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D2.5: Guidelines and recommendations of setting up CoI for stimulating creative designs of educational resources for CMT

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Summary

This deliverable (D2.5) epitomizes information of practical relevance on the method for setting up appropriately designed Socio-Technical (S-T) environments, comprising of the C-Book technology and the CoI, to jointly and interactively scaffold and stimulate creativity in the design of digital educational resources for CMT. This information is provided in the form of guidelines and recommendations proposed to be taken into consideration by creative industries and other related stakeholders in the design of digital education resources and beyond. Description of the method is followed by specific tips of how to implement and facilitate consequent steps of the whole process. D2.5 is purposefully organized and written to be particularly addressed to (a) national (related to the four countries used as design and evaluation contexts), and (b) European policy-makers, who are responsible for promoting and implementing practices fostering creativity, innovation and sustainability in the creative industries, including education. We particularly address this audience since we view them as catalysts for launching and activating any of the proposed actions and designs to be taken up by creative industries in the field. D2.5 is structured in two main sections: (1) Guidelines and recommendations on the method for setting up Communities of Interest, and (2) Guidelines and recommendations on the C-Book technology use. It concludes with a scenario on the possible exploitation of the proposed ‘business model’ by a publishing company, based on the recommendations developed in previous sections of this deliverable and discussions between partners. The main part of D2.5 is followed by three Annexes (Annex 1: the D2.5 template used for collecting information from partners, and Annexes 2 and 3: the Tables of Horizontal Analyses of the templates), and an Appendix submitted separately containing the complete D2.5 templates.
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Introduction

The main goal of the M C Squared project was to develop (a) a new technology for the design of CMT resources (the C-Book technology), allowing the design of a new genre of authorable e-book, we call 'the e-book', and (b) a methodology based on the generation of Communities of Interest (CoI) as a social environment nurturing the creative design of CMT resources in collectives of educational designers. The rationale of M C Squared project is that by providing professionals from the education industry and other creative industries focusing on educational design (i.e. Publishing houses, etc.), with an appropriate Socio-Technical (S-T) environment as a facilitating work context they will have more opportunities for richer creative design processes resulting in more creative products.

A 3-year joint work in iterative cycles allowed us to design, develop, evaluate and refine the ‘model’ of such a S-T environment, comprising the C-Book technology and the CoI, and aiming to jointly and interactively scaffold and afford creativity in the design of digital educational resources fostering CMT in end-users/learners. This deliverable (D2.5: Guidelines and recommendations of setting up a CoI for stimulating creative designs of educational resources for CMT) includes guidelines and recommendations for starting up, activating and making use of this environment, proposed as a “business model” to professional designers from the education sector and other creative industries stakeholders specialising on educational design as well as to national and European policy-makers. D2.5 is the outcome of work pertaining to Work Package 2 (WP2) which is described in the Document of Work (DoW) as follows:

D2.5) This is a set of practical guidelines and recommendations on the method of setting up Communities of Interest as a business model for supporting creative designs for CMT resources. It is addressed to interested creative industries stakeholders as well as to national and European policy-makers.

The work reported in D2.5 has been organized and run in the context of task T2.6 (Agreeing on a set of important guidelines and recommendations of how to set up a CoI for stimulating creative designs of educational resources for CMT) (Leader: CTI, Contributing Partners: LKL, UCBL, UB), with a focus on collecting and compiling information of practical relevance about the M C Squared project’s proposed “business model” for setting up creative designs for CMT resources, and providing it in the form of guidelines and recommendations to the benefit of interested stakeholders. Our method of work within task T2.6 was based on designing, organising and running an internal evaluation procedure among all partners involved in collaboratively designing, putting in action and testing this ‘model’ along consecutive cycles of work. To this end, a template was designed (D2.5 template, see Annex 1) by the leader of this task (CTI) and sent to all M C Squared evaluation partners (LKL, UCBL, UB and CTI) as a guiding framework for each to share the experience gained and the insight developed out of their 3-year involvement in the project (in WP6 and WP7). They were also asked to summarisewhat they recommend in terms of: (a) how to set up, organize and moderate a CoI to support creative designs for CMT resources, (b) how to ensure the best use of C-Book technology so that such creative designs are effectuated. The completed templates were then submitted to content analysis by the CTI team and all themes were identified, labelled, organized and commented in tables providing a comprehensive map of an
‘horizontal’ analysis of all collected input (see Annexes 2 and 3). These tables accompanied by a short summary report per section of thematic categories were subsequently sent to M C Squared technical partners (UU, UP, LKL and CTI) for review, and in order to comment on the information included and add anything more they deemed important to feed the contents of these table. After receiving all this input the CTI team proceeded to the synthesis of D2.5. Finally, a “scenario” was jointly conceived and developed by CTI and UU outlining how a hypothetical case of a creative industry specialising in the design of educational resources for CMT could make use of our proposed business model to boost creativity, productivity, quality of work and (eventually and hopefully) economic profit in their professional practice.

The analysis of all the information collected confirms that the application of the proposed model is suitable for fostering creativity in the design of creative digital educational resources on a European level and flexible enough to espouse the particularities of national contexts. In the following sections it is exemplified how these particularities had an influence, throughout the lifetime of the project, in setting up diverse CoI and using the C-Book technology for designing creative educational resources for CMT. Nevertheless, the articulated set of recommendations transcend the boundaries of specific contexts and in this way constitute an efficient method of eliciting and promoting creative designs in the Education industry and other sectors of the creative industries context.

Summing up, D2.5 epitomizes information of practical relevance on the method for setting up appropriately designed S-T environments, comprising of the C-Book technology and the CoI, to jointly and interactively scaffold and afford creativity in the design of digital educational resources fostering CMT in end-users/learners. This information is provided in the form of guidelines and recommendations proposed to be taken into consideration by creative industries and other related stakeholders in the design of digital education resources (for CMT) and beyond. Description of the method is followed by specific tips of how to implement and facilitate consequent steps of the whole process. However, it is important to mention here that D2.5 is purposefully organized and written to be particularly addressed to (a) national (related to the four countries used as design and evaluation contexts), and (b) European policy-makers, who are responsible for promoting and implementing practices fostering creativity, innovation and sustainability in the creative industries, including education. We particularly address this audience since we view them as catalysts for launching and activating any of the proposed actions and designs to be taken up by creative industries in the field.

D2.5 deliverable is structured in two main sections: (1) Guidelines and recommendations on the method for setting up Communities of Interest, and (2) Guidelines and recommendations on the C-Book technology use. They are followed by three Annexes (Annex 1: the D2.5 template used for collecting information from partners, and Annexes 2 and 3: the Tables of Horizontal Analyses of the templates).
1. Guidelines and Recommendations on the Method for setting up Communities of Interest

This section aims at providing guidelines and recommendations for the initial set-up, planning, orchestration, monitoring and evaluation of the CoI as the nucleus for the implementation of socially creative design work and the production of socially creative design products in the field of digital educational resources for CMT. First, we elaborate on the recommendations addressed to national policy makers in the countries in which the CoI involved in the design of c-book units within the frame of the M C Squared project are based. All suggestions put forth in this section have been based on the outcomes of an internal evaluation procedure, which was centrally designed by CTI (the partner in charge of this deliverable) but was separately led within each CoI with the moderation and participation of the members of the research teams, who were also responsible for reporting the outcomes of the whole task. Their input was collected by the CTI research team and was submitted to content analysis, the findings of which have been organised to be presented and discussed in this section.

1.1 Recommendations from the Greek CoI

1.1.1 Recommendations concerning size, composition and membership/recruitment of a CoI

If the task is to help generate a new kind of medium enabled by a new technology, social creativity is a necessary ingredient. A Community of Interest (CoI) collaboratively designing c-books in the Education industry should comprise professionals representing diverse Communities of Practice (CoP), each with a distinct disciplinary and knowledge background, field of professional practice and area of expertise. At the same time, many CoI members bring overlapping fields of experience by simultaneously participating in more than one CoP (e.g., a teacher educator with design expertise). Thus, each CoI member carries one main CoP membership but also potentially a subsidiary working knowledge and practical experience background from participating in more than one CoP in parallel. Inside the CoI, these members participate as representatives of the CoP they chose as most appropriate, according to their personal statements for their everyday professional activity, their personal interests and the task at hand.

In the Greek context, according to the new curriculum, the employment of digital technologies for mathematics education is perceived as a venture to infuse empirical mathematical activity in the school students’ experience with mathematics, in the attainment of which both national scale teacher education initiatives and the ‘Digital school’ national project’s infrastructure have been accordingly designed to serve. The latter two initiatives are longitudinal, with the first to have reached almost a 35% of the Math teachers in the country. The Greek Ministry’s policy was therefore to employ in-service teachers in many capacities simultaneously for complementary contributing to all these levels.

Some basic recommendations and guidelines for setting up a CoI in a Greek context are:

- Recruit a group of people with diverse expertise, the latter dictated by the nature and demand of the design task(s).
• Accept and invite CoI members being willing and keen to adopt “hybrid” identities (being representatives of more than one CoP), or switch between different identities, so as to ensure flexibility and richness of perspectives.

• The level of diversity within each sub-group formed in a CoI can be varied, depending on the broadness of the design task (focus on a single curricular area or combine two curricular areas, e.g. mathematics and environmental education). In either case, the minimum level of diversity has to follow the simple but functional scheme: developer(s) – educational designer - in-service teacher(s)/teacher educator(s) – junior researcher - senior researcher – academic. In c-book units with an interdisciplinary character at least two members with expertise in one of the two interweaved fields have to be included as basic actors.

• At the initial stages of a CoI formation, allow for a larger number of members to interact in a joint task.

• Progressively restrict the number of sub-groups within a CoI to a maximum of 5-6 individuals per sub-CoI, as the CoI matures and the tasks become more demanding.

• Make provisions for an expected shift in the initial pool of members so as to keep the work in the project scheduled irrespective of individual, professional, or other availability issues.

The recruitment of CoI members can be based on former collaborations with professional educational designers from different CoP aiming to foster educational innovations related to the design of digital resources. In addition, any challenges posed by coordinating institutions (academic, professional, systemic, interventionist) should be taken into account. The members recruited in this way are expected to share diverse perspectives on mathematics, mathematics education but also on areas beyond mathematics. They have to represent diverse fields of expertise, ranging from technical to educational design and teacher education and a range of pedagogical and epistemological perspectives on math education, creative mathematical thinking and creative learning and teaching. Finally, some more criteria relevant to the CoI members’ personality traits are proposed to be:

• Ability to focus on productivity while maintaining a critical and argumentative perspective to what is being produced

• Acceptance of the notion of a product as an 'object under development'

• Professional responsibility and sense of commitment in their expressed identity and role

• ‘Playful’ attitude to work and sense of satisfaction out of professional collaboration with others

• Being open to accept/ acknowledge the perspectives projected by other communities and willingness and readiness to cross own ‘boundaries’

• Creative stance and performance already evidenced before joining the CoI (estimated through a general impression, not by means of some kind of ‘measurement’).

1.1.2 Recommendations concerning planning, orchestration, monitoring and evaluation of CoI-related design work

A factor considered decisive for initiating CoI interaction and establishing a baseline communication channel is the communication of of individual members’ prior CMT representations in ways that they could be used as a knowledge base for capitalizing on the diversity of perspectives brought in by each individual member. Besides, the CoI members’ initial conceptions of (mathematical) creativity can serve as a starting point for their design work on the c-book units and
directly influence the affordances and constrains for mathematical learning of the specific design. To ensure for functional and creative interaction within the CoI the following recommendations are made. The person or group or authority in charge should:

- Organize enough face-to-face meetings of the CoI members in parallel to their online interaction.
- Plan several CoI online activities in advance in terms of type of interaction (one to many, many to many), the triggering event and content feed, brainstorming of initial ideas, with a focus on the outcomes (i.e., draft widget designs), etc.
- Evoke the externalization of CMT representations. Allocate time for face-to-face meetings involving focus-group discussions and interviews with CoI members, in which pertinent stirring-up activities are conducted, such as the “bring along the description (and evidence, if applicable) of a selected activity carried out with (your) students, which you think that facilitates CMT”.
- Define a moderation model foreseeing a central moderator role, but also predicting for shift, partial delegation or rotation of this role to specific CoI members acting as “knowledge brokers”.
- Provide each CoI working group with a certain degree of structure on the task at hand (e.g., use of “creativity sparkers”, such as “triggering themes” to boost the CoI’s creativity with respect to their design thinking processes, and a minimum of technical specifications), while also allowing for individual and collective expression of diversity and debate on important issues of pedagogical design with digital media.

When the task is to co-create something new, for which it is difficult to plan ahead and have a clear understanding of the of the object of construction (the c-book), a proper moderation can facilitate maintaining of the focus, handling diversity and ambiguity, managing productivity, while ensuring the continuation of all creative processes, and most importantly, allowing for the production of highly creative ideas to come up. A moderation model is proposed to include three types of moderating activities: a) contextualizing activities, related to the design and organization of the work, b) monitoring activities, related to the facilitation of discourse within the CoI, and c) meta-activities, related to direct interventions from the part of the moderator to summarise and evaluate the CoI members’ current activity and provide a common frame of reference for all CoI members as support to their work (management of process and content). The communication model to be established should be informal, yet professional, in the sense that there are products to be developed and deadlines (sometimes strict) to be met. However, there might be instances when the management of the whole task from the part of the moderator may become overwhelming over time, especially during the initiation phase, when it might be difficult to keep track of all ideas and promote them equally. In such cases but also at any opportunity, the moderator should:

- Pay close attention to the initial/ brainstorming phase and document the flow of all ideas on a regular basis.
- Prioritize several contextualizing activities at the initial phase of design work.
- Perform monitoring activities from the beginning and on a periodic basis.
- Ask for and acknowledge contributions from “knowledge brokers”.
- Perform meta-activities on a regular basis. These may include, for example, meta-comments, serving as communication “bridges” to communication gaps are necessary, weaving, in the
form of summarizing discussion, and delegating for supporting collaboration within the CoI. Special attention has to be given when participants do not adopt their expected roles, or take more overlapping roles, which risk to result in reduced productivity and disrupted flow of information.

- Maintain consistency and a similar communication style with all members.
- Stir up enthusiasm. Apart from the members’ resilience, personality traits or the moderator’s calculated moves, emotional support should be provided to all members. In fact, this is a really important element, at the heart of any learning or design experience.

Intrinsic motivation and the sustainability of the CoI have been also raised as issues related to the CoI composition and in need to gather the moderation focus. It is crucial to invent ways to integrate and boost the shared common interest with the individual CoI members’ motives, to employ appropriate incentives and rewards to ensure the unity and sustainability within the CoI. The following measures are recommended to be taken towards this end:

- Ensure professional sustainability by keeping balance between estimated workload, inherent interests, intrinsic and extrinsic motivation and rewards and appropriate incentives. These criteria are critical in influencing the size of the CoI and the number of recruited members.
- Estimate before recruitment that prospective CoI members are interested in:
  - being part of cutting-edge developments in the uses of digital technologies in education
  - participating in joint productions as bringing something useful and new to the traditional 'scenario' and 'artefact' constructs as well as to their own teaching/ teacher training/ research practice
  - the potential for publication availability of the new constructs to the wider community
  - viewing an academic challenge either in CMT or SC or online learning, or alternative perceptions of the use and learning of mathematics
  - taking the challenge of integrating educational paradigms and epistemologies.
  - receiving various forms of accreditation and public recognition of the joint constructions and their individual contribution to them.
  - accepting that their joint productions can be used as a base for the design and development of others, with an explicit reference to their own work,
- Build and preserve a more personal relationship with each member, not restricted only to online asynchronous interaction. A culture of joint responsibility should be cultivated through moderating activities and specific personal and professional qualities of individual members so that all members are equally engaged in activities.

1.1.3 Recommendations on cross-CoI collaboration

The cross-CoI collaboration is based on and promotes interaction between two different design contexts, each with its own contextual characteristics, culture and tradition. The first step to get involved is such processes is that the CoI adopts an alien c-book unit and an internal discussion takes place to decide on the principles for its redesign. Then, and before finalizing it, it is necessary that the CoI shares their ideas with their partners and discusses with them their suggestions for improving the redesigned c-book unit. In cross-CoI collaboration it is therefore recommended to:
• Negotiate, develop and use a common language for inter-CoI communication. Shared meanings ensure coherence in the outcomes of the collaborative work.
• Create and use at least three separate workspaces to afford for different modes of cross-CoI collaboration at various stages of the process, i.e.: (i) one workspace per CoI for intra-CoI collaboration, and (ii) a shared workspace for CoI inter-CoI collaboration.
• Devise and make use of common tools (for example ‘templates’) as boundary objects to facilitate communication and the exchange of ideas and develop a shared view, but also to effectuate a deeper understanding of the other team’s context.

The need for attaining ‘a common language’ enabling the collaboration between two CoI led us to propose the following methodological approach consisting of a series of steps for each CoI. Namely:

• Evaluate the CMT affordances of the alien c-book unit by secondary designers.
• According to the evaluation results go back and redesign it.
• Start a discussion in shared workspace to present the redesigned version to your partner CoI and ask for suggestions and comments.
• Incorporate those suggestions you deem interesting and fitting to your own (design, pedagogical, etc.) perspectives.
• Send the final (redesigned) version to the partner CoI and ask them to evaluate its CMT affordances, and
• Create a ‘space’ for discussing and agreeing on the similarities and differences of CMT affordances as perceived through the various aspects of the two different contexts, e.g. a different education system, various degrees of willingness from the part of schools and teachers to promote innovations, the teachers’ readiness to integrate educational technologies in their teaching practice and make any necessary changes according to them.

1.2 Recommendations from the UK CoI

1.2.1 Recommendations concerning size, composition and membership/recruitment of a CoI

Based on the input provided by the UK research team, the following conclusions have been drawn:

• There is no optimum number of members regarding the quality of the c-books.
• However, the optimum size is conditional on the context: the topic of the c-book, the availability of teachers, whether teachers view working on a c-book as part of their job, whether there is a reward or not.
• Involve several people in early design stages of the c-book for productive brainstorming for ideas but only a few with direct involvement, monitoring and responsibility in a drafting phase before sharing with the rest of the CoI members.
• Reduce the number to 3-4 people when it comes to the actual specifics of the c-book and maybe even 2, when editing the c-book leads to more streamlined production.

Such a configuration reduces the overhead of communication, leads to more streamlined production and minimizes diffusion of responsibility. The dynamics of the CoI working on a c-book is one of flux: phases with only a few people working on a c-book are mixed with phases where there is a larger group from within the CoI that communicates about the c-book and provides feedback to be carried forward in future iterations.
• Bring together people from diverse and different backgrounds to provide diverse but complementary expertise and input.

For example, less experienced members might be more enthusiastic about exploring new ideas than more experienced ones. Nevertheless, experienced teachers may offer a lot of ideas for potential activities to be included in c-books, and mathematics educators with an expertise in task design with digital tools are able to support the development of those ideas and the creation of usable as well as creative c-books.

To create such a diverse CoI, the recruitment of CoI members should be carried out according to the following recommendations:

• Utilize existing professional networks (academic, educational, etc.) and former collaborations to identify potential CoI members.
• Use personal judgment with regards to their personality/characters and potential as an input to selection of the CoI members.
• Identify which members could act as ‘knowledge brokers’.

Moreover, due to the challenges that the UK context poses on the recruitment of teachers (such as the large workload and the need to relate any extra activities to the actual implemented curriculum), the following measures should be taken to enable teachers’ participation:

• More effort (with respect to availability of time and money) should be placed on behalf of employers and the government on encouraging professional development for their teachers, as teachers are often confronted with an overload and find it difficult to devote time to participate in professional development courses/workshops/activities.
• More extensive technological support should be provided especially to those lacking expertise with digital tools. Potential CoI members are better convinced to take an active role in the CoI if they know that there is technical support available. This also requires time and money.
• Provide a more extensive ‘authoring course’ or open textbook like the massive online open textbook (MOOT).
• The c-book, as boundary object, needs to be rooted in what the teacher needs: something they can incorporate and use almost instantly in their daily classroom practice.

1.2.2 Recommendations concerning planning, orchestration, monitoring and evaluation of CoI-related design work

On this field a mix of interactions is recommended by the UK team:

• Online, such as email and skype interactions. For a nationwide or even global community this seems the most fruitful method.
• At initial stages organize face-to-face meetings by a ‘broker’ and, especially, teachers for brainstorming ideas.
• Hold larger CoI meetings every 6 months. These can be targeted at certain CoP (e.g. math education students) or organized concurrently with conferences (e.g. The Textbook conference - ICMT)
• Encourage the use of a communication and collaboration space such as CoICode by providing support for its use through tutorials, by ensuring that it works swiftly and stable and by showing more clearly how the whole creative design process may benefit from its
use. In case that the use of CoICode is not immediately identified as useful to the social creativity process, some effort has to be directed towards better presenting to the CoI members and explaining and justifying its potential value.

The most effective collaborations though seem to rely heavily on ‘brokers’ whose role is to ‘translate’ and circulate any (creative) ideas between the different CoP. The brokers are also foreseen to fulfil a mediating function of ‘brokerage’ between the CoI members and the M C Squared system, to safeguard the representation of the different CoP and intervene when appropriate to ensure fruitful outcomes of the CoI members’ interactions. Since the availability of teachers in extra-school initiatives is limited in the UK context and the learning curve of becoming a good designer is quite steep, there is a need for a multi-skilled ‘broker’ to ensure that all voices of different CoP are heard. Some of his/her desired skills should be:

- technological affinity
- design expertise, and
- the capacity to translate concrete ideas into challenging materials.

When interacting around the design of a c-book a standard procedure should be employed, during which the recording of creative ideas is followed by the design of a draft c-book as a boundary object to be disseminated to the whole CoI. The cycle is repeated and the c-book is further developed. Thus, the moderator should be able to respond in consecutive phases:

- By being active in the first stages of the c-book design to evoke and encourage any (wild-new) ideas.
- By starting working on a first version of c-book, or asking another designer to do so, while also securing a period of relative ‘rest’ for the designer(s).
- By initiating communication around the draft c-book for a limited time period, in which the wider CoI may comment and give feedback on and/or invite other specialists to provide their feedback. The moderator is the one to close the feedback phase and set the priorities for the next version.
- By leading this process until the CoI, or him/herself, feels satisfied with a first release version of the c-book, which should be nevertheless seen as an improvable boundary object.

Apart from a general course of steps and actions to be taken by CoI members, such as the above mentioned, any other prescriptions should be ‘mean and lean’. More structure risks to actually backfire and impede creativity.

On the other hand, sustained participation, especially from the part of teachers, is identified as a considerable challenge that can be met by the following proposed measures:

- Promote engagement and enthusiasm by being ‘visible’ and showing some activity on the CoICode.
- Provide rewards to teachers such as, money for buying math educational resources for their schools, certificates of participation, access to the created resources and the C-Book technology tools.
- Offer continuous technical and/or practical support.
- Resolve any technical issues (e.g., stability of software).
- Design an end-product with the aim that it can be directly transferred and used in the classroom.
• Organise occasional face-to-face meetings and spend time with people from individual existing networks to promote their participation in the CoI.
• Encourage the involvement of moderators when noticing low rates of interaction and productivity within the CoI.
• Send gentle reminders and requests for boosting work.

1.2.3 Recommendations on cross-CoI collaboration
• For establishing a language/communication channel, CoI members have to be explicit with their suggestions and claims, clearly justifying their design decisions to ensure constructive collaborations.
• One workspace, operated under some kind of ‘roles’ or ‘rights’ system, is sufficient since it can be better managed.
• There is no need for more support tools, as this means less degree of freedom for the actors, which may lower creativity. However, creating space for different modalities of communication e.g., a web-conference platform, whiteboard sharing, logging of communication would be desirable. In other words, an environment that would allow for a larger degree of freedom for actors to communicate, and in the meantime store the whole process and also scaffold it based on the findings of the process, is much desirable. Some tools, such as the common CMT evaluation grid, helping developing a shared understanding may act as a catalyst for enabling collaboration and social creativity to emerge between and across the CoI members.
• For comparability of the processes and products it is probably important to use a common method, however, this is a laborious endeavour in itself, whereas the validity and reliability of the common methods is questionable and might bring up issues difficult to resolve.
• An optimum mode of cross-CoI interaction could be: first a one- or two-hour initial skype meeting (or face-to-face, if that is possible), then follows the redesign and communication phase which takes place online, most probably in CoICode. Two weeks later another final skype or face-to-face meeting.

1.3 Recommendations from the French CoI

1.3.1 Recommendations concerning size, composition and membership/recruitment of a CoI
Based on the input provided by the French research team, the following conclusions can been drawn:
• The size of a CoI depends on the skills (i.e. mathematical, didactical, pedagogical, technological skills, as well as the knowledge of the school system and curricula) and the required diversity for creative design of digital educational resources to take place.
• In general, small groups of designers (3 to 6), with at least one member being familiar with the technology, are recommended.
• Attention should be paid to the heterogeneity of the profiles of the CoI members based on their professional/knowledge domains.
• CoI members with complementary expertise or skills help boost CoI creativity by contributing with ideas from less known domains.
• Strong mathematical and didactical/pedagogical expertise and technological skills are critical.
• Individuals with technical skills may become ‘technical brokers’ helping overcome technical boundaries.
• Orchestrate and run activities to arouse a common interest within the CoI for the production of c-book units in order to spark and maintain a creative flow in all design cycles.

Regarding the recruitment of CoI members, attention should be paid to the following:

• Choose CoI members who are representatives of active CoP constituted around design of pedagogical resources.
• Ensure compatibility of the CoP agenda with the CoI agenda to prevent withdrawal.
• Provide institutional acknowledgement (e.g., in terms of salary or reduced teaching load) especially to teachers.
• Verify the amount of time the members can dedicate to the design process.

1.3.2 Recommendations concerning planning, orchestration, monitoring and evaluation of CoI-related design work

For successful orchestration of the CoI members’ interaction, the following recommendations are proposed:

• Organise three face-to-face CoI meetings per each cycle of work:
  o At the beginning, when sub-groups are constituted, roles are assigned, the design agenda is planned, the topics of the c-book units are discussed and chosen;
  o In the middle, when sub-groups present their design project and state of progress and receive feedback;
  o At the end, when CoI activity is assessed, encountered problems are discussed, objectives are recalled, and outcomes are presented.
• Between face-to-face meetings, sub-groups should work autonomously alternating various modalities: f2f meetings and online meetings via Skype for brainstorming and discussing ideas, or asynchronous work to implement/reify ideas.
• Trust and confidence should be fostered in synchronous meetings.
• Synchronous interaction (face-to-face or remote) seem to be the most efficient way of collaboration for various reasons:
  o Collective brainstorming is richer
  o One gets immediate feedback on her/his ideas from the other CoI members
  o Expressed ideas can be further elaborated if not enough clear or misunderstood
  o Convergent thinking may take place much quicker
  o Negotiations are conducted more easily orally than in writing
  o Decisions can be taken directly and collectively. They are then entered into the CoICode.
  o From a pragmatic point of view, a synchronous interaction represents a commitment to work exclusively on the c-book unit design for the time of the meeting, whereas it requires much more discipline to contribute regularly all on your own when interacting asynchronously.
• Asynchronous work concerns rather the implementation, reification of ideas discussed and validated collectively during a synchronous interaction. Asynchronous collaboration is conducted and documented by the CoICode that acts as a logbook and a to-do-list.
• A CoI needs a “pilot”, e.g., a steering committee.
• Distribute and orchestrate the tasks at hand:
  o Assign specific roles (moderator, reviewer, developer) and make their function explicit.
  o Collaboratively set up the design agenda (tasks and deadlines).
• Organize regular reviews of the c-book unit during the design process, including CMT affordances evaluation. These reviews are most efficient when they are done by CoI members who are not directly involved in the design process, in order to bring new insights and make sure that the implicit becomes explicit. One evaluation may be done during the design process, to enhance the CMT affordances of the unit.
• It is important for the CoI members to know what CMT is to be able to think of the resource affordances for stimulating CMT.
• Eliciting the initial CMT representations of the CoI members allows building a common understanding on these representations that progressively evolve along the design process.

The French CoI does not suggest a specific moderation strategy. Rather, the moderators’ role should be assigned to CoI members with the following qualities:

• Organizational and managerial skills: being able to organize design tasks and communicate with people from various professional domains.
• A good knowledge of the topic of the c-book unit.
• Acknowledgement and respect of all contributors.
• Engagement and a sense of responsibility.

In addition, the role of the moderator should entail the following responsibilities:

• To coordinate the tasks at hand, update the agenda, observe and keep the deadlines, follow the design process.
• To supervise the design process, and being responsible for delivering the product in due time.
• To help building a common language.
• To foster exchanges within the sub-groups and within the CoI.
• To help during negotiation stages.
• To rekindle the design process when it is slowing down.
• To invite CoI members to vote for the creativity of the ideas expressed in CoICode.
• To organize the CMT evaluation by inviting CoI members to take part in the evaluation, fixing a date, deciding on the modalities of the evaluation.

Design work should not be structured in advance, but design choices should be collectively discussed within the designers’ sub-groups. The only constraints regard the number of different widgets to be embedded in each c-book unit. Further, pre-structuring a c-book unit or even the workspace is likely to impede creativity of the designers. Critical aspects for ensuring sustainability and maintaining motivation are thought to be:

• Finding balance between heterogeneity and convergent interests.
• Producing resources usable in classrooms (related usage constraints).
• Providing benefits related to professional development, access to new teaching material, institutional acknowledgement.
• Verify the availability of CoI members. 

Finally, the role of a broker cannot usually be assigned in advance. Nevertheless, knowledge brokering seems to play a critical role in the design process. CoI members with technical skills can play such a brokering role by operating at the boundaries between the CoI and the C-Book technology developers.

1.3.3 Recommendations on cross-CoI collaboration

• Establishing a common language/ communication channel is related more to methodology and tools. In particular, it is important to agree on the way CMT should be assessed (with a common grid or other means), on the choice of the people from the two CoI who will evaluate the alien c-book unit, the redesigned alien c-book unit, and if the evaluation will be done collectively or individually.

• The organization of the workspace should be different for each of the two phases, i.e., the first redesign stage and the cross redesign stage. Therefore, two workspaces should be created:
  o The first workspace is meant for the evaluation of CMT performed by the re-designers in order to enhance the CMT affordances of the alien c-book.
  o The second workspace should be organized in agreement with the two CoI groups involved.

• The first phase of the redesign should show new design choices and new directions for a further redesign rather than a finalized redesigned c-book unit, which is likely to cause resistance from the primary designers during the cross redesign stage.

• There is no necessity for developing common tools for the redesign process.
• Rather, comparable methods between the CoI should be developed. 

An optimum mode of cross-CoI interaction would be:

• A preliminary meeting, online or face-to-face for cross-CoI collaboration: the aim of this meeting is to discuss the agenda for the main phases and the CMT affordances evaluation methodology that are the following:
  o The choice of the alien c-book unit and the constitution of the subgroup of the CoI involved in the redesign.
  o The CMT evaluation of the alien c-book unit and the method chosen within the two CoICoI.
  o The re-design stage.
  o The cross re-design stage.
  o The evaluation of the CMT affordances of the re-designed c-book unit should keep the same method to allow comparison of the results.

• A second meeting during which the organization is defined for the cross re-design stages, face-to-face or online and the following points are discussed:
  o the CMT evaluation and the direction for the re-design. This stage signifies the beginning of the construction of a common language (identification of boundaries).
  o the organization of the workspace (purposes, limit, tasks at hand and their distribution, agenda).
1.4 Recommendations from the Spanish CoI

1.4.1 Recommendations concerning size, composition and membership/recruitment of a CoI
Large configurations should be better avoided as communication turns out to become more difficult as a function of the number of CoI members. In fact, social creativity analysis revealed that no more than 6 active contributors are necessary during the design of a c-book unit. In addition, participation of some CoI members in larger groups is more irregular than in the case of smaller groups, in which members participate in a more homogeneous way. As a matter of fact, two levels of CoI membership are identified: "designers" and "collaborators". Designers (among them the moderator) exhibit an increased and active participation stretching over a long period of time. Collaborators are being interested or knowledgeable in a particular c-book unit, or interested in implementing it in a real context. They are the seed of highly creative ideas and their participation is very valuable but low. In particular:

- The number of CoI members depends on the c-book unit planned. In any case, it should be between 4 to 7 people, not including possible reviewers. When the aim of the c-book unit is straightforward (e.g., a topic in the official curriculum) 4 to 5 members, including technicians and widget designers, are enough. A larger number of participants (6 to 7) is required when dealing with a concrete real situation requiring the exploration of its potential mathematical versants.
- As to the number of moderators, it also depends on the c-book unit planned: between 1 and 2 moderators are sufficient, though only one should be the main moderator.

Regarding CoI composition and ensuring diversity and complementarity of perspectives, a CoI should comprise CoI members that:

- Form a heterogeneous group of people, since this will produce more interdisciplinary c-book units.
- Have different interests; it is desirable that there are not only education actors.
- Be interested (at least one member) in implementing the c-book unit in a real context.
- Have abilities and skills on technical matters, so that communication with the technical team and the technical implementation of ideas would be more efficient.
- Have certain knowledge or background on the topics selected for the c-book unit, not only mathematical topics, but also interdisciplinary connected topics.
- Show a certain level of compromise of dedicating time and effort to the design of the c-book.

1.4.2 Recommendations concerning planning, orchestration, monitoring and evaluation of CoI-related design work
In order to foster interaction among all CoI members by means of the workspace it is recommended that:

- A first face-to-face or, if not possible, an online meeting with the whole CoI is organized to present and confront initial ideas, and decide on the general structure of the c-book unit.
- During this first meeting the moderator presents and discusses the CMT grid with the CoI members, who are prompted to share their assumptions about CMT and to consider how it can be applied in the design.
Initial synchronous communication fosters asynchronous communication in the workspace and in general, direct communication is proved to be more effective in several cases.

The moderator should have a prominent role, not only as effective designer of the c-book, but also in enhancing communication and, eventually, social creativity. In particular, it is recommended that the moderator:

- Introduces the socio-technical environment to new members.
- Organizes discussions and directs communication among all CoI members, and especially between CoIs by means of the workspace.
- Stimulates exchange of ideas, motivating members to keep the workspace alive.
- Suggests a first proposal after the first ideas emerge in the initial meeting.
- Confronts different opinions (in the role of a boundary broker).
- Proposes and controls the agenda agreed with the other members.
- Designs in the MC2 platform a first version of each phase of the unit.
- Works/communicates with the technical team.
- Presents and discusses the CMT evaluation grid with the CoI. States a context to define and analyse CMT and apply it to the design.
- Explains the grid for CMT affordance to the designers and reviewers, in a f2f or online meeting.

With such an extended description of work, two moderators are required in the case of longer units, whereas there should be still one main moderator. In addition, the moderator(s) assume a brokering role. Regarding sustainability, the process of designing a c-book unit is highly alive and creative when there is the interest of the CoI of implementing the c-book unit in the real classroom context.

With respect to the CMT evaluation, it is recommended to be done by members of the CoI having not participated in the process of design of the c-book unit evaluated, although with an expertise in the design of c-book units.

1.4.3 Recommendations on cross-CoI collaboration

Cross-CoI processes enhance social creativity and CMT in a wider sense than intra-CoI processes, as there is deeper interaction between CoI. In addition to the use of the common CMT evaluation grid, structuring the redesign process into two stages urges both CoI to collaborate in the joint work, allowing for richer social creativity processes. The CMT evaluation of the alien c-book becomes a boundary object, since it draws the main lines of action for redesigning the unit. Also, the first version of the redesigned c-book unit presented to the pair CoI becomes a boundary object for themselves.

Further, for an effective cross-CoI collaboration the following points should be taken into consideration:

- During cross-CoI design, the common language should be adapted to the new context in which two different CoI are participating. As work progresses, this common language emerges naturally between CoI pairs.
- An initial meeting (f2f or online) for the second stage of the redesign (cross-CoI stage) should be held, in order to present the first redesign of the c-book unit and discuss the different CMT representations of the CoI pairs.
- The first CMT evaluation done by the secondary designers’ CoI of the alien c-book unit helps organizing the first phase of the redesign.
- Regarding CoICode, keeping two different workspaces, one for each stage of redesign (intra-CoI and cross-CoI) is suitable for identifying the socially creative potential of the ideas and the products.
- The CoI collaborate in the redesign, which is divided in two stages (an intra-CoI and a cross-CoI stage) and in the CMT evaluation. This process fosters social creativity and the juxtaposition of the CoI’ CMT representations.

The most effective methodology for cross-CoI design is thought to include:

- Adoption of the alien c-book unit, first CMT potential evaluation to define lines of action, construction of a first redesign, presentation to the corresponding CoI pair, construction of the final redesign version and making the CMT potential evaluation.
- The reviewers should not participate in the redesign of the unit, for the sake of impartiality.

1.5 Synthesis of guidelines and recommendations addressed to European policy-makers

In M C Squared project four distinct socio-technical environments were set-up in four EU countries. The richness of perspectives provided was perceived by M C Squared project as necessary to acquire a pragmatic sense of the c-book’s potential as a new genre of educational resource. Contextual issues in the education industry have been notoriously complex, and evaluating the affordances of any technology without taking them into account provides a very narrow lens with respect to understanding the potential for wide scale implementations across education systems, cultures and countries. Employing four research teams, each developing their own approaches and application designs to study the use of the proposed model of “a CoI in close interaction with C-Book technology” in respective contexts was an evaluation strategy conceived to allow us to capture social creativity by means of separate in depth studies but also by synthesizing across these contexts and frame connections. The respective CoI-cases worked within their own national and systemic contexts while keeping an open link with large-scale systemic initiatives in the education sector. Each CoI's discussions, processes and productions were also exchanged with other CoI, critically commented on and redesigned/produced in a cross-experimentation frame between different countries.

Along the same lines, the influence of the national context on the guidelines and recommendations on the method of setting up CoI for supporting creative designs for CMT resources, as exemplified in the previous sections, is more than apparent. However, there are also significant commonalities among what each CoI-related partner recognises and recommends, suggesting that the notion of the CoI, as well as that of C-Book technology, are flexible enough to allow for and stir up creative designs in diverse contexts. In this sense, in the section to follow we address European policy-makers by providing a synthesis of the recommendations from all four CoI and adapt them to acquire a cross-national rationale.

1.5.1 Recommendations concerning size, composition and membership/recruitment of a CoI

The envisaged features of the c-book as a product seem to constitute the core criterion with regards to decisions that have to be taken in terms of the optimum size of a CoI. Moreover, heterogeneity/diversity in expertise, interests and perspectives are unanimously recognized as sine qua non
prerequisites for a creatively working CoI. The term ‘hybrid’ or ‘complementary expertise’ is coined for CoI members participating simultaneously in diverse CoP and thus, reflecting the required richness of perspectives as a necessary condition for boosting creativity. In particular, for setting up a CoI the following criteria have to be applied:

- At least 2 to 6 educational designers with a variant disciplinary or professional background, including at least one developer, and having some kind of direct or indirect relation to the teaching practice and school context are needed.
- The topic of the c-book and the broadness of the design task (mono- or cross-disciplinary) determine the necessary degree of diversity and the expected roles foreseen for the CoI members.
- The complexity of the design tasks to be performed also determines diversity of disciplinary perspectives and roles in the design of a c-book.
- At least one position in the CoI should be reserved for a moderator with a role to regulate and facilitate the flow of collaborative design.
- Technical skills are essential for the implementation of ideas and for enabling communication with technical staff.
- Last but not least, expertise in graphical design should be available within the CoI designer team, since visual appeal is closely related to affective aspects therefore, it is absolutely vital for enhancing educational resources.

The recruitment of CoI members relies heavily on the context in which the CoI are formed. However, in general:

- It is recommended to be based on former collaborations and membership in CoP constituted as part of or in order to serve educational innovations related to the design of digital resources.
- Appropriate and varied incentives should be provided for the recruitment of all CoI members (and particularly teachers), such as institutional acknowledgement, technological support, usability of the resources on a classroom level.
- Time is an essential resource to be reserved for the design of c-book units.

1.5.2 Recommendations concerning planning, orchestration, monitoring and evaluation of CoI-related design work

There is a need acknowledged by all for organizing and providing a mix of interactions: face-to-face, online, synchronous and asynchronous. In some cases, synchronous interactions are considered more effective than asynchronous and are proposed as the main communication channel between CoI members. As a matter of fact, initial synchronous communication fosters subsequent asynchronous communication in CoICode. In particular, it is suggested that:

- A face-to-face meeting takes place at the beginning of the design process where CoI members get acquainted with each other, roles and tasks are assigned and brainstorming of ideas takes place.
- Specific measures should be taken to boost CoICode use, in case CoI members are reluctant in using it. For instance, support material can be provided (see, 2.1)
• The design process should not be tightly structured to foster creativity. Some -more or less-
general instructions might be given regarding the course of actions, the theme of the c-book,
or its technical specifications.

The explication and negotiation of the designers’ CMT representations is significant for setting up
creative designs of resources fostering CMT. Moreover, it helps building common ground for
collaborative design. Therefore:

• The first CoI meeting can serve as a triggering event for exchanging views about CMT
based on creative activities suggested by CoI members or even through the CMT grid.

Boundary brokers play a major role in the design of c-books. The range of their tasks and
responsibilities varies depending on the CoI setup:

• They communicate creative ideas between diverse CoP.
• At times they assist the moderator in monitoring the design process or,
• They are even charged with the technical implementation of ideas.
• A multiplicity of skills (in other words, a ‘hybrid’ identity) is essential for fulfilling a
brokering role.
• The moderator also assumes the role of a ‘broker’ when organizing discussions on
confronting views in the workspace.

The prominence and breadth of the role of the moderator in enhancing social creativity is
unanimously acknowledged. In particular:

• The moderator should perform at least three types of activities: contextualizing, monitoring
and meta-activities. Among others he/ she is in charge of coordinating, keeping the agenda,
fostering exchanges, meeting deadlines, maintaining a continuous flow of work, motivating
and supporting CoI members, putting forth and denoting members’ suggestions or even
designing the c-book unit.
• The role of the moderator is usually assigned to one person, though two moderators might
be needed in large CoI (still one of them is the main moderator).
• Depending on the CoI setup, the moderator assumes moderating activities as an extension of
her/his role.

Keeping a high level of motivation is challenging and depends on the interaction of various factors,
such as the estimated workload, the interests of CoI members, the benefits they derive from
participating in the CoI, the diversity and complementarity within the CoI. Sustainability of the CoI
can be thus ensured in the following ways:

• Recruit CoI members with the appropriate skills, professional and personal qualities.
• Provide appropriate rewards and incentives (among them the perceived usability of the c-
book unit in the classroom).
• Provide technical and emotional support while designing a c-book unit. The role of the
moderator is here crucial, so that a culture of joint responsibility is cultivated in which all
members are equally engaged in design activities.

CMT evaluation is suggested to be carried out by evaluators (e.g. members of different CoI) who
are not official members of the process of designing the particular c-book unit. It is worthwhile to
take place not only after but also during the design of the c-book unit to enhance its CMT affordances.

1.5.3 Recommendations on cross-CoI collaboration

Cross-CoI collaboration and work is deemed as a strategically ‘European’ challenge to promote and a strategy to capitalise on, since it can enable de-contextualisation and re-contextualisation and increase the degree and depth of our understandings on educational designs and their applications for attaining creativity. It can therefore augment and multiply the possibilities of broader proliferation of c-book resources. To further support this thesis, we reviewed and propose the following recommendations for setting up a cross-CoI collaborations context on a European level:

- Organize an initial f2f or online meeting to discuss the course of action to be taken (including the organization of workspace and CMT evaluation) or, alternatively, to present the first version of the redesigned unit.
- Promote the use of a common language. It is considered -more or less- an important condition for inter-CoI communication, associated with shared meaning and with the common methodology and tools.
- Use two separate workspaces for each of the two stages of the cross-CoI collaboration (representing intra-CoI and inter-CoI communication around the redesign of a c-book unit, respectively) so that local factors as well as boundary crossing processes that influence the design become explicit.
- The development of common tools might result in uniformity that facilitates comparison between CoI, however it might reduce the freedom of designers to interact in less prescribed ways.
- The use of common methods enhances comparability, however, their validity and reliability is likely to be questionable and might bring up issues difficult to resolve.
- Develop a common methodology, a particular process to redesign a c-book unit followed by all partners. For instance, besides the initial meeting, a second one related to cross redesign should take place.

1.6 Reflection on the Method of setting up CoI

The employment of four distinct S-T environments enabled the cross-fertilisation among CoI, as in the case of constructing and adopting common methodological tools for evaluating social creativity and CMT, as well as it allowed cross-case designs and analyses of CMT representations between the four CoI. In addition, it added another level of diversity in designing CMT resources, that of the educational context. For instance, in future studies, the particularities of the national and systemic contexts should be taken into account so that the most efficient method is used for setting up CoI in each context. In particular, in countries were in-service teachers have an established role in large-scale initiatives related to digital resources, teachers are willing and keen to actively participate in the design of educational resources. In cases where the workload together with the curriculum place tight restrictions on teachers regarding their availability and the choice of resources to be used in the classroom, it might be more difficult to engage teachers as designers, therefore specific incentives should be employed. A strictly utilitarian view on the use of resources (which can be directly integrated in the mathematics classroom) from the teachers’ side might also collide with creativity,
yet it should be taken into account if teachers are to be recruited for designing c-books. This situation might not be encountered in contexts where the academic value of designing mathematical resources is appreciated also resulting in more innovative designs.

Moreover, the choice to work with four instead of one CoI resulted in a set of recommendations that is common across CoI. At the same time, some recommendations are met only in particular CoI and are connected with the educational culture of the specific context as explicated above. If we want to obtain a deeper understanding of the nature of the processes that allow the design of creative resources, then it is necessary to study them across various educational contexts and clarify connections and differences between them. The horizontal analysis of the CoI templates gives evidence about the role of the context diversity both by de-contextualizing the findings and by using synthetic knowledge to later try to re-contextualize generic findings.

In conclusion, diversity in experiences, expertise, histories and assumptions within a CoI is likely to fuel social creativity in designing digital resources. Small and flexible configurations are appropriate depending on the broadness and the complexity of the design task, while technical skills are crucial. Furthermore, the recruitment of CoI members can be ideally based on former collaborations, while personality traits and motivational issues (related to intrinsic and extrinsic incentives) should be also taken into consideration. The moderator’s role in a CoI is fundamental and is constituted of a broad range of activities which are focused not only on the optimal collaboration between CoI members, but also on delivering a creative end-product. Apart from the moderator, knowledge brokers also play a decisive role as they transcend the boundaries and bridge the differences between diverse worlds. Moreover, since the aim is to design resources that promote CMT, CoI members’ CMT representations are the foundation and the starting point for building creative designs. The negotiation of CMT representations also takes place when engaging in cross-CoI designs, in which the high level of diversity might further augment creativity.
2. Guidelines and Recommendations on the C-Book technology use

This section aims at providing guidelines and recommendations on the best use of the C-Book technology for bringing about creative designs for CMT resources. These recommendations came out of the synthesis of the suggestions that were put forth by all M C Squared research and evaluation and technical partners. In particular, these suggestions refer to the use and further development of CoICode, the C-Book authoring tool and the c-book unit technical specifications, the exploitation of the widgets available and automated feedback and learning analytics as main components of the C-Book technology. They have been summarised and presented in the form of guidelines and recommendations for the optimal use and development of the C-Book technology, based on the analysis of information that was collected from partners on the four CoI first-hand experience with the C-Book environment and the rich exchange that took place among evaluation and technical partners throughout the three year course of the M C Squared project.

2.1 Recommendations on further developing and using the Collaboration and Communication Workspace (CoICode)

The C-Book technology encompasses a set of tools, among which CoICode, a communicative and collaborative environment enabling CoI members/ designers to have an asynchronous communication and collaboration on their ‘creative designs’. The CoICode provides “workspaces”, on which the CoI members can insert posts containing plain text, upload files or widget instances or a link to a shared c-book unit, in two parallel interfaces: a threaded forum discussion view and a mind-map view. It has been anticipated that by providing this ‘dual view’ affordance, that is as a collaboration and communication space, CoICode can inspire collaborative design with a sustained focus on creativity and enable multiple boundary crossing exchanges among designers by supporting dense artefact exchange and improvement. In fact, the CoICode tool was employed in diverse ways in different phases of the M C Squared project and according to the needs and particularities of each CoI. Before elaborating on the differences in CoICode use, we proceed in highlighting some commonalities in the way M C Squared partners view its optimal use with the CoI.

All partners agree and recommend that in order to enable/ enhance the use of CoICode it is important to:

- Provide support to assist and motivate CoI members in using the CoICode for communicating and designing a c-book unit. This assistance might come in the form of tutorials, the guidance provided by the moderator, or even as hands-on experience provided during workshops.
- Make obvious to all CoI members what is the added value of using CoICode as a communication tool for fostering intense exchanges related to the technological implementation of ideas in place of or in combination with email or skype communication.
- Possibly examine the possibility to add some tools for synchronous communication to CoICode, as this might as well also trigger asynchronous communication.
• Improve some CoICode features, especially those related to the recording of communication such as, semantics as well as speed, stability and other general Java issues.

The issue of organizing the workspace in a manner that is easy for CoI members to follow and sustain discussions, has been also raised, while this issue is tightly bound with the complexity of the design process. With regards to it, it is recommended that:

• Adornments or other signposts are used for denoting, e.g. that multiple ideas merge into a new c-book version. In case this is not possible, the moderator could create a sequel workspace.
• Adding an option of ‘closing’ the workspace on a specific date would help respect the agenda and control the number of posts. However, in general, there should be no many limitations, otherwise fluency and thus creativity might be impeded.
• A large number of posts very often results in a chaotic, cramped workspace. For this reason, the moderator should consider doing some “maintenance” job from time to time, such as rearranging posts in the threaded forum discussion view so that the CoI members can easily follow discussions and discern new ideas.

In terms of its use, all partners suggest providing clear rules to CoI members (in the form of a CoICode user guide) for posting their contributions, such as:

• Use the semantics in the prescribed manner.
• Articulate one idea per post.
• Elaborate a distinct idea in a single tree.

Another important use of CoICode is the one providing to the CoI members the opportunity to rate each other’s contributions against the core attributes of creativity (novelty, appropriateness and usability). Creativity voting was considered and promoted as an indispensable part of the design process allowing a formative evaluation procedure to take place, giving a relatively direct feedback to the CoI members on the ‘quality’ and ‘creativity’ of their ideas and productions and boosting their creative design work. To support this affordance all partners, agree that certain rules should be universally applies, such as:

• It is important that each CoI member votes for every post.
• The three ‘creativity criteria’ are fully understood and used by all CoI members.
• Voting is held in a specific timeframe, preferably close to the upload of the post.
• A general reminder system for voting along with some personal reminders, and possibly the addition of a positive textual feedback, are all to the benefit of the voting procedure.

In general, it is recommended to provide enough guidance and support to the users on the norms of effective CoICode use, such as making clear for them the essence and granularity of posts and the negotiation of how to vote on each post. This would allow both the design process to be enhanced and also data analytics allowing for reflection to be provided. Moreover, by consistently following the same rules across all CoI members and different CoI, the context of various workspaces can be comparable and CoICode data analysis can become more comprehensive and consistent across CoI.
2.2 Recommendations on further developing and using the C-Book authoring tool and the c-book unit technical specifications

A c-book unit is structured into sections and pages containing text, links, files and widget instances, the latter developed out of a set of mathematics widgets, which are either prefabricated or custom made with the use of related widget factories incorporated in and provided by the C-Book technology. The design of digital environments rich in opportunities for mathematical meaning making is enabled by the appropriation of widgets designed to foster CMT by affording dynamic manipulation, visualisation and modelling, interconnected representations, simulations of phenomena and situations embedding mathematical rules. Furthermore, the student activities designed to go along with the use of the c-book are aimed to be open ended, constructionist, exploratory and discursive/argumentational and embedded in realistic contexts such as environmental issues, artistic designs, workplace problems, game construction and play.

Towards this end all partners agree on and suggest the following recommendations regarding the C-Book authoring environment:

- Technological support is recommended on the level of the C-Book Author (CBA) and the widget factories for creating individual extra widgets. This support can be provided via a series of tutorial videos and user manuals.
- The author affordances would need to be as user friendly as possible, but also providing deep structural access to widget design and inclusion and architecture and positioning of text in relation to widget instances.

C-Book technology is recognized as a special type of technology designers should get acquainted with to exploit its affordances in the most creative way. This could be achieved, for instance, by means of a workshop organized at the beginning of the design process. Most importantly, c-books are not merely digitized versions of their paper counterparts. Instead, this novel genre of e-books introduces new affordances (i.e., interoperability, multimodality, feedback and learning analytics) allowing the meshing of narrative with dynamic constructionist expressive media. The C-Book technology provides a diversity of media for exploitation by designers and end-users (such as videos, widgets, external and internal URL links) allowing this way the c-book to become an interesting and engaging new educational resource as well as to facilitate exploration and analysis of mathematical ideas and even provide unique opportunities for manipulating mathematical objects in ways that are not feasible without the use of the C-Book technology (e.g., constructing and manipulating geometric objects). The interplay of all these elements in one ‘product’ triggers the designers’ imagination and motivation to take full advantage of this potential in their design choices for c-book units.

The internal evaluation that took place within all four CoI, backed up by the expert view of the technical partners led us to the production of the following list of specifications for the design of a c-book unit, as considered under the current state of the C-Book technology:

- The size of a c-book unit should be in accordance to what is allowed by the existing C-Book technology and what best suits its end-users. Too many pages with several widgets in each of them might, on the one hand, slow down the c-book response time and, on the other hand, overwhelm the user and result in reduced attention.
• A page of a c-book unit should not look like a traditional textbook exercise or a micro-experiment. Widget instances and the accompanying narrative should function in unison with each other and this sense should be clearly communicated by the appearance of the widget instance(s) within the page.

• A c-book page should contain, where appropriate, a variety of widget instances, preferably from different factories, so that end-users have the opportunity to establish connections between different representations. Designers/authors should take the advantage of the shared functionalities between different widgets offered by the C-Book technology and grasp the opportunity to use more than one of widgets in the same page.

• By and large, designers should bear in mind the factors that are likely to foster CMT, such as connection between different knowledge domains, asking for as many answers as possible to a given question or problem, posing open problems, allowing students to make and test conjectures (e.g. by providing appropriate feedback), giving equal emphasis to social and aesthetic aspects, and draw on them in the design.

• Aesthetic aspects are playing a vital role in boosting user motivation and engagement, and so the use of a consistent layout throughout pages in the form of a pre-defined template is strongly recommended.

• However, it is also recognised and strongly recommended that the C-Book technology should be further developed and improved to minimise any speed, size and interface usability issues to the least possible.

On the other hand, the current widespread use of tablets and other mobile devices imposes also a set of requirements to be met when designing c-book units to be played in them. Among other things, the following issues should be addressed in future developments of the C-Book technology:

• User interaction is performed with finger instead of mouse, a feature influencing several design choices consequently. For example, interaction areas should be more distinct, drag and drop has a different behavior than on the desktop, and icons and buttons should be large enough to avoid double tapping.

• The screen size is smaller than on monitors, therefore less items should be put on screen, with more space between the interactive ones.

• Widgets should present the minimum amount of text content as possible to conform to the modern design of apps for smart phones and tablets, where most of the information is either self-explaining or represented with images and icons.

• Zoom in and out should be performed with pinch action and no zooming buttons or navigation arrows should be present.

• Resolution should be kept under the estimated tablet resolution to have most page parts visible without continual scrolling.

Regarding the use of widgets, c-book designers/authors are recommended to be aware that:

• The use of existing widgets within the C-Book authoring environment is straightforward, based on the published widget catalogue, which contains brief information on the widget factories as well as links to further documentation.

• Some widgets come with cross-widget-communication features, logging or feedback features as documented in the widget catalogue. However, if a c-book author needs some additional interoperability features, he/she should contact the authors of the respective
widget factories (in the case of Cinderella, the missing widget features may be added by using CindyScript).

- Interoperability between widgets is possible “out of the box” for some of the existing widgets.
- Some widgets provide feedback to students or logging to the learning analytics server in order to allow teachers to analyse students’ work. For many applications, the C-Book technology provides the widget factories that can be used by c-book authors without any programming knowledge, for example:
  - GeoGebra or Cinderella for geometry widgets,
  - MaLT for widgets related to logo programming,
  - EpsilonWriter for widgets related to algebra,
  - Cinderella for physics simulations.
  - Web-sus-x for situational game design.

However, in several cases, an author of a c-book may either want to produce specialized widgets for a particular purpose or add feedback, logging, or interoperability features to existing widgets. For advanced applications, authors may for example use Cinderella, with the help of tech people with programming skills, in order to realize almost any imaginable widget and any related cross-widget-communication needed. It is also possible to add feedback and logging features if required (note that Cinderella is being actively developed, so some features which do exist may not have been documented adequately yet).

The advantage of re-developing all widgets in HTML5/JavaScript is that using c-book units with lots of widgets becomes feasible even for schools with slow internet connections:

- Firstly, loading the old and large pieces of Java software is not necessary. It can be replaced by tiny specialized widgets with very short loading times.
- Secondly, Java-enabled browsers are not needed anymore when viewing c-books which only contain widgets that have already been ported to HTML5/JavaScript.
- A word of caution with relation to the use of the HTML5/JavaScript player, and in particular of mobile devices:
  - All widgets had to be ported from their original programming language (Java in most cases) to HTML5/JavaScript.
  - Authors should always test their c-book units in both environments - Java and HTML5/JavaScript - before publishing them, since there may be some differences in the user interface to some of the widgets. If in doubt, users should contact the widget authors.

Another component of the C-Book technology is automated feedback and learning analytics to inform designers on end-users’/students’ behaviour and their learning outcomes. To achieve its full capabilities, it is recommended that some level of cooperation between designers, domain experts and developers depending on the functionality may be required on feedback authoring:

- The most important issue to observe is the role of task analysis at early stages of design to identify the level of feedback specificity and its complexity in order to determine the level of involvement of different expertise in the configuration process.
- A possible process for authoring feedback is to follow a ‘layered’ incremental approach that requires interdisciplinary involvement by domain and widget experts, learning designers or...
technologists who can appreciate both the domain needs and the affordances and constraints introduced by the C-Book technology and developers to write specific analytical modules.

- After the initial authoring the skill threshold for configuring the feedback messages is reduced.
- In terms of the analytics dashboard our recommendation is that designers, developers, authors and teachers work in tandem to properly configure the c-book unit and take care that logging is enabled for all the widgets that one may expect that the availability of data will help reflecting on the unit’s usage.

**Classroom implementation of the c-book units** should be also taken into account when designing them. Suggestions stemming from the CoI pinpoint specific features of the C-Book technology that can lead to efficient classroom use. These are:

- Provide access for students with disabilities and calibrate CBA features for better classroom management (e.g. allocating teachers and students to particular c-books or activities).
- Add a final enquiry for the students to automatically collect feedback about the CMT potential and the use of the c-book unit.
- Provide suggestions for orchestration, for example information about the aim and goals of the c-book unit, the teaching and learning strategies possible to be employed and preferred classroom organization in an accompanying document.
- Inform teachers to ensure that everything works correct in the exact context where they are going to implement the c-book unit.

### 2.3 Recommendations on collaboration among technical partners and between them and the CoI

Working with several technical partners from all over Europe, and also with users (CoI members) who tried to use the software (still in development) was an interesting challenge for all partners. Out of the experience gained from M C Squared project we recommend the following actions for a successful collaboration among technical partners or between them and the CoI to take place:

- Organize weekly technical update meetings: At least one member from every technical team should join the weekly online meetings. In this way, all major issues can be resolved in time.
- Organize face-to-face meetings for strategic discussions, to develop new ideas (such as the cross-widget-communication mentioned above) and to improve the communication between the teams. The combination of those two different kinds of meetings is quite fruitful.
- Early, long and effective face-to-face technical tutorials should be organized for the CoI. If possible, each technical team should organize a workshop for the respective CoI as early on as possible in the project in order to provide a good basis for later developments. This should be accompanied by video and written documentation.
- All new features of the technology appearing in the course of the project should be communicated in a similar way: by workshops with the CoI members, via tutorial videos and written documentation.
- In some cases, it may be most effective for a technical team member to spend a few days working close with a CoI in order to take a first-hand view and develop the specialized
widgets needed in collaboration with the CoI. This is even more important in cases where the CoI is not yet aware of all the new opportunities the software allows for.

2.4 Reflection on C-Book technology use

Apart from the commonalities identified in the use of the C-Book technology and the shared views in highlighting issues of common interest as recommendations for policy-makers and future users, our analysis of the input received by the four CoI allowed us to realise that the C-Book technology was employed in diverse ways that matched their specific needs and context. For example, there were cases in which the ColCode was approached as a tool that was not to be used continuously, but in ‘bursts’ of communication around a particular draft design. Or, other cases where face-to-face interactions among CoI designers were taking place without in parallel recording of the different ideas and how they evolved over time on the CoICode workspace. In some other cases, the CoICode was used as the primary communication tool, while in a few instances some other forms of synchronous communication supported the use of CoICode.

Another challenge that each of the four CoI tackled in different ways was the granularity of the node: some CoI applied the rule that each post should contain a single idea, which they found as working quite well in their own context. However, other CoI recognized that by inserting separate ideas in single nodes might be counter-productive to the creative process; in those cases, posts contain more than one idea, just like in face-to-face discussions participants usually express several ideas in one response. In the latter cases the problem with automatic analyses is recommended to be solved by retrospectively deconstructing a multi-idea node into separate single ideas, with this act to be done by the moderator or another person in charge of following the forum discussion. From a management point of view, the use of multiple trees, as some CoI have suggested, might be an efficient way to reduce the complexity of the representation of CoI communication (since each tree refers to the elaboration of a separate idea). However, the coherence between the different phases and sections might be more difficult to deduce from the tree-like structure, while in practice there exist not so clear-cut boundaries between ideas as the tree-like structure might suggest. In conclusion, for creativity to be fostered in the design process of producing creative digital educational resources for CMT, the C-Book technology is proposed as a rich environment to assist, nurture and promote its users’ aspirations and facilitate their creative ideas to become implemented. The C-Book technology provides the advantage of being a complex although user-friendly computational system with a set of interrelated components, each of them offering specialised support to enable and boost creative designs for CMT. CoICode is proposed as a tailor-made communication and collaboration tool with a built-in voting system for creativity, flexible enough to respond to the needs of diverse CoI as well as to extend itself in many more applications. Its use is decisive in providing the necessary structure to the design work of the CoI members, while also leaving enough freedom for a space of open communication and boundary crossing exchange to be offered to CoI designers as a necessary support to social creativity. The same applies to the c-book authoring environment and the accompanying widgets: designers have at their disposal a spectrum of customizable tools allowing them to take advantage of the interplay of various features and functionalities that can assist them in thinking of and implementing their creative ideas, so that the end-products, the c-book units produced can afford enhancing, without prescribing creative
mathematical thinking in their end-users/learners. Finally, automated feedback and learning analytics is another set of customisable tools available by the C-Book technology allowing both designers and teachers to pre-configure the feedback the end-users/students can receive while using a c-book unit and which data to be collected on the outcomes of such uses, as important information to be processed, considered and guide the creative work of designers. Based on the recommendations and guidelines that have been summarised and discussed in the previous sections of this deliverable, we argue that prospective users and policy-makers (both on a national and a European level) can profit of and capitalise on all the advantages provided by the C-Book technology in supporting social creativity in the field of professional educational design for CMT and beyond.
Endnote: A scenario on a creative industry making use of the proposed business model

We conclude D2.5 by providing a scenario with a hypothetical example of a creative industry having adopted the ‘CoI+C-Book technology’ construct proposed by M C Squared as ‘business model’. This scenario was jointly conceived and developed by CTI and UU based on the outcomes of the work in D2.5 that led to the guidelines and recommendations on the method for setting up CoI and on the C-Book technology use, all presented and discussed in the previous sections. Our purpose was to outline how the hypothetical case of a company stemming from a creative industry sector could be inspired to explore opportunities for boosting innovation, quality of products and services, productivity of work, and (eventually and hopefully) economic profit in their professional practice if making use of our proposed ‘business model’.

More particularly, we espouse the view of a business model as ‘a recipe’ for creative managers coined by Baden-Fuller & Morgan (2010), which we adapted to address creative industries (instead of persons). This view assumes a ‘dynamic’ practicality and usability in the proposed business model, along the meaning encapsulated in the ‘recipe’ idea: a recipe while it displays the general principles of cooking and particular details of the ingredients of a dish, it allows a creative chef to get inspired and experiment to create her/his own successful variations and innovations. By assuming a similar role to a ‘business model’ proposed to a company from the creative industries it means that it is conceived to operate in a way that it provides a general frame of how to arrange things inside the company, while also leaving space for adaptations and explorations of the many possibilities for innovation. The example selected focuses on a company from the publishing sector specialising in the design of educational resources for mathematical learning.

A scenario on the possible exploitation of the business model by a publishing company

Publishing companies constitute a prominent sector of the creative industries (Howkins, 2001). Although a well-established and stable industry, it has nevertheless minimally involved in technological revolutions and was rather reluctant in launching innovations (Benghozi & Salvador, 2016). However, Tian et al. (2008) argue that publishing companies would have much to gain in terms of new value propositions and business models if they were more open to the many opportunities offered by the digital technologies, and if they welcome innovation in the sense of rethinking of the overall design of their products including their dimension, use, design, service or business model (Von Hippel, 2007). This exploitation scenario takes the view of a publishing company for mathematical learning materials. First, two words about how things stand for such organisations.

A growing number of publishing companies of educational materials have started recently to get involved with ICT-products. Although paper textbooks are still an important part of the business model of most educational publishers, publishers cannot ignore the new digital media. The general potential for new business models due to the popularity of digital technology as a medium cannot
be ignored, together with the logistics and economy-of-scale in production, availability, forms of payment, possibility for diversity in access rights, potential for visibility and collateral business such as co-advertising products from within or even outside the e-book industry, etc.

Most education products however, are either digital versions of paper book resources or supplemental tools and environments, for example for viewing video tutorials, practising and testing. These resources for viewing, practicing and testing, although not providing a visible change to pedagogy, use digital affordances in ways which are new and unachievable with paper media and thus can seldom be developed entirely based on in-house expertise.

This is even more the case for educational materials for mathematics education. Tools that are really touching the concepts and are proven pedagogically novel and useful within Math Education are often complex and require a strong combination of mathematical knowledge, educational knowledge, knowledge from other domains, where mathematics can usefully reside, and information technology skills to be produced. Most publishers of educational materials cannot afford such a diverse team of specialists to build such technology, especially when (only) targeting the niche of Math Education. This is the reason publishers often link their textbooks to proven technology tools, like graphical calculators, existing dynamical geometry software, some dedicated applets and animations and sometimes general purpose practice- and testing software with feedback features (mostly of a multiple choice and seldom based on sound mathematical interaction). This situation usually results in a scattered proposition of educational technology for Math Education, providing little new learning experiences with mathematics. As a result, technology is not very much used in most schools. Furthermore, dependency on context characterising educational services is making it very difficult for products to be useable across cultures and education systems, making it in turn very costly to survive, especially for companies in small countries.

The C-Book infrastructure developed in M C Squared project is proposed as a real solution with respect to the problem above. For the designers of educational resources, the C-Book technology provides interoperability of proven tools of great diversity, but also customisability of these tools and advanced authoring, allowing the designers to combine them in a creative way. The technology also affords customization and authoring of data analytics specific to a particular widget instance and the c-book as a whole. The c-book architecture has special authoring affordances supporting and inspiring collaborative design and development of potentially new kinds of resources. So, these two main features of widget diversity and collaborative design are new and open to new kinds of exploitation plans among publishing companies of educational materials for math learning.

A publishing company opting to make use of and exploit the C-Book infrastructure is argued to have a strong proposition to support the educational design of identifiably novel technology-based learning materials. Some of the background software (DME from University of Utrecht), supplemented with new components of the C-Book technology have been already used in a commercial context (a Dutch publishing company) and gave evidence of improved design work.
However, we believe that there is more potential for a new kind of business model. In the education sector, design is increasingly becoming a recognisable aspect of many different types of jobs, e.g. teachers, ICT developers, consultants, teacher educators, curriculum writers, even students and their parents. Publishing companies may address this phenomenon by providing interesting entrepreneurial venues for this new design dynamic:

- By inviting, for example, diverse groups to come up with creative ideas of resources meshing text with a limitless variety of dynamic widgets, or

- By becoming the hubs or the instigators of Col-embedded diverse expertise, inspiring and challenging collectives of professional designers with a diverse background to mix their contrasting perspectives, disciplinary background through boundary-crossing interactions, moderated by persons with the capacity to act as 'brokers' and with the duty to organise the design practice of these collectives by identifying, coordinating, putting in reflection and finally helping them 'transform' their perspectives into more creative ones, in the language of the project, new/novel, appropriate and usable.

All this activity can be stimulated and supported by the functionalities of the "ColCode + C-Book author + widgets + feedback and LA data" system as a business model.

For learning mathematics this is particularly revolutionary, as it potentially provides the 'reader' of a c-book with many opportunities for meaning-making, through manipulation of linked representations or the engagement with games or models of a huge variety. This may lead to a considerable change in the view of and relationship with mathematical content and thinking processes. Imagine of mathematics as a knowledge domain embedded in a much larger variety of situations, stories, problems or issues of societal concern, such as environmental sustainability. To accomplish this, a publishing company may have to train and provide boundary brokers or moderators with a hybrid expertise. It may have to bring together individual designers in a design community to share their ideas. It may have to think of joining the forces of two or more communities of designers with a different national background so that the resulting c-books are proliferable to much larger markets across European countries at a low cost, since re-design and remixing of existing book would be much less arduous than preparing a new one from scratch. This could potentially start with a process of twinning and evolve from there. Publishers may thus be interested in investing in a new kind of broker, one who on top of a hybrid knowledge regarding domains and concepts at hand, would also have the knowledge of de- and re- contextualizing resources and helping designers quickly developing communication channels for this. The affordances of C-Book technology allow any combination of the above options at all levels.

A publishing company may nevertheless adapt the above model or think of more ‘models’ for attracting revenue by including designers in this process. Think for instance of the ‘teachers paying teachers’ model. Why is it working? Because in that community, detail and relevance is highly valued and because good quality products are instantly recognised within the community through voting systems, reviews etc. Individual designers make a name for themselves and prosper as a result of the popularity of their work.
Publishing companies need to make a much better use of the affordances of proposed business model and come up with new kinds of business ideas. For instance, they may need to find ways to promote c-books showing the potential for a new kind of medium. Hire consultants or make a deal with a famous story-teller to turn a popular story into a story filled with opportunity for mathematical meaning making. Think of Harry Potter and the mathematics which can be embedded in the games within. Also, show new genres of visualisation of mathematical constructs and transformations. Let the readers create things and make a book of their own. Make spaces for business ventures not only by individual designers but also by successful CoI, groups of diverse designers who seem to come up with a rich variety of ideas and who acquire kudos and visibility by means of the value, originality and usefulness of their products.

Publishers, traditionally attract revenue directly from the consumer or alternatively from the provider of educational services, the school, the district or the education system. Possibilities such as the ones proposed or possible adaptations of them allow trying out many different permutations of these traditional models. When the product is visibly novel and interesting, as in the case of c-books developed by communities of designers, it is really worth trying out a variety of methods. For instance, in some education systems in Europe, there is a principle that education should bear no cost to the end consumer since it is a democratic right for every citizen. In that case, c-books could be made available for free, making this medium visible and putting it to use. Then individuals could opt to look for c-books outside the system which have accrued recognition through digital infrastructures.

In any case, many publishing companies of learning materials for math may find these innovations very promising to further explore. In paragraph 8.1 of deliverable D8.3.2 usable business model are discussed and worked out in more detail.

References:
Annex 1: The D2.5 ‘Guidelines and Recommendations’ template

Aim and suggested use of this template:

This template has been designed to be used by M C Squared evaluation partners and technical partners as a guiding framework for describing, reflecting on and sharing information with regards to specific guidelines and recommendations on:

- the method for setting up Communities of Interest as a business model for supporting creative designs for CMT resources,
- the use of the C-Book technology to facilitate such creative designs.

Information to be collected via this template is to be based on research evidence and experience gained through the three-year consecutive cycles of design work conducted under WPs 6 and 7 as well as all other WPs. It is to used under WP2 and more specifically in T2.6, and with the intention to provide necessary input for preparing deliverable D2.5. D2.5 will report on a set of guidelines and recommendations addressed to interested creative industries (and more particularly the education industry), as well as to national and European policy-makers.

1. Guidelines and Recommendations on the Method for setting up Communities of Interest

Each research partner will have to reflect on all decisions and actions taken by their team to set up and implement their CoI-related design work and critically assess them in the light of the experience gained and evidence gathered from their evaluation studies, to write up specific guidelines, tips and recommendations on how to set up a CoI in order to effectuate optimum conditions for the emergence of creative designs of c-books on a local (their national) context. In particular, each partner will have to consider the following issues and transcribe important knowledge into specific guidelines to be addressed to potential national stakeholders and policy-makers interested in setting up similar schemes of CoI-related design work:

- Is there an optimum number of members for a CoI working on the design of a c-book? Does optimum size of a CoI depend on any factors and situations?
- What is the most effective composition of a creatively working CoI? Define levels of diversity and complementarity between CoI members and how they can be ensured.
- What are the best courses and procedures for recruiting the members of a CoI?
- Provide specific tips for successful orchestration of the CoI members’ interaction (f2f and online) Is there any sense of eliciting the initial CMT representations/conceptions of the CoI members and use them in the design work?
- Estimate and delineate the role of ‘brokers’ in the design process?
- Provide specific guidelines on the moderation strategy in different design phases, including ways to keep the design on track when the work flow is stagnated, to resolve tensions that arise etc.
- What is the suggested degree of structuring the design work through design specifications concerning tools, c-book theme, target group etc.) to CoI members in advance?
How to ensure the sustainability of the CoI? How to maintain a high degree of motivation and enthusiasm among the CoI members?

In cases of cross-CoI collaboration, some of the issues on which specifications can be drawn are:

- Establishing a common language – communication channel. Is that a must?
- Number of separate workspaces: how many? (i.e., one per CoI and one for the common design work)
- Is there a necessity for developing some common tools (in the form of templates or else)?
- Is there any sense of developing some common method (i.e., in the evaluation or in the analysis of the data, so that the same approach is taken and findings are shared between the CoI)?
- Define some optimum mode of cross-CoI interaction and how and when this could feed and stimulate redesign.

2. Guidelines and Recommendations on the C-book technology use

Each research and technical partner will have to provide guidelines and recommendations on the best use of the C-Book technology for bringing about creative designs for CMT resources. In particular, each partner will have to consider the following issues and transcribe experience gained through mc2 design practice into specific guidelines to be addressed to potential national stakeholders and policy-makers interested in setting up similar contexts of creative design work with the C-Book technology:

- Use of the Collaboration and Communication Workspace (CoICode), such as
  - maximum number of posts per Workspace
  - setting up specific rules for posting ideas (e.g. contributing to existing threads before adding new ones)
  - setting up voting rules (e.g. when, which posts, which CoI members)
  - providing a quick guide or prompts so that users become familiar with CoICode functionalities.
- The c-book unit technical specifications, such as
  - size of a c-book unit (e.g. number of activities, number of pages, number of widgets per page or per c-book unit)
  - the widget instances’ specifications (e.g. size, appearance etc)
  - the c-book unit appearance (e.g. possible templates or pre-designed themes)
  - interoperability
  - content specifications (e.g. relation between text, graphics and widget instances)
  - multimodality in document design
  - any kind of feedback and scaffolding to the user?
Annex 2: The ‘Horizontal Analysis Table’ summarising the outcomes of the content analysis of D2.5 templates (per identified theme and per partner) on “the Method for Setting up a CoI”

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</table>
|                     | - The size of a sub-CoI depends on:  
|                     |   - The character of the c-book (mono-disciplinary or cross-disciplinary) determines the level of diversity required in a CoI, thus CoI size.  
|                     | Minimum level of diversity: developer(s) – in-service teacher(s)/teacher educator(s) – junior researcher – senior researcher – academic.  
|                     |   - Complexity of design tasks  
|                     |   - Growing acquaintance with the socio-cultural environment: the size of sub-CoI gradually decreases from large configurations to include 5-6 members.  
|                     | - Depends on skills and diversity required for a creative design of digital educational resources.  
|                     | - Set up small groups of designers (3 to 6) with a member familiar with technology  
|                     | - No optimum number of members related to the quality of the c-books.  
|                     | - Reducing the number to 3-4 people when it comes to actually specifics of the book and maybe even 2 when editing the book leads to more streamlined production.  
|                     | - The optimum size is conditional on the context: the topic of the c-book, the availability of teachers, whether teachers see working on a c-book as part of their job, whether there is a reward or not, etc.  
|                     | - Several people involved in early conception stages of the c-book but only a few with direct involvement, monitoring and responsibility in a drafting phase before sharing with the rest of the COI members.  
|                     | - Depending on the c-book unit planned, between 4-7 people (apart from possible reviewers). 4-5 members, (including technicians/widget designers) when the aim of the c-book unit is straightforward (e.g., a topic in the official curriculum). A higher number of participants (6-7) required when dealing with a concrete real situation. In general, SC analysis revealed no more than 6 active contributors.  
|                     | - Number of moderators: Depending on the c-book unit planned, between 1-2 moderators (one main moderator). |

The envisaged features of the c-book as a product seem to constitute the core criterion for almost all research teams with regards to decisions that have to be taken in terms of optimum size of a CoI. The topic of the c-book and whether more than one disciplinary perspectives need to be applied so that a more holistic approach is achieved is directly connected with the necessary degree of diversity to be attained in the CoI, and the expected roles foreseen for the participating CoI members. Diversity of disciplinary perspectives and roles in the design of a c-book is also determined by the complexity of the design tasks to be performed. Most of the evaluation partners recognize the need for at least 2 to 6 educational designers with variant disciplinary or professional
background, including at least one developer, and having some kind of direct or indirect relation to the teaching practice and school context. What is also worth noting is that partners agree that the CoI should foresee that at least one post is reserved for a moderator to regulate and facilitate the flow of collaborative design.
| **CoI composition**<br>levels of diversity & complementarity | **Greek CoI**<br>- Invite CoI members **adopting hybrid identities** (participating in more than one CoP simultaneously) or **switching between identities**: flexibility and richness of perspectives.<br>- Ensure **diversity** and vary the level of diversity according to **broadness of design task** (see, **size of CoI**). | **French CoI**<br>- Pay attention to **heterogeneity** of the profiles of the CoI members based on **professional or knowledge** domains<br>- CoI members with **complementary** expertise or skills boost creativity by contributing with ideas from less known domains.<br>- Choose CoI members representing **active CoP** in domains related to the CoI concerns.<br>- Strong **mathematical and didactical/pedagogical** expertise and **technological** skills.<br>- Individuals with **technical skills** may become **technical brokers** helping overcoming technical boundaries.<br>- Arouse a **common interest** for the production of c-book units in order to spark and maintain a | **UK CoI**<br>- People from **diverse and different backgrounds** are brought together to provide diverse but complementary expertise and input.<br>- Pay attention to **heterogeneity** of the profiles of the CoI members based on **professional or knowledge** domains<br>- CoI members with **complementary** expertise or skills boost creativity by contributing with ideas from less known domains.<br>- Choose CoI members representing **active CoP** in domains related to the CoI concerns.<br>- Strong **mathematical and didactical/pedagogical** expertise and **technological** skills.<br>- Individuals with **technical skills** may become **technical brokers** helping overcoming technical boundaries.<br>- Arouse a **common interest** for the production of c-book units in order to spark and maintain a | **Spanish CoI**<br>- The CoI members should:<br>- Form a **heterogeneous group** of people to design interdisciplinary c-book units.<br>- Have **different interests**; it is desirable that there are not only education actors.<br>- Be interested (at least one member) in **implementing** the c-book unit in a real context.<br>- Have abilities and skills on **technical matters** to communicate with the technical team and the technical implementation of ideas.<br>- Have certain **knowledge or background** on the topics selected for the c-book unit<br>- Two levels of CoI membership: "designers" and "collaborators". Designers (among them the moderator): **increased** |
| creative flow all over the design cycles. | and active participation stretching over a long period of time. Collaborators: Being interested/knowledgeable in a particular e-book unit, or interest in implementing it in a real context. **Seed of highly creative ideas**, low but very valuable participation. |

Heterogeneity/diversity in expertise, interests and perspectives is unanimously recognized as a sine qua non of a creatively working CoI. In particular, the degree of diversity is determined by the broadness of the design task (mono- or cross-disciplinary). Also, technical skills are essential for the implementation of ideas and for enabling communication with technical staff. Moreover, the term ‘hybrid’ or ‘complementary expertise’ is coined for CoI members participating simultaneously in diverse CoPs and thus, exhibiting richness of perspectives which boosts creativity. Two levels of CoI membership are identified: ‘designers’ (active and committed participants) and collaborators (highly creative but less active or ‘peripheral’ members).
<table>
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<th>Recruitment criteria</th>
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|                      | - Former **collaborations**  
- **Challenges** posed by coordinating institutions (academic, professional etc.)  
- **Personality traits** and positive mindset: ability to focus on productivity, critical attitude, professional responsibility and sense of identity and role – mission, playful attitude to work, mobility, readiness to accept/acknowledge the existence of other communities and to cross boundaries, creativity (see also, sustainability) | - Being representatives of active **CoPs** constituted around the design of pedagogical resources.  
- Compatibility of the CoP agenda with the CoI agenda.  
- **Institutional acknowledgement** (e.g., in terms of salary or reduced teaching load) is an important factor for the recruitment of CoI members, mostly teachers.  
- Amount of **time** the members can dedicate to the design process. | - Utilize **existing professional networks** and former collaborations to identify potential CoI members. Contact by email, f2f communication, organize f2f meeting for everyone to participate.  
- **Personal judgment** with regards to their personality/characters and potential to input to the CoI.  
- Identify which members could act as ‘**brokers**’  
Due to the challenges that the **UK context** poses on the recruitment of **teachers**, the following measures should be taken:  
- More effort (with respect to time and money dedicated) should be placed on behalf of employers and the government on encouraging **professional development** for their teachers  
- More extensive **technological support** especially for those lacking expertise with digital tools. Potential CoI members are better convinced to take | - A certain level of compromise of **dedicating time and effort** to the design of the c-book unit. |
The recruitment of CoI members relies heavily on the context in which the CoI are formed. It can be based on former collaborations and communities of practice constituted as part of educational innovations related to the design of digital resources. The recruitment of teachers might be challenging, in that case appropriate incentives should be provided: institutional acknowledgement, technological support, usability of the resources. Moreover, time is recognized by most of the partners as an essential resource for the design of c-book units.

|  |  | active role in the CoI if they know that there is technical support available. This needs time and money. |
|  |  | - Provide a more extensive ‘authoring course’ or open textbook like the massive online open textbook (moot). |
|  |  | - The c-book, as boundary object, needs to be rooted in what the teacher needs: something they can use almost immediately in their daily classroom practice. [Actually the aforementioned are not recruitment criteria, but measures taken to enable the recruitment of teachers.] |

The recruitment of CoI members relies heavily on the context in which the CoI are formed. It can be based on former collaborations and communities of practice constituted as part of educational innovations related to the design of digital resources. The recruitment of teachers might be challenging, in that case appropriate incentives should be provided: institutional acknowledgement, technological support, usability of the resources. Moreover, time is recognized by most of the partners as an essential resource for the design of c-book units.
<table>
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<tr>
<th>Orchestration of interaction</th>
<th>Greek CoI</th>
<th>French CoI</th>
<th>UK CoI</th>
<th>Spanish CoI</th>
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</table>
| - Organize f2f meetings     | - Three f2f CoI meetings per cycle necessary: 1) At the **beginning**: sub-groups are constituted, roles are assigned, the design agenda is planned, the topics of the c-book units are chosen; 2) In the **middle**: sub-groups present their design project and receive **feedback**; 3) At the **end**: CoI activity is **assessed, outcomes** are presented. Between f2f meetings sub-groups work autonomously alternating **various modalities** (f2f meetings and online meetings via skype for brainstorming and discussing ideas, or asynchronous work to implement / reify ideas). - A CoI needs a “**pilot**”, e.g., a steering committee. - Foster **trust** and **confidence** in synchronous meetings - **Distribute** and orchestrate the tasks at hand: - Assign specific **roles** (moderator, reviewer, developer), make their function explicit | - Online: email and skype interactions - **f2f meetings** by a ‘broker’ and, especially, teachers for brainstorming ideas - Larger CoI meetings, once every 6 months - Attempt to boost the use of CoICode (see part 2) - Agreed upon standard procedure of interacting around a c-book *The use of CoICode remained a challenge, especially for teachers. Those with more ‘trust’, interest and experience with digital tools, were happy to contribute on CoiCODE. Confidence of opinion also played a role. Every feature of CoICODE had to be presented to the CoI members, explained and justified for its potential value for recording conversations.* | - Direct communication (f2f, online meeting) turned out to be more effective - Organize a first **f2f or online meeting** with the whole CoI to present and confront initial ideas and decide a general **structure** of the c-book unit (initial synchronous communication fosters asynchronous communication). Also state **CMT assumptions**. - CMT potential evaluation of the c-book unit should be done by members of the CoI that have not participated in the process of design of the c-book unit evaluated, but have designed different c-book units. | - Direct communication (f2f, online meeting) turned out to be more effective
- Organize a first **f2f or online meeting** with the whole CoI to present and confront initial ideas and decide a general **structure** of the c-book unit (initial synchronous communication fosters asynchronous communication). Also state **CMT assumptions**. - CMT potential evaluation of the c-book unit should be done by members of the CoI that have not participated in the process of design of the c-book unit evaluated, but have designed different c-book units. |
- Collaboratively set up the design **agenda** (tasks and deadlines)

- Organize regular **reviews** of the c-book unit during the design process, including CMT affordances evaluation, done by CoI members not directly involved in the design process

- Small group of **CMT evaluators** (2 or 3 people) who didn’t participate to the design process for bringing new insights. One evaluation may be done during the design process, to enhance the CMT affordances of the unit.

- **Synchronous** interaction (face-to-face or remote) is the most **efficient** (collective **brainstorming**, immediate **feedback**, elaboration of expressed ideas, **convergent** thinking, **oral** negotiations, **direct** and **collective** decisions). It represents a commitment to work on the c-book unit design during the meeting.

- **Asynchronous** work concerns the **implementation, reification** of ideas discussed and validated collectively during synchronous
interaction. **CoICode** acts as a *logbook* and a *to-do-list*. Entails more *discipline* to contribute regularly.

All CoI point out the need for organizing a mix of interactions: face-to-face, online, synchronous and asynchronous. In general, it is suggested that a face-to-face meeting takes place at the beginning of the design process where CoI members get acquainted with each other, roles and tasks are assigned and the brainstorming of ideas takes place. As a matter of fact, initial synchronous communication fosters subsequent asynchronous communication in CoICode. Actually, in some cases synchronous interactions are considered more effective than asynchronous and constitute the main communication channel between CoI members. This is also the case with CoI members who are reluctant in using the CoICode, therefore specific measures should be taken to boost its use. Some structure in interaction is recommended provided by following a standard procedure for designing a c-book unit.
Greek CoI | French CoI | UK CoI | Spanish CoI
--- | --- | --- | ---
**Initial CMT representations**
- The explication of individual members’ CMT representations would serve as a knowledge base for capitalizing the diversity of perspectives brought by each individual member*.
- Ask CoI-members to bring along the description (and evidence, if applicable) of a selected activity carried out with their students, which they thought as facilitating CMT. Dedicate time in f2f meetings for focus-group discussions and interviews with CoI members.

*This was a working hypothesis of the research team from the beginning, but was later verified by experience with members’ asynchronous discussions, indicating a stiffness and inflexibility in explicitly negotiating CMT, at least at a theoretical level.

- It is important for the CoI members to know what CMT is to be able to think of the resource affordances for stimulating CMT.
- Eliciting the initial CMT representations of the CoI members allows building a common understanding on these representations that progressively evolves.

During the first meeting the moderator presents and discusses the CMT grid with the CoI members. CoI members are prompted to share their assumptions about CMT and to consider how CMT is applied in the design.

Evaluation partners stress the significance of the explication and negotiation of designers’ CMT representations for designing resources that foster CMT; it helps building common ground for collaborative design. The first CoI meeting can serve as the triggering event for exchanging views about CMT based on creative activities suggested by CoI members or even the CMT grid.
<table>
<thead>
<tr>
<th>Role of ‘brokers’</th>
<th>Greek CoI</th>
<th>French CoI</th>
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<th>Spanish CoI</th>
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</table>
|                  | Assuming – at times – a moderating role, in particular by performing monitoring activities. | - Knowledge brokering plays a **critical role** in the design process.  
- The role of a broker cannot be assigned in advance.  
- CoI members with technical skills often play a brokering role of operating at boundaries between the CoI and the DME technology and widgets developers. | - Boundary crossers  
- A multi-skilled ‘broker’ who ensures that the voices of the different CoPs are heard.  
- ‘Translates’ and communicates (creative) ideas between different CoPs.  
- Safeguards the representation of the different CoPs and intervenes when appropriate to ensure a fruitful outcome of the CoI members’ interactions.  
- Mediating function of ‘brokerage’ between CoI members and the MC-squared platform is the most prevalent.  
- Desired skills: technological affinity, design experience and the capacity to translate concrete ideas into challenging materials | The **moderator** becomes a boundary broker when organizing discussions in the workspace for confronting ideas of different CoI members. |


The limited availability of teachers (e.g. teachers being busy, teachers not seeing a direct application of a c-book to the curriculum, etc.) in combination with a quite steep learning curve of becoming a good designer and acquiring the skills to design c-books led to the necessity of employing the aforementioned ‘brokers’.

Boundary brokers play a major role in the design of c-book units since they communicate creative ideas between diverse CoPs. The range of their tasks and responsibilities varies depending on the CoI setup: at times they assist the moderator in monitoring the design process or they are even charged with the technical implementation of ideas. Thus, a multiplicity of skills (in other words a hybrid identity) is essential for fulfilling a brokering role. The moderator also assumes the role of a broker when organizing discussions on confronting views in the workspace.
<table>
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<tr>
<th>Greek CoI</th>
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<th>Spanish CoI</th>
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<tbody>
<tr>
<td><strong>Moderating strategy/ activities</strong></td>
<td>- Three types of activities: contextualizing activities (design and organization), monitoring activities (facilitating discourse), meta activities (management of process and content)</td>
<td>- No specific moderation strategy.</td>
<td>- Organizing discussions and directing communication among all CoI members, or between CoI’s by means of the workspace.</td>
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<td>- Document the flow of ideas on a regular basis.</td>
<td>- The moderator’s qualities:</td>
<td>- Suggesting a first proposal after the first ideas emerge in the initial meeting.</td>
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<td></td>
<td>- Prioritize contextualizing activities at the initial phase of design work.</td>
<td>- <strong>organizational and managerial skills</strong>, able to organize design tasks and communicate with people from various professional domains</td>
<td>- Confronting different opinions (in the role of a boundary broker).</td>
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<td>- Perform monitoring activities from the beginning and on a periodic basis. Let the members gradually adopt some of them.</td>
<td>- a good knowledge of the topic of the c-book unit</td>
<td>- Explaining the grid for CMT affordance to the designers and reviewers, in a f2f or online meeting.</td>
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<td></td>
<td>- Expect and acknowledge contributions from “knowledge brokers”.</td>
<td>- acknowledge and respect all contributors</td>
<td>- Proposing and controlling the agenda agreed with the other members.</td>
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<td></td>
<td>- Perform meta-activities in a timely manner.</td>
<td>- engagement and a sense of responsibility</td>
<td>- Effective designer of the c-book unit: designing in the MC2 platform a first version of each phase of the unit (2 moderators in the case of longer units), working/communicating with the technical team.</td>
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<td>- Maintain consistency and a similar communication style with all members.</td>
<td>- The moderator:</td>
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<td>- Stir up enthusiasm.</td>
<td>- <strong>Coordinates</strong> the tasks at hand, updates the agenda, observes deadlines, follows the design process.</td>
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<td>- Build personal relationships.</td>
<td>- <strong>Supervises</strong> the design process, is responsible for delivering the product in due time.</td>
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<td></td>
<td>- Provide emotional support.</td>
<td>- Helps building a common language.</td>
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<td>- Helps during negotiation</td>
<td>- Fosters exchanges within the sub-groups and within the CoI.</td>
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<tr>
<td></td>
<td>- Helps during negotiation</td>
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<tr>
<td>The Greek CoI adopted a synthetic moderation strategy based on existing moderation models (ref?) and literature on s-c (ref?).</td>
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<tr>
<td>- Rekindles the design process when it is slowing down.</td>
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<td>- Invites CoI members to vote.</td>
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<td>- Organizes CMT evaluation.</td>
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<td>- This process continues until the CoI, or at least the broker, is satisfied with a first release version of the c-book, a book that can be seen as an improbable boundary object.</td>
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No specific moderator assigned probably due to the form and nature of CoI interactions. The role of moderator is played by the broker. Certain measures should be taken to foster participation of more CoI members, especially teachers, so that the types and nature of interactions change.

- Introducing the socio-technical environment to new members |
- Stimulating exchange of ideas, motivating members to keep the workspace alive |
- Presenting and discussing the CMT evaluation grid with the CoI. Stating also a context to define and analyze CMT and apply it to the design.

The prominence of the role of the moderator in enhancing social creativity is unanimously acknowledged. She/he is in charge of coordinating tasks, keeping the agenda, fostering exchanges, meeting deadlines, maintaining a continuous flow of work, motivating and supporting CoI members, putting forth and denoting members’ suggestions or even designing the c-book unit. In general, she/he is to perform three types of activities: contextualizing, monitoring and meta activities. The role of moderator is usually assigned to one person, though two moderators might be needed in large CoI (still one of them is the main moderator). In some cases, depending on the CoI setup, the broker assumes moderating activities as an extension of her/his role.
<table>
<thead>
<tr>
<th>Degree of structuring</th>
<th>Greek CoI</th>
<th>French CoI</th>
<th>UK CoI</th>
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<td></td>
<td>Semi-structured approach: 1) use of creativity sparkers, i.e. triggering themes to boost the sub-CoI’s creativity with respect to design thinking, e.g. ‘climate change’, ‘curves in space’, ‘amusement park’, 2) minimum of technical specifications: 10p., max. 2 widgets from different widget factories.</td>
<td>- Design work <strong>not structured</strong> in advance. Design choices collectively discussed within the designers’ sub-groups. - Constraints on the number of different DME widgets to be embedded in each c-book unit. - Pre-structuring a c-book unit or even the workspace was found as a factor likely to <strong>impede</strong> creativity of the designers.</td>
<td>- Prescriptions for the design work should be ‘mean and lean’. For example, a general course of actions to be taken by the CoI members could be given. - More structure would actually backfire and impede one of the pillars of the project: creativity.</td>
<td>- Structure according to the decisions of the CoI. Final re-structure for the sake of functionability of the c-book unit (not many widgets in the same page, divide the c-unit in different phases, not many pages in each phase).</td>
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The design process should not be tightly structured to foster creativity. Some -more or less- general instructions might be given regarding the course of actions, the theme of the c-book unit, or its technical specifications.
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<tr>
<th>Sustainability</th>
<th>Greek CoI</th>
<th>French CoI</th>
<th>UK CoI</th>
<th>Spanish CoI</th>
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<tr>
<td>- Ensure professional sustainability by keeping balance between estimated <strong>workload</strong>, inherent <strong>interests</strong>, intrinsic and extrinsic <strong>motivation</strong> and rewards, appropriate <strong>incentives</strong> etc.</td>
<td>Critical aspects for ensuring sustainability and maintain motivation:</td>
<td>In order to promote engagement and enthusiasm:</td>
<td>The process of designing a c-book unit is highly alive and creative when there was the interest of the CoI of implementing the c-book unit in the real classroom context.</td>
<td></td>
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<tr>
<td>Prospective CoI members should:</td>
<td>- Finding balance between <strong>heterogeneity</strong> and <strong>convergent</strong> interests.</td>
<td>- Provide <strong>rewards</strong>: money for buying mathematical resources for their schools, confirmations of participation, access to the created resources and the DME tool.</td>
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<tr>
<td>a) wish to be part of cutting-edge developments in the uses of digital technologies in education</td>
<td>- Producing resources <strong>usable</strong> in classrooms (related usage constraints).</td>
<td>- Offering <strong>technical</strong> and/or <strong>practical support</strong>.</td>
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<td>b) perceive of joint productions as bringing something <strong>useful and new</strong> to their own teaching / teacher training / research practice</td>
<td>- Providing <strong>benefits</strong> related to professional development, access to new teaching material, institutional acknowledgement.</td>
<td>- Resolve technical issues (e.g., stability of software)</td>
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<tr>
<td>c) perceive of the potential for <strong>publication</strong> availability of the new constructs to the wider community</td>
<td>- Verify the <strong>availability</strong> of CoI members</td>
<td>- Design an end-product that can be directly <strong>used</strong> in the classroom</td>
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<tr>
<td>d) recognize an <strong>academic challenge</strong> either in CMT or SC or online learning, or alternative perceptions of the use and learning of mathematics</td>
<td></td>
<td>- Occasional <strong>face-to-face meetings</strong> and spend time with the people from individual existing networks</td>
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<tr>
<td>e) be interested in taking the challenge of integrating <strong>educational paradigms</strong> and epistemologies.</td>
<td></td>
<td>- Encourage <strong>involvement of brokers</strong> when noticing low interactions and productivity within the CoI.</td>
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<tr>
<td>- During design work the moderators should build and preserve a more <strong>personal</strong></td>
<td></td>
<td>- Send gentle <strong>reminders</strong> and <strong>requests</strong> for work.</td>
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</tbody>
</table>
relationship with each member, which is not restricted to online asynchronous interaction. A culture of joint responsibility should be cultivated through moderating activities and specific personal and professional qualities of individual members so that all members are equally engaged in activities.

Sustainability of the CoI can be ensured on the one hand through recruiting CoI members with the appropriate skills, professional and personal qualities and, on the other hand, by providing appropriate rewards and incentives (among them the perceived usability of the c-book unit in the classroom). Also, technical and emotional support should be provided while designing a c-book unit. The role of the moderator is here crucial, so that a culture of joint responsibility is cultivated in which all members are equally engaged in design activities. Keeping a high level of motivation is challenging and depends on the interaction of various factors, such as estimated workload, interests, benefits, diversity and complementarity within the CoI.
### Cross-CoI collaboration

<table>
<thead>
<tr>
<th>Recommendation-1</th>
<th>Greek CoI</th>
<th>French CoI</th>
<th>UK CoI</th>
<th>Spanish CoI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convene an initial meeting to organize redesign</td>
<td><strong>Necessary</strong>&lt;br&gt;- Two different design contexts with their own contextual characteristics.&lt;br&gt;- Resolve the problem of assigning different meaning to the same terms and practices&lt;br&gt;- A shared meaning ensures coherence in the outcomes of the collaborative work</td>
<td>f2f or online&lt;br&gt;Discuss the direction for the redesign chosen, identify boundaries, organize the workspace&lt;br&gt;(They see this as the starting point for the next recommendation)</td>
<td>f2f or online&lt;br&gt;The secondary designers present the first version of the redesigned c-book unit to the primary designers</td>
<td></td>
</tr>
</tbody>
</table>

### Recommendation-2

**Use a common language in the inter-CoI communication**

- Related more to methodology and tools: should agree on the way in which the CMT should be assessed (with a common grid or other means), on the choice of the people from the two CoI who will evaluate the alien c-book unit, the redesigned alien c-book unit, and if the evaluation will be done collectively or individually.

### Recommendation-3

**Use two separate workspaces for each of the two stages of the cross-CoI collaboration**

- Necessary to have access to the process that takes place (i) initially within the CoI<br>- Necessary Workspace-1 (by the redesigners’ CoI) to enhance the CMT affordances of

### Reservation

- They prefer only one workspace (as something

### Necessary

Moderator is responsible for stating a common language, especially when there is a new member in the CoI, as well as in the case of cross CoI collaboration,
CoI collaboration

(\text{stage-1, intra-CoI}), and (ii) between the two CoI (\text{stage-2, inter-CoI}).

- \text{Workspace-1} ensures access to the local factors, the influence the redesign
- \text{Workspace-2} ensures access to the boundary-crossing process that helps local factors to cross boundaries and catch the attention of the partners

the alien c-book

Workspace-2 (with the two CoI involved) to organize better and easily the posts

that is better managed

---

**Recommendation-4**

Use common tools (for example a template) to organize and present the collected data

<table>
<thead>
<tr>
<th>Necessary</th>
<th>They do not feel this is necessary</th>
<th>No need for more tools.</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Ensures that data are readable and sense-making for the reader</td>
<td>- Obtain uniformity that facilitates comparison between the CoI that leads to a deeper understanding of the other team’s context.</td>
<td>- For comparability reasons it is important to use a common method</td>
</tr>
</tbody>
</table>

**Recommendation-5**

Establish a common methodological tool to facilitate comparison of the work done between different pairs of partners

This stems from the previously mentioned need for uniformity.

A process of five steps:
- Evaluate CMT affordances of the alien c-book unit by secondary

They agree it makes sense to develop comparable methods.

- For comparability reasons it is important to use a common method

The methodology followed in WP7-cycle 2 turned out to be the most effective one: adoption of the alien c-book unit, first CMT potential evaluation to define lines of action, construct a first redesign, present it to the corresponding CoI pair, construct the final redesign version and make
designers

- According to the evaluation results go back and redesign it
- Start a discussion in the workspace-2 to present the redesigned version to your partners and ask for suggestions and comments
- Incorporate those of the suggestions you think are interesting and fitting to your own pedagogical perspectives, and
- Send the final (redesigned) version to the other CoI and ask them to evaluate its CMT- affordances.

| Recommendation-6 | N/A | Actually they suggest two meetings. A preliminary (online or f2f) to discuss the agenda for the main phases of the redesign as well as the evaluation methodology. Then a second meeting for discussing the direction for the chosen redesign and the organization of the workspaces. | - 1-2 hour initial skype meeting (or f2f) to organize things
- Redesign and communication phase (probably in CoICode)
- 2 weeks later another final skype or f2f meeting. | - The methodology followed in WP7-cycle 2 turned out to be the most effective one: adoption of the alien c-book unit, first CMT potential evaluation to define lines of action, construct a first redesign, present it to the corresponding CoI pair, construct the final redesign version and make the CMT potential evaluation.
- Moreover, the reviewers should not participate in the redesign of the unit, for the sake of impartiality. |
Annex 3: The ‘Horizontal Analysis Table’ summarising the outcomes of the content analysis of D2.5 templates (per identified theme and per partner) on “the C-Book Technology Use”

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<thead>
<tr>
<th>Use of CoICode: enabling/enhancing its use</th>
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<th>French CoI</th>
<th>UK CoI</th>
<th>Spanish CoI</th>
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<tbody>
<tr>
<td>Provide <strong>support material</strong> explaining the basic functionalities of the CoICode (for example, small video tutorials accompanied by a short guide)</td>
<td>Provide support material explaining the basic functionalities of the CoICode (for example, small video tutorials accompanied by a short guide)</td>
<td>During face to face meetings, organize demos and workshops aiming at providing <strong>hands-on experience</strong> with the use of CoICode. The use of any tool implies <strong>instrumental genesis in the users that takes some time</strong></td>
<td>- More support for using CoICode, for example through tutorial materials, as to build confidence and support. - Ensure CoICode works swiftly and stable. - Show more clearly how the creative design process <strong>benefits</strong> from its use. - Promote better collaboration through CoICode by considering improving its features related to recording of communication (e.g., semantics influenced the recording of ideas, speed and general Java challenges). <strong>UK sees CoiCODE as a tool that might not be used continuously but in ‘bursts’ of communication around a particular draft design</strong>. <strong>Around these ‘bursts’ registration by designers should be done, but probably on a more limited scale.</strong></td>
<td>- A <strong>common language</strong> related to CoICode use is developed facilitating communication and design. The moderator has the responsibility to introduce new members to it. - Add tools (chat/videoconference) for <strong>synchronous communication</strong>. - Receiving warning <strong>emails</strong> is considered as a factor that enhances communication and SC. - Provide <strong>daily report</strong> of the contributions in the workspace.</td>
</tr>
</tbody>
</table>

It is recognized that support material is needed to assist and motivate CoI members in using the CoICode for communicating and designing a c-book unit from a distance. This assistance might come in the form of workshops, tutorials or of the guidance provided by the moderator. The benefits of using CoICode should be also stressed. Moreover, adding a chat tool is recommended since synchronous communication triggers asynchronous one.
<table>
<thead>
<tr>
<th>Use of CoICode: managing the workspace</th>
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<th>French CoI</th>
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<th>Spanish CoI</th>
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<tbody>
<tr>
<td>- An ongoing “maintenance” of the workspace is needed. The moderator should thus:</td>
<td>Setting up a maximum number of posts is likely to impede fluency and thus creativity.</td>
<td>- Use of multiple trees: although from a management point of view separate trees or separate workspaces, might be efficient, the coherence between the different phases and sections might be more difficult to deduce.</td>
<td>- There is should be no limitations of space and of the number of comments allowed in the workspace.</td>
<td>- There is should be no limitations of space and of the number of comments allowed in the workspace.</td>
</tr>
<tr>
<td>- Keep the number of posts per workspace up to 80-100 posts.</td>
<td></td>
<td>- Denote multiple ideas that merge into a new version of a c-book by adding a node.</td>
<td>- Adding an option of closing the workspace on a specific date. This helps respecting the agenda and controlling the number of comments.</td>
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<td>- In case of large CoI create a sequel workspace without interrupting ongoing discussions.</td>
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<tr>
<td>- Rearrange posts in the threaded forum discussion view.</td>
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</table>

*In case the same rules are consistently followed by all CoI members and across CoI, the context of various workspaces would be universally comparable and CoICode data analysis would become more comprehensive and consistent across CoI. Again, the role of the moderator in safeguarding the rules is indispensable.*

The issue of organizing the workspace in a manner that is easy for CoI members to follow discussions, but also reflects the complexity of the design process concern all CoI. For this reason, it is recommended that posts are rearranged from time to time and the system provides more space for adding nodes without looking cramped. In case this is not possible, the moderator should create a sequel workspace. In general, fluency should not be inhibited by setting a limit to the number of nodes in a workspace.
<table>
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<th>Spanish CoI</th>
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</table>
| Use of CoICode: posting contributions | Specific rules for posting contributions are needed:  
- Use the CoICode semantics in the prescribed manner.  
- Articulate one idea per post.  
- Contribute to an idea by replying directly to the post containing it.  
- Introduce a new tree with an idea which cannot be related to a previous one. | - Express only one idea per post  
- Start a new tree when contributing an idea that is not related to any of the expressed ideas.  
- CoICode user guide elaborated by the French research team | Granularity of the node: Inserting separate ideas in single nodes might be counter-productive to the creative process. Then the problem with automatic analyses could only be solved if a multi-idea node would be deconstructed into separate ideas. |
|  |  |  | - There should be a possibility to directly embed pictures and videos in the comments so that the user can easily refer to them  
- Use the semantics and define relations between comments to clarify asynchronous communication. |

CoI suggest the formulation of clear rules for posting contributions such as following the semantics, articulating one idea per post, elaborating a distinct idea in a single tree. In case the same rules are consistently followed by all CoI-members and across CoI, the context of various workspaces would be universally comparable and CoICode data analysis would become more comprehensive and consistent across CoI. However, in practice, prescribing the granularity of a node is a challenging issue; posts often contain more than one idea as in face to face discussions participants usually express several ideas in their responses. This might be solved by deconstructing a multi-idea node into separate ideas (which can be done by the moderator or another person who follows the discussion).
Use of CoICode: voting contributions

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</table>
| - Voting **rules** should be established, discussed and explained before the beginning of the design process.  
- Each CoI member should vote for every post (except off topic – social).  
- The operationalization of the three **criteria** should be fully understood and shared between CoI members.  
- CoI members should agree on a certain **timeframe for voting** to be held (as soon as or soon after the post appears in the workspace).  
- It could be also possible to have **external evaluators** participate in the voting procedure.  

*In this way the rating procedure becomes an indispensable part of the design process allowing a formative evaluation procedure to take place, which gives a relatively direct feedback to the CoI members on the creativity of their ideas and boost their creative design work. It could be also possible to have external evaluators participate in the voting procedure.* | - The moderator **recalls** the other designers to vote.  
- No specific voting rules.  
- Present the **importance** of voting for creative ideas and explain the voting principle.  
- It is easier to vote when one **follows** regularly the evolution of the posts in the workspace.  
- Explain the meaning of the **attributes** of a creative idea  

A detailed **reminder** system for voting through email cues might be beneficial. Also **personal** reminders via other means of communication, such as emails or a face-to-face chat. | - Apart from voting **adding comments** with (positive) opinions is motivating for the author and the other members of the CoI (positive feedback, if this is the case). |

Voting contributions is another essential feature of CoICode. It is an indispensable part of the design process allowing a formative evaluation procedure to take place, which gives a relatively direct feedback to the CoI members on the creativity of their ideas and boost their creative design work. Certain rules should universally apply: Each CoI member should vote for every post, the three criteria should be fully understood and shared between CoI members and
voting should be held in a specific timeframe preferable close to the upload of the post. A reminder system would be also beneficial, as well as adding the option of providing positive feedback.
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<tr>
<th>Greek CoI</th>
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<th>UK CoI</th>
<th>Spanish CoI</th>
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<tbody>
<tr>
<td><strong>c-book unit technical specifications/use of authoring tool</strong></td>
<td><strong>- Small video tutorials</strong> accompanied by a user manual should be available for designers/ authors to familiarize themselves with the basic functionalities of the C-book authoring environment.**</td>
<td><strong>- Technological support is recommended on the level of DME and widget factories via a series of tutorial videos and user manuals.</strong></td>
<td><strong>- The technology added value</strong> (e.g., modelling features and dynamic simulations) should be taken into account when designing c-book units. In this sense, the role of the <strong>widgets</strong> must be essential, in the design process as well as in their implementation with students.**</td>
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<td></td>
<td><strong>- Include more than one widget instance from different widget factories in a page so that users have the opportunity to establish connections between different representations.</strong></td>
<td><strong>- No particular recommendations about size. Some widgets can be heavy; therefore, pay attention to the loading time when using several widgets in the same page or activity.</strong></td>
<td><strong>- Control the total <strong>size</strong> of a c-book unit, as well as each page of it, to avoid low <strong>speed</strong> problems and loosing students’ attention.</strong></td>
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<td></td>
<td><strong>- Because of current technical impediments related to the size of a c-book unit:</strong> 8-10 pages per c-book unit would suffice.</td>
<td><strong>- Try avoiding huge pages requiring scrolling up and down the screen</strong></td>
<td><strong>- A short number of pages works better for students.</strong></td>
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<td></td>
<td><strong>Multimedia content (images, videos etc.) should be uploaded with Media Manager.</strong></td>
<td><strong>- Aesthetic aspects should be attractive for the users, playing a role in their motivation and engagement.</strong></td>
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</tr>
<tr>
<td></td>
<td><strong>Images (preferable formats: PNG or JPEG) and videos should be converted in the smallest possible resolution (pixels) that matches the c-book resolution.</strong></td>
<td><strong>- It is important to mesh text with widgets and other media, to enable users to manipulate and build their own knowledge by using the widgets. The narrative may be used as a guideline for the c-book unit and for fostering the affective aspects.</strong></td>
<td><strong>-</strong></td>
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<td></td>
<td><strong>- The resolution depends on the devices used by the end-users. If tablets are used, resolution should be kept under the estimated tablet resolution to have most page parts visible without continual</strong></td>
<td><strong>- The forum widget, which draws on the socio-constructivist background of the French CoI, enables collaboration among</strong></td>
<td><strong>-</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Technological support</strong></td>
<td><strong>UK CoI</strong></td>
<td><strong>Spanish CoI</strong></td>
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<td><strong>French CoI</strong></td>
<td><strong>UK CoI</strong></td>
<td><strong>Spanish CoI</strong></td>
</tr>
<tr>
<td></td>
<td><strong>- The size of the c-book cannot be prescribed</strong></td>
<td><strong>- C-books should be designed with tablets in mind (HTML5): not too many large widgets on a page as resolution might be an issue. In addition:</strong></td>
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<tr>
<td></td>
<td><strong>- Interaction is performed with finger instead of mouse, this has an influence on several design choices (e.g. interaction areas should be more distinct, drag &amp; drop is not the most suggested means of interaction, icons and buttons should be large enough to avoid double tapping)</strong></td>
<td><strong>Screen size</strong> is smaller than on monitors. The design of the widget should consider putting less items on screen, with more space between the interactive ones. As a consequence, a different <strong>structure</strong> of the widget should be taken into consideration (with sub-menus grouped by functionalities).**</td>
<td><strong>-</strong></td>
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<tr>
<td></td>
<td><strong>Widget should present the</strong></td>
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<tr>
<td></td>
<td><strong>- Control the total <strong>size</strong> of a c-book unit, as well as each page of it, to avoid low <strong>speed</strong> problems and loosing students’ attention.</strong></td>
<td><strong>- A short number of pages works better for students.</strong></td>
<td><strong>-</strong></td>
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</table>
scrolling. If end-users have high definition monitors, then the page dimensions could be enlarged.

- A **widget’s size** should conform to the e-book unit page size; widgets should not have larger width or height than a page, but should leave enough room for text and additional widgets.

- A page of a e-book unit should not look like a traditional textbook exercise or a micro-experiment. Widget instances and the accompanying narrative should function in unison with each other. This sense should be clearly communicated by the appearance of the widget instance within the page.

- Agree on a format, a generic design of the e-book unit, as a **template** to be used by all CoI members (certain fonts, colours, size of textboxes etc.) throughout the whole e-book unit. A consistent layout would provide uniformity in appearance along the pages.

- Authors should be informed and become familiar to the **functionalties and the information shared between different widgets** in order to grasp the opportunity to use them in the same page in the most learners.

- **Videos** are educational resources and sources of information for further work. Thus, when a video is embedded in a e-book unit, it is necessary to ask questions about it.

- Have in mind factors that are likely to foster **CMT**, such as the connection of different knowledge domains, asking for as many answers as possible to a given question or problem in a limited time, including **social and aesthetic aspects**, and draw on them in the design.

- A special focus should be placed on deciding which data should be specifically captured, in order to **assess some CMT** components on the user’s side and to design adapted **feedback**.

- Organize **regular review** of the e-book unit by members who have not participated to the design of the unit to bring to the fore new ideas.

- Have in mind C-book technology **affordances** (x-widget communication, feedback, LA…) and try to make the most of them.

- minimum amount of **text** content as possible. This is to conform to the modern design of apps for smartphones and tablets, where most of the information are either self-explaining or represented with **images and icons**.

Zoom in/out (where present) should be performed with **pinch** action. Pan should also be performed by dragging the screen with fingers (i.e. no zooming buttons or navigation arrows).

Pre-defined **templates** would be interesting, especially with regard to different Operating Systems.

- **Content** should be left to the authors/designers.
creative way.
- More than one widget factories could be used, preferably related to each other, through the narrative, or through widget communication, small videos, URLs and images.

- The technology enables to embed videos, widgets, external and internal URL links to enrich the c-book unit for providing a diversity of media to the learners and for giving a rhythm to the work which allows the c-book unit to be interesting and engaging. The interplay of all these elements intervenes as a motivational factor.

The need for some form of instructions regarding the authoring environment is highlighted by research partners. In addition, it is recognized that the C-book technology is a special type of technology designers should get acquainted with to exploit its affordances. For example, interoperability and multimodality are two features designers should employ in order to produce creative resources aimed at fostering and assessing CMT. As a matter of fact, the added value of technology distinguishes a c-book from an ordinary textbook or an e-book. Regarding the specifications of the c-book unit, partners suggest restricting its size according to what its allowed by the current technology and what suits best their end-users. Aesthetic aspects are also important and the use of a consistent layout throughout pages is recommended. The role of the narrative regarding its interweavement with the widgets and its relation to affective aspects is also underlined.
Given our specific interests in feedback and Learning Analytics, we think it would be good that every c-book has at least some feedback configured. To achieve its full capabilities feedback authoring may require some level of cooperation between designers, domain experts and developers depending on the functionality. The following issues are important to observe:

- Designers may want to consider dependencies between pages and widgets and define those in terms of rules to provide recommendation e.g. in case a student is trying to achieve something in a widget but may benefit from first undertaking a task in a prerequisite widget
- Although time may be hard to estimate, an initial small pilot may provide enough indication for setting minimum and maximum thresholds and allow feedback to be adaptive based on those
- Depending on the level of specificity required feedback may be configured to cover landmarks or more fine grained user states. This decision may affect the complexity of the configuration and will require some interaction with either the widget developer to provide a widget-specific analysis or even with a developer to address the feedback requirements within AuthELO

Our suggested process for authoring feedback is to follow a ‘layered’, incremental approach that requires interdisciplinary involvement as follows:

<table>
<thead>
<tr>
<th>UK CoI</th>
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<tbody>
<tr>
<td><strong>c-book unit technical specifications/use of authoring tool: LA</strong></td>
<td>Learning analytic support is needed at three levels:</td>
</tr>
<tr>
<td>- Designers may want to consider dependencies between pages and widgets and define those in terms of rules to provide recommendation e.g. in case a student is trying to achieve something in a widget but may benefit from first undertaking a task in a prerequisite widget</td>
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<td>- Although time may be hard to estimate, an initial small pilot may provide enough indication for setting minimum and maximum thresholds and allow feedback to be adaptive based on those</td>
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<tr>
<td>- Depending on the level of specificity required feedback may be configured to cover landmarks or more fine grained user states. This decision may affect the complexity of the configuration and will require some interaction with either the widget developer to provide a widget-specific analysis or even with a developer to address the feedback requirements within AuthELO</td>
<td>- General learning analytic logs.</td>
</tr>
<tr>
<td>- Developers (as in programmers or trained learning technologies) can then code the analysis of the data that provide the ‘evidence’ for the feedback provision</td>
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</tr>
<tr>
<td>- In their own turn and from this point on, teachers can just configure the feedback messages (and even open up the code and modify parts of it)</td>
<td>- DME learning analytic logs.</td>
</tr>
<tr>
<td>- In their own turn and from this point on, teachers can just configure the feedback messages (and even open up the code and modify parts of it)</td>
<td>- Widget factory learning analytic logs.</td>
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Automatic feedback should be taken into considerations. Two main types of feedback can be considered: technical and educational. The first allows students to move smoothly through the c-book unit content and to interact with the various widgets and media embedded, and the latter lets them reflect on their achievement and provide guidance in case of mind-fixation.
At a technical level each widget instance and its respective task(s) must be represented by an object that encapsulates the particularities of the activity and can offer information regarding the state or what has been achieved etc. This organisation is required so that the configuration remains at a reasonable level of complexity and is manageable.

In relation to the feedback messages and their purpose in particular our recommendations are as follows:

- Feedback messages must be relevant to the area of the c-book that user activity was detected (coding constructs that allow this to be defined)
- We believe it is better for feedback to be relevant to what the student seems to be trying to accomplish and just enough so that the student can overcome their inability to deal with or understand something. In other words, it must be given in small increments and not provide whole solutions.

In general, it is good to provide different levels of feedback but this must be done with caution because it gives opportunities to students to game the system and obtain answers without effort.

Lastly, in relation to the analytics dashboard it is worth keeping in mind that the analytics dashboard is designed for reflective learning designers. It can be used for exploratory data analysis but it becomes much more effective if there is an initial (learning) activity plan to compare the output against. Therefore, it is suggested that designers do the analysis based on work that has been done in advance. Our recommendation is that designers, developers, authors and teachers work in tandem to properly configure the c-book and take care of the following:

- Units and widgets must be given unique and descriptive identifier names.
- The units must be configured so that logging is enabled for all the widgets that one may expect that the availability of data will help reflecting on the unit’s usage (note the option of automatically recording all data from all widgets is available for convenience but results in a large amount of data that may be overwhelming during exploratory analysis).

During the analysis users must be aware of the following:

- The dashboard is a data-centric web based application that is constrained by the limitations of the hosting environment (browser).
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<tbody>
<tr>
<td>• If the period of c-book usage is approximately known, then the dashboard should synchronise with the remote data repository only for that period as this saves precious memory space and increases the analytical capability of the tool.</td>
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<tr>
<td>• By the same token, if there are certain sessions within that period that are going to be analysed then it is suggested that only those periods are selected for analysis and not the whole dataset.</td>
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<tr>
<td>• Flashback queries are very CPU intensive operations. They must be used sparingly and not for very big datasets or data periods.</td>
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<tr>
<td>• It is always preferable to use visualisations at the lowest possible level in case the same information can be obtained at different levels. In this case the operations involved require less interactions with the user, they are more efficient and information is communicated with the designer in a more direct way.</td>
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The most important issue to observe is the role of task analysis at early stages of design to identify the level of feedback specificity and its complexity in order to determine the level of involvement of different expertise in the configuration process. A possible process for authoring feedback is to follow a ‘layered’ incremental approach that requires interdisciplinary involvement by domain and widget experts, learning designers or technologists who can appreciate both the domain needs and the affordances and constraints introduced by the technology and developers to write specific analytical modules. After the initial authoring the skill threshold for configuring the feedback messages is reduced.

In terms of the analytics dashboard our recommendation is that designers, developers, authors and teachers work in tandem to properly configure the c-book and take care that logging is enabled for all the widgets that one may expect that the availability of data will help reflecting on the unit’s usage.
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| c-book unit technical specifications/ use of authoring tool: implementation in the classroom. | Include some specific information for the teacher about the c-book unit such as the aim of the c-book unit, teaching and learning strategies recommended for this c-book unit, classroom organization while implementing the c-book unit (collectively, or individually). This could be achieved by having two versions of the c-book unit, one for the student and the other for the teacher based on the login rights, making some contextual information appear or disappear. | - Adapt the c-book unit technology for universal access also for students with physical limitations  
- Be able to introduce changes in the c-book unit without losing data previously entered by students.  
- Be able to define several teachers for the same classroom in the DME environment.  
- Be able to assign groups of students to widgets/pages/activities in the same c-book unit  
- Adding an option to export the c-book unit to a pdf document  
- Adding a final enquiry for the students in order to collect (automatically) their opinions about the CMT potential of the unit, as well as some feedback on the use of the c-book unit.  
- Teachers should make sure that everything works correctly in the exact context (classroom, school) where they are going to implement the c-book unit. | |

Classroom implementation should be also taken into account when designing c-book units. CoI’ suggestions regard specific improvements in the C-book technology so that classroom use becomes more efficient. For example, providing access for students with disabilities and improving DME features regarding classroom management. Also, it would be fruitful if the c-book authors made suggestions for orchestration (providing information about the aim of the c-book, the teaching and learning strategies, classroom organization etc.)