] keystage 3`

We make this users' evaluation possible through the careful elaboration of a **questionnaire**, simple enough to be used massively and accurate enough to allow for more than a ranking of resources and for precise detections of aspects to be improved.

In the second year we will bootstrap these quality improvement cycles by organizing tests of resources in the classroom and analyzing quality reports from users' evaluations.

An aspect of the subject that is **outside the scope** of the project, but that we will nevertheless address in the model of the processes, is the elaboration of **new content** or the structuration of existing content, around specific issues such as the adaptation to a given pedagogical context, for example "la perspective en classes de 1ère L". Through facilitating online social networking, we will allow the community to appoint content managers that will supervise a given subject area, the pedagogical planning, the recruitment of volunteers to adapt or author pedagogical and technical content related to the issue at stake. But we will not organize these networks ourselves. We will **not** try to organize the existing contents that we provide per subject, per country or per level, in a **top-down** approach **but** will simply provide the community with enough tools, including quality assessment tools, to organize itself in a **bottom-up** approach, as users see fit. Our belief in the "wisdom of the crowd" will prove whether funded or

unfunded and the user's experience at the completion of the project will largely depend on the success or failure of the whole **web 2.0** approach on which this project is based.

In many cases, assessing the fulfillment of a Quality criterion is not simple. This can be due to several reasons, but it is usually either because there is no means of measuring accurately and objectively (e.g. learner satisfaction, or the suitability of the teaching method) or the thing to be assessed is simply not measurable directly (e.g. all learners have 24/7 access to the VLE)

The four generic tools to assess one or a number of aspects of the Quality of the e-learning process are:

1. checklists, ensuring that every Quality aspect is going or has been taken into account,
2. incident forms, to report a quality breach,
3. questionnaires, to give assessment through feedback,
4. web server usage logs.

We are not going to implement all these tools but we will try to get reports from the users besides the forum discussions, for example by providing optional questions about satisfaction that link to forms to ensure that user's comments reach the person in charge.

The central tool in our approach is the questionnaire described in Sec. 6, filled by teachers planning or having used a specific resource in the classroom.

3.2 Modeling processes

The modeling of the activities, roles, artifacts and workflows that take place in the use of the services related to the project is based on the work of the e-Quality European project within the action MINERVA of the programme SOCRATES [34]. We used the software eLUP "e-Learning Unified Process", based on Unified Modeling Language (UML), that structures the quality approach, and adapted the framework and the content that were produced in the e-Quality project [19]. These adaptations are light; some adapted workflows, activities, definitions, best practices and quality criteria are given in the appendix, to be understood as authored by the e-Quality project; our contribution resides in a description of a vision of the implementation of this quality approach.

The eLup editor: elearning Quality Process Editor integrates the data gathered within the e-quality project and ensures their coherence. It is based on the conceptual model adopted by the E-Quality project. Emphasis was placed on the conceptual model [25], general information about quality processes [7],

the general quality process charter [9], the best practices database [8] and the methodological guide [17].

This methodology decomposes the processes that take place into **workflows** of **activities**, performed by persons enacting a **role**, through interactions with **artifacts**. You can find the definitions of each identified artifacts, roles and associated activities in the e-Quality project [25] and lightly adapted to our context. From the e-Quality project we single out the two main workflows:

- Life-cycle of a teacher in Sec. A,
- Main activities of a tutor in Sec. B.

We adapted the existing workflows and workflow details from the e-Quality project without changing their global structure. Our adaptations are minor. Two of these workflows are described in the appendix.

Each workflow is decomposed in activities, roles and artifacts forming a diagram. These diagrams are commented in the corresponding sections and an example of an activity is given for each, together with an example of a best practice and the quality process that follow.

These quality processes are identified by a quality criterion and a commitment to ensure the criterion is met, which is checked by subsequent indicators, before, during or after the activity. Once again our contribution is light.

The main focus of our interest is the principal end-user, namely the secondary math teacher and our goal is to provide her with a good teaching experience through her life-cycle as user of the project. To achieve that goal, we need to understand and model the different life-cycle of a resource, its genesis, its planning, its design, its production, its use and its improvement. We need to define conceptually the processes and the activities that take place, the roles of the people that act and the artifacts that they interact with. This lead to quality criteria, commitments for these criteria to be met and best practices to facilitate these commitments.

e-Quality in ODL	Student	Teacher	Institution	Course	Learning event
INTERGEO	Teacher	Author	Project	Resource	Teaching event

Table 1: The correspondence between e-Quality and INTERGEO models

We analyzed the educational model proposed in the e-Quality project and found it was possible to adapt it to our situation. The e-Quality project focused on providing a **student** with the right cooperative framework for him to **learn** from an Open and Distance Learning university **course** and assess the learning experience. Our objective is to provide a **teacher** with the right framework

to **teach** using a particular **resource** found on our web-site and assess the teaching experience. The artifacts are similar, the roles are somewhat shifted, as summarized in Table 1, but the need for emulation and support, feedback and analysis are strikingly akin.

Some features in ODL are of course irrelevant. For example diploma are not to be considered. Learning scenarii might develop afterwards based on the curriki platform that we are using, but are outside the scope of the INTERGEO project at this stage. Nevertheless the analogy was very fruitful and led us to include activities that we had not identified at first as important in our preliminary conceptual model.

Of course some other processes that are relevant to our model don't have an analog in the ODL model. The crucial example of this is given by the promotion of roles, which is alien to ODL where a student remains a student and a teacher a teacher.

Following this analogy, the adaptation of the content, workflow charts, best practices, indicators produced by the e-Quality project is relatively light. The core of the content developed by the e-Quality team is recycled in the annex of this document. The main difference consists in **roles**. In ODL a student remains a student, and there is a clear distinction between the status of an academic and of a student, a teacher being unable to attend a course for example. In the INTERGEO project, on the contrary, every role is supposed to be filled by the same kind of users, that is, secondary math teachers, who enact fluctuating roles. They can be a simple user of a resource, while being the author of another, testing in the classroom a third one, tutoring on the use of a fourth, and managing the content of the subject "Thales theorem in Hungary" for example. Therefore the roles are specific to a given resource: For this resource, that user is seen as a tutor. The roles of a given user regarding a resource follow this cycle:

Simple user → a priori reporter → enrolled teacher → a posteriori reporter → tutor → author → manager

3.2.1 Teacher's needs

This model is not only a convenient way to describe the processes but is as well **diagnostic** [2] and can be used as a tool for quality, understood as a continuous workflow oriented to taking decisions to improve the situation. Our main interest is to satisfy the needs of the teacher along his use of the services, described in Table 2. This model will help us to define the correct user's interface of the platform in order to make as sure as possible that most users needs are met.

To summarize, the teacher searches the server for resources to teach in her/his classroom; once found, s/he enrolls as a user by providing an a priori assessment

Stage	Description	Teacher needs
Teacher needs and interest in the offer of the project	At this point, the teacher discovers that our project is offering resources, which may meet his/her needs.	Between this stage and the subsequent step in which the teacher will join the project, there is a need to satisfy the information requests from the teacher, to inform him/her about the features of the resources, how to register, the necessary technology equipment, the characteristics of interactive geometry teaching
Teacher joins the project	Once the teacher is registered, some other needs arise: At this point, it is very important that the project offers appropriate ways to meet these needs. The process of 'joining' is intended to organize and control the performance of these aspects.	– Need to inform the teacher on the use of the technology: virtual learning environments, interactive geometry, beamer technology – Need to set-up schedules, rules of work – Need to receive administrative and technical support
Teacher is ready to enroll as a user of available resources	At this moment the teacher has all the information and skills to start using any resource. During this and the following two stages the teacher may also need technological support, administrative support or other services	– Need to find and obtain resources from the repository – Need for technical support – Need for administrative support
Teacher enrolls as a user of a resource	Start of the learning/teaching process	– Need to receive learning materials, teaching materials and other resources – Need to receive tutoring support – Need to receive technical support – Need to receive administrative support
Teacher performs the teaching event	End of the teaching process	– Need to give feedback regarding the teaching experience – Need to give suggestions regarding the improvement of the resource – Need to receive a promotion (as a tutor or author) if interested

Table 2: Adaptation of the five main stages in the teacher life-cycle, from the e-Quality project to the INTERGEO project

and scheduling the course. After an appropriation phase, the course is taught and an a posteriori evaluation is given. S/he can then be promoted to the role of tutor of the resource.

3.2.2 Author with hats

The teacher using a resource revolves around the needs described in Table 2 and goes around the cyclic process described in Fig. 3. But the resource itself follows a similar cyclic process, it has to be planned, designed, produced, prepared, advertised, usage has to be guided and supported, pedagogically and technically, a feedback has to be given during the appropriation stage and after the teaching event.

The author of a resource has several hats on her head to manage this cycle. In nowadays interactive geometry communities, the author is very often confused with the only role of **content producer**. She indeed provides the contents of the learning resource, but other roles have to be taken into account, she states the intellectual property license; planning and designing, for example, have as well several aspects, whether pedagogical or technical.

It is nevertheless true that due to its technical aspect, interactive geometry needs good learning material producers, experts of their tools and understanding the limit of interoperability. They really are the "kings in the INTERGEO castle" and even though we wish to point out that their role is multiple, the community will continue to summarize it under the term "author".

In order for a teacher contemplating the use of a resource to actually use it in the classroom, some motivation and guidance are required. This is the main role of the **tutors**. The author of a resource is its first tutor but he can be joined in this task by other teachers that used and liked the resource and who want to promote its use by helping others coping with problems they might encounter. This help is mainly done through collaborative tools such as forums and chats embedded in the platform and attached to the resource. The output of this guidance is the adoption by the teacher of a schedule for the use of the resource, both in her teaching progression throughout the year so that it will fit in the course, but as well locally the planning of the resource during the teaching event itself. This is summarized in an individual teaching plan where all the resources from the project used by this particular teacher in a given class are planned, it is a place where the learners are sent in order to retrieve the assigned activities.

Just as a teacher can be promoted to the role of tutor, after a cycle, the resource does not necessarily die and can be improved by taking quality steps towards a revised version. The **quality manager** of a resource is going to be, at first, in a bottom-up manner, the author of that resource. More elaborate quality management of resources through their integration in subject areas managed in a top-down approach is to be encouraged but the project will not try to organize this more than providing the tools to the community for its self-organization.

Before this organization process bootstraps itself, it is the responsibility of the author herself to establish the quality approach, to budget the human costs of quality steps, to establish or not training programs and optionally to take advice from the coordinator of the subject area if there is one in order for the resource to fit in a general learning plan. She will be helped in this by the feedbacks from users.

This **feedback** consists in assessments from the users through filled questionnaires and in forum interaction. The users who answer to questionnaires will be mainly teachers who use or plan to use the resource, or the author herself, but can be as well didactical experts contacted through the coordinator, who conduct researches on the use of the content from our project. The questionnaire itself is the topic of Sec. 6. This feedback from the user is quantifiable and statistical when it comes from the numerical values collected by the questionnaire, but consists as well in verbal exchanges, linked to the questionnaire or on the forum attached to the resource, acting as a mailing list. This is especially valuable for the author in order to take the fundamental quality step of revising the resource, whether reusing it in another context or simply producing an incremental version.

It has to be pointed out that according to the **license** given to the resource by the author, other users may or may not take on their own hand this quality step of revising the resource. The first authoring activity, which is often overlooked or forgot, is to choose a distributing license. The INTERGEO project promotes the use of open licenses such as the Creative Common Share Alike so that adaptations, whether light such as translations, or heavy such as redesigns of pedagogical goals, can be undertaken by teachers other than the author. It is specially the case of tutors, their natural role is to be promoted from a pedagogical tutor to the author of the next version. Such endorsements exist in open-source software projects where commiters fell responsible for the project. In the same manner, we think that teachers will organize in teams of tutors and that these tutors will promote improvements and will commit new versions. The project will bootstrap this approach on selected contents during the quality testing that will happen in the second year of the project.

3.2.3 Licenses

Unclear licenses are a real impediment to the use of resources found on the Internet. The INTERGEO project aims at rising the awareness of the share holders in the value chain to this issue. The author (or in a more elaborate set-up the learning material designer) has to choose a license contract for the content that she intends to produce. The INTERGEO project is promoting the use of open licenses that allow adaptation and reusability such as the Creative Commons Share Alike license. The main issue at stake is the possibility for a user to change role without having to ask for permission: a tutor seeing a need for improvement in some content can edit it right away, thus becoming an author

of the resource, while more restrictive licenses will require the user to wait for author(s) approval. We will propose several licenses from which to choose, namely (for the time being):

- Creative Commons Public Domain
- Creative Commons Attribution-Sharealike
- Creative Commons Attribution Sharealike Non-Commercial
- Creative Commons Attribution-Sharealike Non-commercial-No Derivative
- GFDL GNU Free Documentation License

It is not in the scope of this document to discuss these licenses but quality improvement goes hand in hand with promoting reusability and adaptation, which leads to the preferred choice going to CC Share Alike license. Authors have to make informed choices and we will provide FAQ regarding legal matters to prevent misunderstandings, for example it is not because some content is licensed with an open license that its author loses his right to relicense it with a more restricted license for another use; he can distribute his own selected content, available for free on the server, through a commercial editor with a standard commercial copyright. The technical implementation of these licenses should reflect their philosophy and legal bindings, for example a user of a resource should be able to contact the author(s) of a resource to ask for permissions for a given use if this permission is not granted by the license; or a change in a resource should trigger a message to be sent to its authors so that they can ask to be removed from the list of authors if the content no longer reflects the pedagogical choices they initially had in mind regarding the resource.

The author can be a person or an institution as well as an avatar but has to be ultimately linked to an identified user responsible for her/his production.

An author doesn't lose her/his right to relicense the content for another use, for example for commercial distribution.

S/he can ask to be removed from the list of authors of a resource that has been adapted in a way that no longer reflect her/his views.

3.2.4 Reuse

The reuse and improvement of existing material plays a crucial role in the INTERGEO project. While our first goal is towards the effective use of the available content in the classroom, the sustainability of the project relies on its adoption by the users through a quality approach, bringing confidence in the content hosted by the project. This will only occur when the existing material quality is assessed through users' evaluation, the feedback pointing towards ways of improvements, and this feedback being taken into account in the actual revision

of the existing content according to this feedback. As we see in Sec.6, the feedback given by users of a resource will be of two kinds, a numerical evaluation of different criteria and a textual feedback through the forum. Both feedbacks have to be taken into account. This will prove difficult if no common language is used by the users and the tutors, small homogeneous design groups should be fostered.

Interactive geometry resources are usually pedagogically and technically planned, designed and produced by a small group, sometimes by a unique person, enacting different roles that gain to be explicit. It is a mixture of technical possibility, together with a desire to illustrate a notion with an available tool that yields the production of a usage scenario adapted to the artifact that has been so produced.

The INTERGEO project intends to promote the creation of teams that will unite around an idea, based on learning material, leading to a possible usage and to its production as a multimedia artifact. The preliminary design of a resource will take place whether in face to face meetings or through the online forum and chat tools. We expect that some inspiring resources will remain as **germs**, work in progress forever, without clearly identified pedagogical use, stemming different finalized resources for different situations. Creativity has to be promoted.

The use of available external media, such as free picture, sounds or content repositories will be as well promoted. Conversely, the INTERGEO project will provide, together with the open file format standard, a standard for the Application Protocol Interface (**API**) of the different software, allowing for the development of external exercisers, learning scenarii and learner's activity control, based on pieces of interactive geometry found on the INTERGEO website. It is not the purpose of the INTERGEO project to develop such tools but to work towards making them possible through an easy integration by an interoperable API and easy automatic retrieval and navigation through the repository.

3.3 Implementation

As we repeatedly mentioned, the model of the processes is the work of the e-Quality project and our adaptation is minor. Our main contribution to the process model is the implementation of the role changes.

The completion of a task entitles the user for a promotion to the next role. In fact every action on the platform should be rewarded by an increased level of confidence in the action of the user: A teacher who is enlisted for a long time, who has replied to many messages on forums, who has filled in several reports, should be considered as a trusted user and her reports should be weighted accordingly in averaging the reports into a global quality evaluation. Of course didactical experts will begin with a much higher weight than average users. If the total weights of reports for a resource reach a certain level, to be defined by the experience at the end of the project, we might consider labeling the

resource with a certain title and the users should feel that they are part of this labelisation process.

3.3.1 User to Reporter

A simple user can browse our repository, download and use a resource, together with associated pedagogical documents, for the teacher, for the learners, the general guidelines, the users forum of the resource and so on.

This activity will be tracked by the platform and will adapt the user interface accordingly: after having tracked a complete review of the available data, or a download, the system will present an a priori questionnaire to the user.

Hits statistics of the resource have to be apparent, such as "two users are viewing this resource", so that a user can see that his/her action is taken into account.

3.3.2 Reporter to Teacher

If this questionnaire is filled, enrollment as a teacher planning to use the resource is proposed.

A positive answer will provide with a form to be filled, attached to the resource and specific to this teacher, asking to decide for a scheduled date for the teaching event. This form will be revisable by the user. The schedule is accessible through a permalink URL that the teachers can distribute to their learners.

User's story example: "For tomorrow assignment on proportionality, I advise you to go through the activity that we did yesterday, titled 'measuring a pyramid', you will find it on the webpage for the class on the INTERGEO project."

Links to the self-evaluation grid and a check-list allow the teacher to understand what to look for and what to remember to notice during the teaching event.

A reminder is sent by email, to the teacher and to the tutors, if the teacher is not active on the forum asking questions or reporting on his appropriation of the resource prior to the teaching event.

A compilation of filled questionnaires, whether a priori or a posteriori, with their numbers and statistics is available. The name of each enrolled teachers with the scheduled date is available if authorized by the teacher. A map of their localization could be a good idea to promote the sense of reality to the community.

3.3.3 Teacher to Tutor

After the date of the teaching event, the a posteriori questionnaire is made available.

A reminder is sent by email, to the teacher and to the tutors, if the teacher does not report on the teaching event.

Once the report is given the teacher is automatically congratulated and is proposed to become a tutor in order to support fellow teachers.

The name and characteristics (since when, number of interventions) of each tutor is available if authorized by the tutor.

3.3.4 Tutor to Author

A seasoned tutor that actively supported several teachers surely has gathered ideas about improving the resource and this knowledge should be invested in the creation of a new version of the resource, so a promotion will be automatically proposed at some point to be decided on actual usage analysis.

The name and characteristics (since when, number of interventions, cause of the changes) of each author that has contributed to the resource is available, if authorized by the author, to promote the feeling that feedback is taken into account and that anybody can and should participate.

3.3.5 Author to Manager

The promotion to manager of a subject will be definitely left to the community to organize, whether on a voluntary basis as self-promotion, or through internal hiring of key authors. The INTERGEO project will bootstrap this process by selecting and appointing experts in interactive geometry for different broad subject areas such as language or preferred software but the actual organization of their subject will be left to them.

The name and characteristics (since when, responsibilities) of each manager that has contributed to the subject is available, if authorized by the author, to promote the feeling that organization is taking place and that anybody can and should participate.

3.3.6 User's interface

We describe a full fledged resource in Sec. 4.3 as a collection of sheets, a learner sheet, a teacher sheet, a technical sheet and so on. The resources at the beginning of the INTERGEO project will be only germs, with a short description and a learner sheet. Only the learner sheet is visible to a visitor which is not an identified teacher so that learners can be directed to the resource page for an online use of the resource.

Following the SFoDEM CD-ROM [12], each sheet is associated, on the resource page, to a "tab" which opens it. Other technical tabs allow to edit the sheet,

see its versions or use its forum facility. A tab is grayed if the information is not yet present or if the status of the user does not permit to perform the action. Tabs such as "Edit" should be grayed when the license or status does not allow the action, but should nevertheless trigger a contextual action such as "become an author" or "contact the authors" depending on the situation.

Each sheet consists of a wiki page where the insertion of interactive geometry constructions is done in a easy to use wiki syntax in the same way as static images.

All sheets are exported, together with the construction files, in a downloadable bundle that can be viewed off-line.

This users interface stems from the work of the SFoDEM project [12, 13, 18, 15] at the genesis of the INTERGEO project.

4 Questionnaire elaboration

We are describing in this section the methodology that lead us to define the resource evaluation questionnaire by the users. We are not concerned here about other processes or overall project quality.

In a nutshell, our methodology is the following:

- Identify each characteristic relevant for the quality of a resource
- Formulate its evaluation as a question in theoretical terms
- Reformulate this question in a language accessible to the user
- Reformulate the question to make it quantifiable
- Organize and compile the answers into several grain levels of quality.

4.1 Overview

Mahé and Noël [24] point out difficulties with using resources available on the Internet due to their visibility and spotting, as well as the possibility of selection based on an assessment of their quality. These issues raise a number of questions: How to choose a resource? Why this one rather than an other? How to determine which resource is the best adapted to the user's needs?

The authors claim that indexation of pedagogical resources by using specific metadata answer partially some of the above mentioned questions, providing information about the types of activity at stake, the time required for their realization... However, this information is not sufficient to choose the best suited

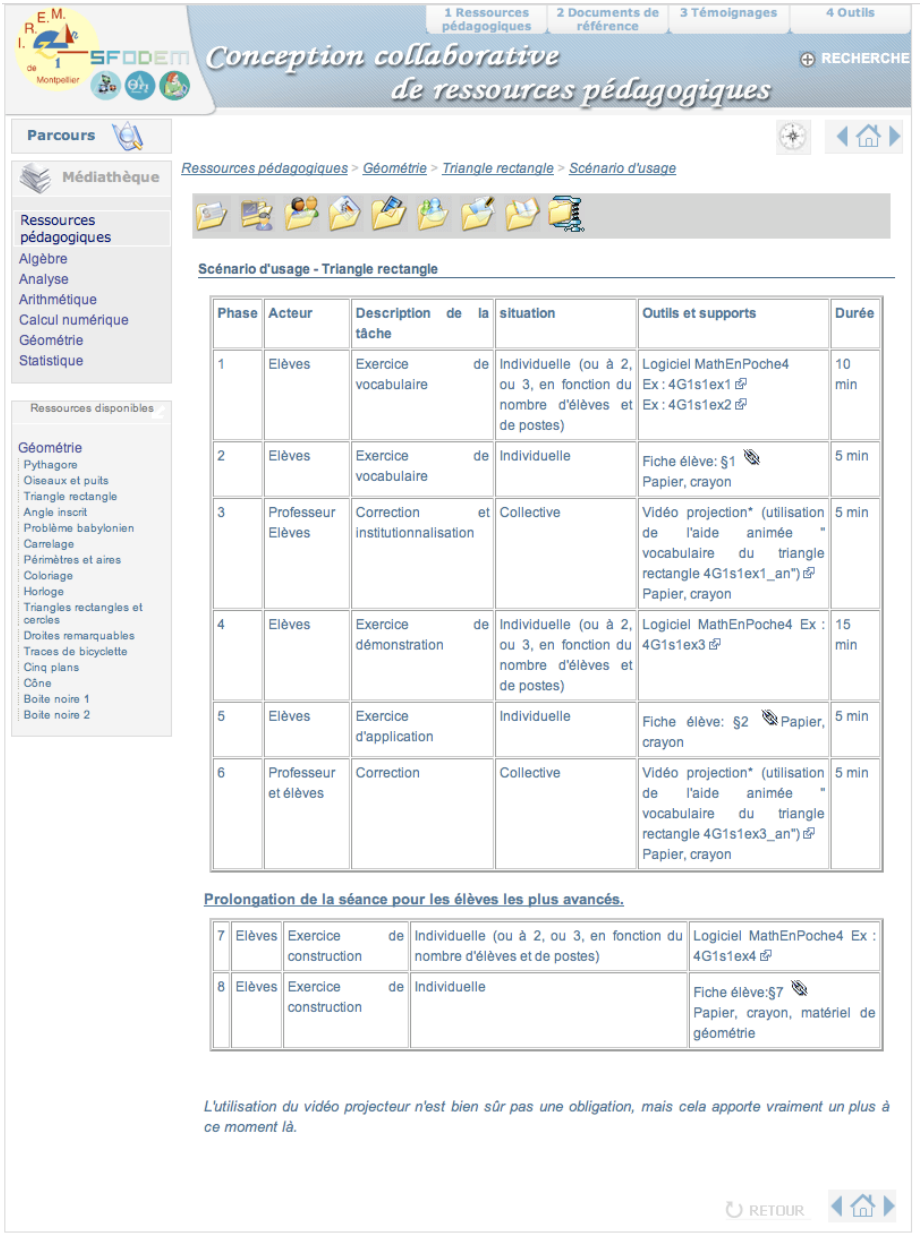

Figure 2: The SFoDEM CD-ROM [12] interface for a resource, the usage scenario tab.

resource among a number of similar resources. What kind of information is relevant and allows to choose the resource which is the best adapted?

In what follows, we give a brief overview of research works addressing the issue of quality assessment of pedagogical resources.

As regards the indexation of pedagogical resources, the Canadian Web site Normetic[26] is devoted to the issue of describing pedagogical resources in order to facilitate their searchability and interoperability. The adopted metadata draw on the LOM standards. In France, the Ministry of Education devotes a case [6] to the issue of pedagogical resources indexation whose main aim is to give value to pedagogical patrimony.

Beyond indexation, quality assessment of pedagogical resources becomes a topical issue. Mahé Noël [24] suggest distinguishing between the process of *validation*, i.e., verifying of the conformity of a resource to certain requirements, and the *evaluation*, i.e., estimation of the quality of a resource with respect to certain criteria. Validation of a resource rely on various criteria:

- technical validation (verifying the technical possibility to open and work out the resource),
- content validation (verifying the coherence of the content with respect to the curricula...),
- design validation (verifying the navigability of the resource),
- description validation (verification of the accuracy of the metadata as well as of their correspondence with the resource).

Evaluation requires to define specific criteria. These can follow the four above mentioned categories:

- technical evaluation (the resource functions reasonably well, is free of bugs and defects that inhibit intended use[1]),
- content evaluation (evaluation of the quality and validity of the content, usually done by subject matter experts),
- design evaluation (evaluation of ergonomics and the degree to which the resource is likely to meet the instructional goals[2]) description evaluation (evaluation of accuracy of metadata).

Five different modalities of evaluation are reported by Mahé and Noël:

[1] http://www.dlese.org/Metadata/collections/resource-quality.php
[2] http://cloe.on.ca/peerreview.html

- a priori, implicit evaluation meaning simply that authors have to be members of the institution or the network that disseminates pedagogical resources at stake (ex. SPIRAL[3] pedagogical platform of University Lyon 1, France),
- peer-review evaluation, similar to peer-reviewing of scientific publications (ex. FORMIST[4]),
- user evaluation, allowing the users to express their opinions or comment a resource (ex. ENPAIRS[5]),
- cross-evaluation, which combines peer-review with user evaluation (ex. MERLOT[6]).

Tricot al. (2003) [36] point out that evaluation of pedagogical resources is often reduced to evaluating their utility and efficiency and claim that a third dimension needs to be taken into account: usability. Although evaluation criteria they propose have been defined rather for computer-based learning environments, it seems that they can be efficiently adapted to pedagogical resources. Therefore, we give a brief summary for criteria concerning utility, usability and acceptability of a pedagogical resource, which can be used either empirically or by inspection:

- utility is related to the evaluation of adequacy between instructional goal and its accomplishment (p. 395),
- usability concerns the possibility of using the resource (clarity, coherence, simplicity, "handiness"...),
- acceptability is defined as the value of mental representation concerning the resource, its utility and usability (p. 396).

FORMIST, a Web site specialised in training to information searching, evaluating and using, came up with the idea to proceed to an evaluation of resources available on the Web site by a committee of experts. An evaluation grid (see Appendix C) has been elaborated for this purpose proposing the evaluation of 6 aspects of a resource:

1. author,
2. goals and media used,
3. content,

[3] http://spiral.univ-lyon1.fr/
[4] http://formist.enssib.fr
[5] http://www.enpairs.ca/
[6] http://www.merlot.org/merlot/

4. didactical aspects,
5. document structure, and
6. format and accessibility.

The JEM network [5] advocates against peer review, seen as too slow a process, while pointing out related criteria:

Academic criteria: Accuracy of content, adherence to stated learning objectives, clarity of learning objectives, clear identification of target learners, professional presentation, credits to creators, feedback opportunity/assessment support, appropriate references, identification of pre-requisites

Technological criteria: Ease of navigation/user interface, accessibility, clarity of usage instructions, appropriate use of technology, effective/engaging use of technology, technical requirements documentation, usability in learning environments, metadata accuracy, sustainability and openness

4.2 Types of resources

The characteristics and evaluation criteria differ depending on the type of resources we are going to assess.

Resources deposited onto the platform so far are not yet homogeneous (cf. Table 3). The quality assessment process has to be adapted to the type of resources. Table 3 presents different types of resources that have been deposited on the platform before March 2008.

The common file format and what exactly we mean by an Interactive Geometry construction (or Dynamic figure) has not been officially settled yet but the consortium does agree that the following three types of resources will be considered in the INTERGEO project:

1. A figure alone with a short description of the figure and its pedagogical goals;
2. A figure, or several figures, included in a text. The text can be addressed to the teacher, the learner or both.
3. A file (word, pdf, video or other downloadable format) whose content refers to either of the two previous types of resources.

The assessment process discussed in what follows focuses on the second type of resources which are full fledged interactive geometry resources. Some aspects of the quality assessment process will not apply to the first type of resource (bare construction).

1.a	Figure alone	Dynamic figure (i.e., figure with free objects that can be dragged)
1.b		Animation (i.e., figure that can be modified by means of exterior parameters)
1.c.		Figure with menus allowing constructions or other modifications of the figure (ex. TracEnPoche)
2	Figure from 1 with a problem text	Interactive exercise
3	Software	
4	Exercise with a text suggesting a pedagogical enactment	Resource from 2 with documents (e.g., worksheet, teacher file, learning scenario...)
5	Figure from 1 with examples of pedagogical use	
6	Web site presenting lecture, figures, exercises...	

Table 3: Different types of resources available on the INTERGEO Platform.

4.3 The SFoDEM model

We elaborate on the type of resources available on the INTERGEO platform by describing the SFoDEM project, that constitutes the genesis of the INTERGEO project.

The bare constructions are interesting as fragments to be used in alien VLE that use them for illustration purposes inside documents in an environment over which we don't have control, just like some pictures from a free repository can be embedded in a web page or document that has no formal connection with the repository. It is a vision of the project that interactive geometry could pervade tomorrow human interfaces as a standard for interactive objects, just like jpeg pictures (Joint Photographic Experts Group) have allowed for the creation of attractive web pages. Although the INTERGEO server has the clear goal to host such constructions, these bare constructions are not to be assessed as independent entities in the same manner as more elaborate pedagogical constructions.

Indeed, what is the subject of our quality assessment consist in resources of interactive geometry together with a minimum description of its usage. We intend to adopt the SFoDEM model of resources [12, 13, 15]. It relies on three main hypothesis which are still valid for the INTERGEO project:

1. The adoption of e-Learning in the classroom requires support centered on pedagogical design and planning of resources.

2. Pedagogical resources are to be considered as living beings, evolving in response to its usage and through collaboration of teachers that use it, becoming instruments [28] of professional practice.

3. This collaboration takes place when a community of practice [39] emerges around a common objective, a feeling of trust and the sharing of resources.

This training program led to the elaboration of a common framework, defined roles and charts and produced many pedagogical resources.

The SFoDEM resources specifications helps the authors formalize their pedagogical resources in a way that eases re-usability and quality assessment, by identifying, for a given activity, the teacher pedagogical objectives and roles in the teacher sheet, and the learner assignment and description of tasks in the learner sheet to be distributed. Even the better designed exercise is not self explanatory, it is much better practice to explicit the pedagogical intended scenario outside the actual document, with expected difficulties, time allocations and activities sequences in the scenario sheet.

In this framework, a resource goes through several stages, from a resource germ to a full fledged resource consisting of several elements:

- an identification sheet stating the title, authors, license, versions and history, short description;
- a teacher sheet describing an activity from the point of view of the teacher, containing the subject matters;
- a learner sheet describing an activity from the point of view of the learner, for example asking questions to be answered by the learner;
- one or several usage scenario [38] describing an open schedule for the activity decomposed in phases, with actors and performed activities;
- a technical sheet describing the technical details, together with the construction files and downloadable bundles;
- usage reports, from the teacher point of view;
- productions, gathering traces of the work that took place, learners screenshots, mistakes, good ideas that emerged, possible alternative learning paths...

Most resources at the start of the INTERGEO project will be germs, with a simple identification sheet, a technical sheet and sometimes a learner or a teacher sheet. At the completion of the project, we expect that the quality ideas will settle in the community, leading to a reasonable amount of full-fledged resources.

4.4 The ARCS model

Recalling work done in the JEM project [5], we note that John Keller has formulated pertinent criteria to assess the quality of e-Content called the ARCS model, short for Attention, Relevance, Confidence and Satisfaction [20]. They have to be considered in the teacher's and in the learners' perspectives:

- **Attention:** The content should engage learner's attention at once. It is an amazing experience to see how a piece of good interactive geometry manipulated by a skilled teacher results in learners that can not wait to put their hands on the mouse and manipulate the construction themselves: The construction is reacting to the user's input, giving its name to one of interactive geometry constructions nicknames "Imaware", short for "I'm aware". The learner wants to understand the figure and by a sort of empathy, builds a mental model of the construction, which is the most profound step of learning.
- **Relevance:** Learners are overloaded everyday by attractive and irrelevant material such as advertisement, they build protection mechanisms against it and the material shown to them has to prove relevant by examples and applications. Another type of relevance, from the point of view of the teacher, is of course the curriculum.

- **Confidence:** The learner should not be put off balance too much by the content, it should add to his/her knowledge and skills in a way that builds confidence in the learner's abilities through active learning and problem solving. From the teacher's perspective, the level and semantic density has to be adjusted to the audience, the subject matters and the technical aspects of the questions should be mastered enough so that s/he feels confident with teaching the resource and handling the issues that may arise.
- **Satisfaction:** The learner should be able to certify that s/he has met the pedagogical goals of the activity and has mastered the material. The teacher should be able to witness a transfer of knowledge and competencies from the e-Learning activity to the more usual form of learning.

4.5 Assessment processes in interaction

Different types of assessment process are identified in the literature [24], mainly expert review and user review. In the INTERGEO project, we aim at defining and implementing a cross-evaluation of pedagogical resources both by experts and users. These assessments will be bootstrapped by conducting experimentations in the classroom.

Our first implementation of these two levels of review will be quite simple: they will use the same evaluation tool but an expert or an experts group will weight much more than an average user. Each user being identified, s/he will carry a weight asserting the trust in her/his judgment: a beginner assessment will weight less than a seasoned user, that has given many detailed reports and forum messages, and the latter will weight less than a didactical expert.

4.5.1 Expert review

The expert review will be done in two phases: first, a theoretical analysis of a set of selected resources will be done resulting in the design of an evaluation model, second, a large scale assessment process will be carried out by a group of teachers supervised by mathematics education researchers.

Theoretical analysis The design of this process has been initiated in the framework of a Master thesis. The aim of the thesis is to elaborate criteria to assess the quality of dynamic geometry resources. The proposed criteria will draw on the results of the research studies pertaining the evaluation of pedagogical resources and will emerge from an a priori analysis of several selected resources. The obtained evaluation model will be validated by an experimental study with a group of teachers who will test these resources in their classrooms.

Large scale assessment process by an expert community of practice This assessment process will start in September 2008 and will consist in an a

priori analysis of a significant number of resources available on the INTERGEO platform, their testing in realistic contexts and analysing the outcomes of the tests.

Both above mentioned assessment processes done by experts could lead to a quality label of the resource.

4.5.2 User ranking

This is the main topic of this deliverable.

User assessment process needs to be quick, on line and directly linked to the resource. The design of the process requires to:

- Know the profile of the user who will assess resources. At least three different user profiles can be envisaged:
  - teacher (pre-service or in-service),
  - mathematics educator or didactic researcher,
  - outsider
- Formulate quantifiable questions
- Allow comments

The users will carry a weight asserting a degree of trust depending on their status, experience and implication in the project. This weight will be used in averaging different answers into one final score. The degree of detail of answers will be taken into account as well. The feedback will be of two sorts, a quantity for each question, whose analysis will be automated, and an optional textual comment, in their own words, to give a more precise feedback if needed. These comments will be available to the tutors and the authors. If they are in a language they do not understand, this information is somewhat lost.

4.6 Rationale

In light of the previous summary of related works, the proposed methodology will consist in:

- Identifying the relevant characteristics of a dynamic geometry resource in order to asses its quality;
- Formulating corresponding evaluation criterion as questions in theoretical and expert terms; Reformulating the questions to make them understandable by the potential users;

- Reformulating the questions to make them quantifiable: each question should be given one of the following four[7] answers: agree, quite agree, quite disagree, disagree; the scale should always go in the same direction: "agree" being a positive evaluation and "disagree" being a negative statement.
- Designing an algorithm to compute the answers and provide a level of quality

Objectives of the quality assessment process: We want to go beyond a superficial report on the use of a resource by the teacher such as "I used this resource, everything went well, I'm satisfied and my pupils as well"! We want to make the teachers explicit tangible elements of the learners' activity with the resource especially in a manner that will allow for the identification of improvements steps to be taken.

The quality of a resource concerns: the resource itself, the metadata which are attached to it, the possibility of evolution of the resource.

The quality assessment process of a given resource will be carried out both **a priori**, i.e. before using the resource with learners, and **a posteriori**, i.e. after having used the resource with learners. A priori analysis will be required from a user when s/he makes a choice of a particular resource. At the same time, it will be proposed to enroll for a teaching event in the classroom (or in a virtual learning environment) using the resource. After having tested the resource in the classroom, s/he will be asked to answer the a posteriori set of questions.

5 Relevant features

Based on this methodology, we list and organize the features of a dynamic geometry resource usage that seem relevant with respect to its quality assessment. We identified five main criteria that are indicators that can be evaluated to assess the quality of an interactive geometry resource. They are themselves subdivided into more precise criteria.

The five main criteria are:

1. Appropriation by the teacher 5.1
2. Added value of dynamic geometry 5.2
3. Learning potential 5.3
4. Technical quality 5.4
5. Quality of metadata 5.5

[7] With an odd scale, the user is attracted by the answer in the middle, which can be difficult to interpret.

5.1 Appropriation of the resource by the teacher

The appropriation of a resource by a teacher relies on three different aspects of the resource: its mathematical content, the digital file containing the dynamic geometry figure (DGF) and the suggested enactment with the learners.

An important question to which we do not have satisfying answer yet is: which elements of the resource support its appropriation?

This criterion addresses the issues of

- the content quality of the resource, which can be assessed independently of its appropriation;
- the possibility for the teacher to integrate the resource to his/her planned teaching sequence;
- the didactical and pedagogical appropriation of the resource.

5.1.1 Mathematical and instrumental quality of resource

1. Is the resource correct from a mathematical point of view? (Examples of inconsistencies: use of approximate values, calculation with measures, limit cases, position of the figure with no mathematical interpretation...)
2. Does the provided DGF correspond to the mathematical activity proposed in the resource? Does the provided DGF behave as it is expected in the activity?

5.1.2 Integration of the resource into the teaching sequence

Some teachers are reluctant to use dynamic geometry because they believe that their pupils need to master the technological tool well enough before using it to learn mathematics. Researchers point out that both competences - mathematical knowledge and instrumental skills - are strongly intertwined (Artigues 2002 [1]). A way to support the appropriation of a resource by teachers is to explicit prerequisites, distinguishing instrumental and conceptual aspects (Restrepo 2007 [29]). The prerequisite should be specified in a document intended mainly at the teacher.

1. When the prerequisites are specified:
   (a) Do they distinguish between prerequisites in terms of mathematical prerequisites and instrumental skills?
   (b) Are they compatible with the curricula and institutional expectations?

(c) Are they relevant with respect to the planned activity?

2. To what extent is it possible to reinvest the outcomes of the resource use in the teaching sequence planned by the teacher?
3. Is the resource used in an experimental setting of the class, independently of the planned teaching sequence?
4. Is the resource used to make the teaching sequence progress?

5.1.3 Didactical and pedagogical appropriation of the resource

A successful integration of technological tools requires a specific organization of the use of instruments in the learning of mathematics, as shown in Trouche (2005) [37, 14], which is theorized trough the idea of orchestration. It points out that the teacher needs to manage the uses of instruments and their relation to mathematical learning. To achieve this, the teacher needs support brought by the resource.

1. Regarding the organization of the learning and the role of technology, does the resource provide enough elements related to:
   - the management of mathematical content at stake?
   - the management of interactions between learners and dynamic geometry?
2. Regarding the pedagogical organisation of the class, does the resource provides enough elements related to:
   - the setting of the classroom (use of a computer by the teacher by means of a video-projection, use of computers by learners in a computer lab, what learner/computer ratio...?
   - the temporal organization of the session with the resource (succession of phases of individual and group work, management of collective phases...)?
3. If the resource does not provide any elements about its pedagogical or didactical use: Is it possible/easy to foresee its enactment in the classroom? (a priori) Could you envisage your own way how to use it in your classroom? (a posteriori)

5.2 Added value of dynamic geometry

This criterion aims at collecting users' opinions about dynamic geometry, namely how they perceive possible contributions of the use of DG within the resource in comparison with the traditional paper and pencil environment, as well its contributions to achieve the specified pedagogical goals.

5.2.1 Opinion regarding added value

1. To your opinion, does the use of dynamic geometry in the resource present an added value in comparison with working on this activity in the paper and pencil environment?

   In order to deepen the consideration of added value, we suggest to question the users what features of dynamic geometry represent the added value for them. We will refer to research works concerning added value of dynamic geometry and its perception by the teachers (Laborde 2001, 2004, Lins 2003 [21, 22, 23]).

   (a) More precisely, do you think that the added value of the use of dynamic geometry in the resource comes mainly from the fact that:
   - Dynamic geometry is a visual amplifier because it improves the graphical quality and precision of the figure drawn with DG (example of the graph of $x \mapsto x^2$ function or the 3D representation of solids)?
   - Dynamic geometry offers the possibility to obtain easily and quickly many cases of the same figure?
   - Dynamic geometry provides an experimental field for the learners' mathematical activity, because it supports exploration and trial-error strategies?
   - Dynamic geometry encourages learners' autonomy and responsibility, because the feedbacks enable them to validate by themselves their constructions?
   - Dynamic geometry makes possible the articulation of different representations of the same mathematical problem?
   - Dynamic geometry requires working on geometric properties of a figure rather than on its spatio-graphical properties? Indeed, to obtain a figure, which will resist to dragging test, the user has to explicit its geometric properties while constructing it (idea of robust construction).
   - Dynamic geometry allows the creation of new mathematical problems specific to the DG environment (black boxes, soft constructions...)?

   It is commonly accepted that the **drag mode** represents the most peculiar feature of dynamic geometry, which can be used in various ways according to the pedagogical goals aimed at and to the mathematical content at stake:
   - to illustrate geometric properties of a figure: dragging and observing that a given geometric property remains unchanged in the figure;
   - to conjecture geometrical relationships: dragging and observing whether the supposed relationship remains present on the figure;

- to validate a construction (robust construction): dragging and observing whether the geometric properties defining a figure remain unchanged in the figure;
- to illustrate the link between hypotheses and conclusion (soft construction): dragging in order to satisfy the hypotheses of a theorem or a problem and observing the property stated in the conclusion as a necessary consequence of these hypotheses;
- to study trajectories by using the tools "trace", "locus"...

However, there is also evidence that the drag mode and the dynamic aspect of dynamic geometry is not obvious for the teachers (Lins 2003, Rollet 2006, Tapan 2006, Soury-Lavergne 2007 [23, 30, 33, 32, 31]). The quality of a dynamic geometry resource and its added value will depend on highlighting the use of the drag mode in the description of the activity:

(b) Does the resource mention the way the drag mode is used?

(c) Does the resource explicit the use of the drag mode in the learner's worksheet?

Another facet of the opinion on the added value of the use of dynamic geometry in the resource is related to the contribution of DG to the learning of mathematics:

2. According to your opinion, does the use of dynamic geometry contribute to achieve the specified pedagogical goal(s)?

5.3 Learning potential of the resource

This criterion concerns the assessment of the quality of the resource from the point of view of possible learning. It may be related to an a priori analysis of the resource, before its actual use.

We feel it is important to address the following issues:

- the adequacy between the pedagogical goals specified in the resource and the effective outcomes in terms of learning mathematical knowledge or developing instrumental skills;
- the learner's activity;
- the quality of feedback considered in the resource which will guarantee the construction of knowledge at stake by the learner.

5.3.1 Adequacy between the pedagogical goals and the possible learning (a priori) / the effective learning (a posteriori)

Is the pedagogical goal specified in the metadata?

The above mentioned adequacy has to be checked at two levels where discrepancies are possible:

- adequacy between pedagogical goals specified in the metadata and the knowledge aimed at by the resource;
- adequacy between the knowledge aimed at by the resource and the effective outcome in terms of learning.

1. To your opinion, does the pedagogical goal(s) specified in the metadata of the resource correspond to the knowledge/skill that are expected to be developed by using the resource?
2. To your opinion, can the expected outcome of the use of the resource be achieved?(a priori)
3. To your opinion, is the expected outcome of the use of the resource effectively achieved?(a posteriori)

5.3.2 Learner activity, from passive to active

Berryman (1993) [3] stresses that the learners have to be actors of their learning:

> "students need chances to engage in choice, judgment, control processes and problem formulation; they need chances to make mistakes" (p. 375).

The same principle, drawing on constructivist approach to learning and teaching (Piaget 1947 [27]), seems to be commonly accepted in mathematics education. Therefore our interest in this criterion of the quality process is to evaluate the degree of the activity of the learner, to distinguish between activity that lets the learner passive or guides him/her strongly and activity where s/he needs to make choices and take initiatives.

1. Does the activity require the learner to take actions and make choices?

5.3.3 Quality of the feedback in the resource

Referring to the Piaget's theory, Brousseau (1997) [4] says that student learns by means of adaptations to the "milieu" which is source of contradictions, difficulties and disequilibria.

Bound by the didactical contract (ibid.), pupils know they have to behave in a given situation by acting on it. The milieu opposes feedback to actions or to inadequate choices of the learner. In order to learn, the learner has to understand

as insufficient his/her control of the situation. Indeed, it is the feedback provided by the milieu that allows the learning occur in the learner. Consistently, Berryman (1993) points out that experiential feedback is key to learning.

1. Does the dynamic geometry figure provide feedback that can be mathematically interpreted so that the learner can validate his/her actions and solution?

5.4 Technical quality of the resource

5.4.1 Exploitation of the resource with other DG pieces of software

1. Can the resource be open and worked out with other pieces of DG software than the one used to create it?

5.4.2 License

1. Does the resource need an adaptation to your educational context?
2. Does the resource need an evolution that the present license does not allow?

5.4.3 Technical problems

We aim at revealing all possible technical problems that can occur when using the resource:

- display quality;
- printing quality;
- projection quality when such use is suggested;
- computer crash when opening or working out the resource;
- quality of mathematical symbols edition;
- ...

5.5 Quality of metadata associated with the resource

Two main issues are to be considered (Mahé and Noël 2006 [24]):

5.5.1 Correctness of the metadata

1. Are all the required metadata provided?
2. Are they accurate?

The annotator tool should check for basic correctness so there might not be a need to implement this sub-criterion.

5.5.2 Correspondence between the metadata and the resource

1. According to your opinion, do the metadata provided in the resource correspond to the resource?
   (a) Do specified pedagogical goals (knowledge/skills) correspond to the ones the resource aims at?
   (b) Are the specified mathematical and instrumental prerequisites really necessary in order to use the resource?
   (c) Is the specified school level realistic?
   (d) Does the suggested way of using the resource seem relevant?

6 Questionnaire

Here is the a posteriori questionnaire that the previous criteria yield. The a priori questionnaire should be similar. Its implementation has to be simple enough so that basic feedback won't require more than three minutes to fill. It can be a list of five different sliders, one for each main criterion, with four positions, from "I agree" to "I disagree", that can be used "as is" for a quick review, or opened to reveal other more precise sliders for a thorough review. A thorough evaluation should weight more in the averaging process than a quick review. Each statement carries a line for textual comment for finely tuned human interpretation. More detailed explanations and precisions should be given as tool-tips or help pop-ups for each statement.

The five main criteria as simple sentences with which the teacher is invited to agree or disagree are:

1. The resource behaves as expected, integrates well into my course and makes my teaching sequence progress.
2. Interactive geometry adds value to the activity.
3. The pedagogical goal is reached, the learners verify they understand.

4. The resource is technically robust, interoperable, has an adequate license.
5. The short description of the resource is correct and corresponds to the experience.

These global questions can be "opened-up" in more precise questions:

1. The resource behaves as expected, integrates well into my course and makes my teaching sequence progress.
   (a) The resource is correct from a mathematical point of view.
   (b) The interactive constructions technically behave as is described in the activity without unexpected features.
   (c) There are sensible prerequisites
      i. They distinguish between prerequisites in terms of mathematical prerequisites and instrumental skills.
      ii. They are compatible with the curricula expectations.
      iii. They are relevant with respect to the activity.
   (d) I could reinvest the outcomes of the resource use in the teaching sequence.
   (e) The resource is used in the ordinary teaching sequence and not in an experimental setting.
   (f) The resource made the teaching sequence progress.
   (g) There is enough material to understand and teach the content.
      i. There is enough mathematical material to understand and teach the content.
      ii. The interactions between the learners and the software are well described.
      iii. The scenario clearly describes the setting of the classroom (video-projection, learner/computer ratio).
      iv. The scenario describes the different phases (schedules, individual or group activities).
      v. The resource does not provide any elements about its pedagogical or didactical use but it is easy to foresee its enactment in the classroom.
2. Interactive geometry adds value to the activity.
   (a) Interactive geometry is better suited for the activity than paper and pencil. Because:
      – The graphical quality and precision of the figure is better.
      – Many cases of the same figures are produced.
      – Learners explore and make conjectures.

- Learners validate themselves their constructions.
- Different representations of the same mathematical problem are articulated.
- Geometric properties of a robust figure are explored rather than metric properties.
- The problem is specific to interactive geometry (black box, soft constructions...).

(b) Dragging free objects helps to understand the illustrated notion. Because:

- It illustrates invariant geometric properties of the figure.
- It leads to conjecture geometrical relationships.
- It validates the robustness of the construction.
- It illustrates the link between hypotheses and conclusion.
- It builds trajectories with the "trace" or "locus" tool.

(c) A way to use the drag mode is described.

(d) The use of the drag mode is described in the learner's sheet.

(e) The use of dynamic geometry contributes to achieve the specified pedagogical goal.

3. The pedagogical goal is reached, the learners verify they understand.

(a) A clear pedagogical goal is specified.

(b) The pedagogical goal is coherent with the knowledge aimed at.

(c) The effective learning outcome fulfills that goal.

(d) The activity requires the learner to take actions and make choices.

(e) The interactive geometry figure provides feedback that can be mathematically interpreted so that the learner can validate his/her actions and solution.

(f) The learners fulfills unexpected interesting goals or can take unplanned interesting actions.

4. The resource is technically robust, interoperable, has an adequate license.

(a) The resource can be open and worked out with my preferred software.

(b) The resource does not need an adaptation to my educational context.

(c) Foreseen resource's evolutions are permitted by the present license.

(d) I had no technical problems.

i. The display quality was adequate;
ii. The printing quality was adequate;
iii. The projection quality was adequate;
iv. The computer was stable;

v. The quality of mathematical symbols edition was adequate;

5. The short description of the resource is correct and corresponds to the experience.

   This can be implemented with an optional browser similar to the annotation browser available for authors and annotators, where the accuracy of each individual metadata could be evaluated for a fine-grain feedback. These metadata should be organized to cover the ontology annotation first (with competencies associated to the resource, whether prerequisite, trained or aimed at), then pedagogical (with level of education, kind of studies) and technical metadata as subdivisions.

7 Risks

We should take into account and evaluate the risks that our quality approach might not be adopted by the users. Some are related to the use of interactive geometry and e-Learning in general, some are related to didactic and pedagogy, some are related to quality acceptance.

7.1 Didactical risks

The main risk is that users won't accept the promotions that are proposed to them, they might not use the project or use it as simple consumers and not as supporters and producers.

- The use of the platform is not easy enough, users don't find content, authors don't upload content or don't annotate properly their content with our ontology, teachers don't report because it is too cumbersome, tutors don't provide support, versionning is too difficult. The usability of the platform has to be thoroughly thought, tested and supported.
- The benefits of good annotation and quality reporting have to be made clear to users so that the effort is worth the trouble,
- the sense of self-supporting community has to be fostered,
- the process of improving a resource has to be eased and
- the evolution of resources has to show how it was shaped by users' feedback.

The SFoDEM project identified several obstacles to the adoption of collaborative work, which is the essence of our quality approach. The solutions they found were to foster a sense of community on the long term, for example by providing

training sessions throughout the year. The teachers had to choose between different themes which were offered to them and follow a training on that theme with fellow teachers. The adoption and adaptation of users charts that define the rules of work was as well a practical tool for implication. To make apparent the time line of the resource and to personalize the evolution process also helped by showing the resource as evolving in a way where the input from users is clearly demonstrated. The project is a growing organism shaped by every user.

The INTERGEO project will bootstrap a small community of users that will go through these different stages and cycles, to test the usability and to build communities of experienced users but the risk exists that it proves insufficient.

In particular, to take into account the way the resources are used might be important. Depending on the experience we might include questions which are non an evaluation of the resource but of the teaching event itself, such as the number of students, the number of computers per students, socioeconomic background (public, private, countryside, suburb)... These issues can be addressed in the teacher's setting where s/he is supposed to describe the classes s/he teaches. Of course specific comments can be made on the forum attached to a resource. But how to take this information into account is difficult and may prove to be important. Our understanding is that special groups with common interests are going to emerge.

7.2 Quality acceptance

Quality management is not well established in all European countries and in all fields of activity as was documented by the e-Quality project [10]. Teaching is thought by many actors as an activity that is very intimately personal, many people doubt that it can be taught, think that there are natural born teachers and that nothing can be changed about it. This feeling is real and should be taken into account. Here is a summary of the widely spread false ideas that the project has to address regarding quality management in interactive geometry teaching:

- There is no need for quality assessment, you can tell whether a resource is good by playing with it five minutes.
- It is not possible to improve the quality of a resource, it is whether good or bad.
- I don't want to submit my work to peer review, they have no right to judge me.
- Any critics made on my resources is a critic made on myself.
- Critics are never constructive, they are intended to hurt me.
- Collaborative work is a utopy, nobody can understand me.

- Whenever I give away, I get only critics in return.
- I won't benefit from the work of others.
- I will lose control over my work if I choose an open license.
- My work is going to be looted by profiteers if I choose an open license.

These issues are related to general awareness of the community and the INTERGEO project is simply a part of the overall effort in adoption of good practices in e-Learning. It will benefit from any other effort in that direction.

8 Conclusion

In this document, we have described how we intend to implement a quality assessment for the INTERGEO project. It is based mainly on the user's questionnaire report that will help rank resources and allow for the identification of improvement paths. This questionnaire is based on the work by the INRP authors, and the output of the JEM [5] and SFoDEM [12] projects.

Another view of quality assessment for the project, which is comparatively less important, resides in a model of the processes that take place during the services. This was done by applying the work done by the e-Quality project to our context. Examples of such adaptation can be found in the appendix.

We will try to translate the best practices and general quality process charter into an actual implementation, where the roles are explicitly enacted by users. Guidelines and check-lists, incident reports and best practices will be available in the implementation of each activity in order to promote the adoption of a quality approach during the service. Of course, asking an explicit validation of their use by the teachers would be too heavy, but we hope that it will help users, in particular beginners, in clarifying how interactive geometry can be used to improve their teaching.

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A Life-cycle of the teacher

This role is the central piece of the project. The teacher searches the server for resources to teach in her/his classroom. Once found, s/he enrolls as a user by providing an a priori assessment and scheduling the course. After an appropriation phase, the course is taught and an a posteriori evaluation is given. S/he can then be promoted to the role of tutor of the resource.

We extract in Fig. 3 the detail of the workflow associated with the main activities of a teacher using a resource from the e-Quality project [19]. It is a minor adaptation of the workflow defined in the e-Quality project, following the discussion in Sec. 3.2. We give an example, adapted from the e-Quality project [34] of the detail of an activity with its best practices and the quality criteria it leads to, once again lightly adapted from the e-Quality project. Similar data for the other workflows can be found therein.

Once a teacher knows the project and has identified a suitable resource, the central activity towards all the effort of the project is directed can take place, namely the **teaching event** where a teacher uses a resource from our repository in order to teach with it in front of a classroom (or in a virtual learning system). The process involving this event requires essentially five activities described in Fig. 3 and an example is detailed in this section. Similar diagrams and activity details are available for other workflows in the e-Quality project [19].

Are not included here the registration and the search processes which are obvious prerequisites to be dealt with separately.

The use of a resource by a teacher is a life-cycle that starts with its selection in a list given by a query, and does not necessarily end in the final evaluation report: teachers that used the resource are encouraged to be promoted to the role of tutor of the resource, in order to help other fellow teachers using the resource. The tutor role itself naturally evolves into authoring new versions of the resource, based on the feedback analysis of the teachers gathered through their reports and the discussions on the forum attached to the resource.

Example of an activity: Feedback and evaluation

A.0.1 Description of the activity

The a priori assessment of the resource, as well as a self-observation evaluation grid help the teacher to understand what to look for during the teaching event. The grid can as well be used by an external observer. The assessment tool is the questionnaire defined in Sec. 6. The teachers use as well the forum or the chat tools to ask questions and give feedback.

The author and the tutors react upon the teachers feedback, in particular their quality assessment giving relevant answers, making alterations and improve-

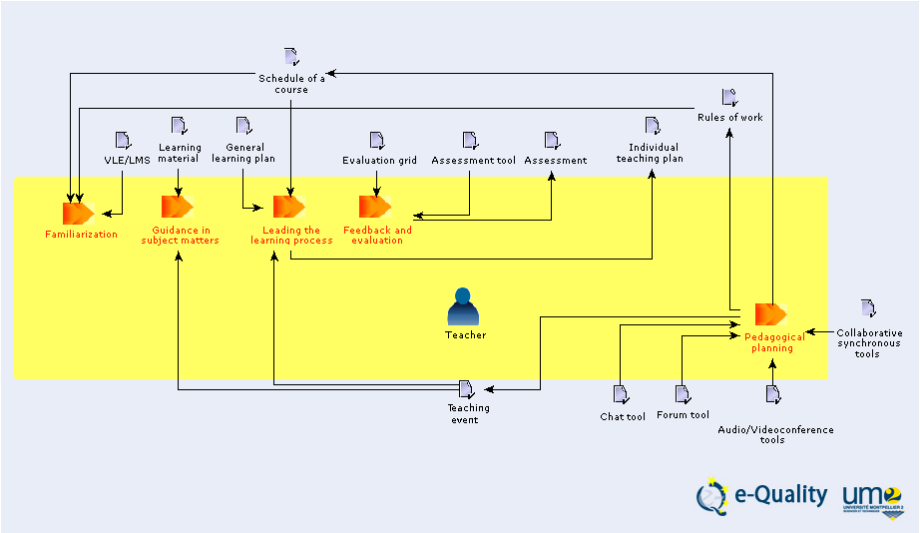

Figure 3: The teacher workflow, extract from [19]

ments, for instance to correct misunderstandings, to bring complementary information or simply to encourage and motivate him/her. The author is responsible for the final evaluation made by the teacher.

1. **To use instruments for continuous assessment:** Information about users' activities are recorded. The users should be aware of what kind of information about their activities is recorded and how they are used in the evaluation. Almost every event, browsing a resource, chatting with fellow users, filling questionnaires, authoring resources etc. will increase the weight given to a user, from beginner to platform expert. Didactical experts will begin with a higher weight than average users. The weight is taken into account in averaging the quality reports given by users and gives users a sense of responsibility and pride in their achievements.

2. **To give feedback:** When the focus is on the teacher' individual course to teach, it is useful to give personal feedback to every teacher, but when the group work is emphasized, the tutors can give feedback to the whole group at the same time.

   It is important that the teachers get feedback during the appropriation period, not just after the teaching event. Especially with a new subject or with new working methods, continuous feedback is important for ensuring the teachers' progress. The feedback must be reasonable and constructive. The feedback must be unambiguous, and the teachers should have a possibility to ask specific questions regarding the feedback.

3. **To assess the teaching event:** Analyzing the feedback of the teachers, evaluating their progress and appropriation and taking into account their teaching reports and the forum discussions is the main source of information about the quality of the resource.

A.0.2 Example of an associated best practice

Best practice	Keywords	Description
Feedback regarding ongoing courses	Feedback	It is useful to give and ask for feedback regularly during the planning of courses, from the enrollment of a teacher to the actual taught course, when it still can have effect on teachers use of the resource. The feedback should be constructive which aims for the progression of the quality of the use by enrolled teachers and their appropriation of the content of the resource.

A.0.3 Quality process associated with the activity

Criteria	Teachers' progress is being continually assessed.
Comment	The authors and tutors have to be aware of most problems that can occur during the teachers' appropriation and teaching event using the resource.
Commitment	Periodically ask for feedback to evaluate the teachers' progress.
Indicator during	provide means of assessment at regular intervals

B Main activities of the tutor

We extract in Fig. 4 the workflow associated with the main activities of a tutor helping fellow teachers using a resource, adapted from the e-Quality project [34], following the discussion in Sec. 3.2. It is the next step as the user of a resource. It is a minor adaptation of the workflow defined in the e-Quality project. The process involving this event requires different activities described in Fig. 3 and an example is detailed in this section. Similar diagrams and activity details are available for other workflows in the e-Quality project [19].

A tutor is a mediator between an author and the teachers that use resources. This means that the tutor should be aware of the teachers' progress, needs and problems to react to them or pass this information to other actors. The line between the tutor and the author can thus be hard to draw, depending mainly on the repartition of roles. The tutor works more on the teachers' terms. The tutor's role has more to do with helping the teachers in situations that occur during the appropriation and teaching event. This is done by first analyzing the situations and then reacting to them. The author is always related to the subject matter. Depending of his/her responsibility in monitoring forum discussion for instance, the tutor is not necessarily top competent in the subject matter of the course. It is recommended to facilitate communication between authors and tutors working with the same resources.

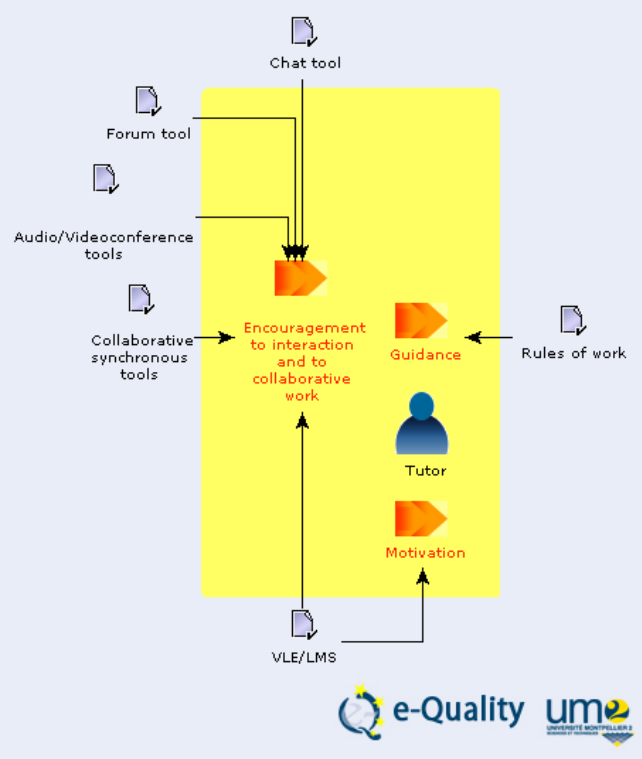

Figure 4: Tutor workflow, extract from [19]

Example of an activity: Motivation

The tutor motivates the teachers. He/she promotes the creation of the community around a resource.

B.0.4 Description of the activity

1. **To motivate the teachers in appropriation:** The need of technical support is so evident that the support of other aspects of the learning process is sometimes forgotten. eLearning is based on the concept of a self-directed learner. This does not take away the fact that most users still need encouragement and support of a pedagogical nature.

2. **To promote an atmosphere that supports appropriation and participation:** The responsibility of the tutor is to create a positive atmosphere around the resource. This motivates the teachers to cope better with possibly forthcoming problems. Even though the tutor is not necessarily in charge of creating and designing the resource, s/he should be aware of the goals to support the teachers in achieving these goals. Besides personal support, there are other ways to promote the teachers' motivation. One is to give teachers a possibility to choose between alternative teaching paths, that is to choose between materials, themes and activities. Activating elements, like forum discussions, group work etc., and regular feedback are also ways to motivate the teachers. The teachers' commitment to the resource is increased by allowing them the power of decision. This can be collective negotiation of the rules, evaluation and learning objectives.

3. **To make the teachers feel part of the educational community:** The main objective of the tutor is to promote the creation of the learning community. Sometimes it is formed naturally, but the teachers may need encouragement. Various methods, like informal chat discussions, group activities and introductions can be used, but the most important thing is to encourage the interaction between the teachers. The tutor acts as a facilitator of a learning community which is not controlled or managed by a tutor, but which is operated by the participation of the users. The tutor has to communicate this to the teachers. At the beginning the tutor may have to participate more to activate the teachers, but s/he has to remember to move to the background when the teachers take on the discussion. Too enthusiastic interference can also cause passivity. A balance is emphasized.

B.0.5 Example of an associated best practice

Best practice	Keywords	Description
Motivating the interaction	motivation, discussion	Authors and tutors should plan the discussions well, so that the use of a resource is motivating for teachers.
Chat-tool for quick conversations	interaction, motivation	Chat is a tool for synchronous interaction, so discussions takes less time than in discussion forums or with e-mail. Chat is useful for quick discussion, like for decision making, planning or for motivating group. It helps build a sense of living community and not a dead server. It can also be a place for non-subject related discussions, like for getting to know the group, which usually motivates users.

B.0.6 Quality process associated with the activity

Criteria	The teacher's motivation is stimulated, adequate guidance is provided when needed and actors collaboration is encouraged.
Comment	The teachers' motivation and interest has to be kept at the highest possible level, in order to maximize the efficiency of the teaching/learning process.
Commitment	The tutor is aware of the importance of continuously maintaining, even enhancing, teacher's motivation, providing adequate guidance and promoting collaboration, and is ready and well prepared to this task. If necessary, additional training or support is prepared for the tutor.

C FORMIST Evaluation grid

We give in this section the example of the evaluation grid defined by the FORMIST project [11]. Not all criteria are relevant to our project, as discussed in Sec. 6.

Références du documentévalué(auteur, titre, URL, organisation):

C.1 Évaluation de l'auteur

Critères d'évaluation	Faible	Moyen	Bien	Très bien
Clarté, facilité d'identification de l'auteur ; accessibilité				
Sérieux, fiabilité de l'auteur				
Degré de compétence dans le domaine				

Bilan de l'évaluation de la source ou de l'auteur:

C.2 Évaluation du support et de ses objectifs

Critères d'évaluation	Faible	Moyen	Bien	Très bien
Clarté de la présentation des objectifs et du public				
Adéquation globale du support aux objectifs				
Adéquation globale du support aux publics visés				

Bilan de l'évaluation du support et de ses objectifs:

C.3 Évaluation du contenu informationnel

Critères d'évaluation	Faible	Moyen	Bien	Très bien
Fiabilité de l'information				
Niveau de précision, d'exhaustivité, d'exactitude				
Degré de nouveauté, d'originalité				
"Fraicheur" de l'information, actualisation				
Clarté d'indication et accessibilité des sources				
Pertinence, richesse des liens externes				
Qualité de la langue (expression écrite, traduction)				
Clarté de présentation de l'information				
Utilité, pertinence des illustrations (schémas, images...)				

Bilan de l'évaluation du contenu informationnel:

C.4 Évaluation des aspects didactiques

Critères d'évaluation	Faible	Moyen	Bien	Très bien
Clarté des explications				
Pertinence des exemples				
Adaptation du niveau au public visé				
Interactivité du support				
Présence de TP, d'exercices				
Pertinence des TP				
Originalité des exercices				

Bilan de l'évaluation des aspects didactiques:

C.5 Évaluation de la structuration du document

Critères d'évaluation	Faible	Moyen	Bien	Très bien
Logique de l'organisation				
Clarté de la représentation de l'ensemble du document				
Facilité d'orientation (sommaire, plan du document...)				
Facilité de navigation (aller-retour, retour page d'accueil, ascenseur...)				
Facilité de lecture des pages intérieures (sommaires internes, boutons de retour...)				
Outil de recherche				
Autres dispositifs d'aide (foire aux questions, archives, page d'aide...)				

Bilan de l'évaluation de la structuration du document:

C.6 Évaluation de la mise en forme, de l'accessibilité

Critères d'évaluation	Faible	Moyen	Bien	Très bien
Design du support, choix des couleurs				
Homogénéité de la mise en forme				
Lisibilité du texte				
Qualité des illustrations				
Rapidité de chargement du document et des pages				
Choix des formats graphiques (chargement, compression des images...)				
Accessibilité du support (référencement dans les outils de recherche...)				

Bilan de l'évaluation de la mise en forme du support :