

***Knowledge and Information Flows in a Hybrid Learning Space:  
the students' perceptions***

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**Abstract**

How much information and/or knowledge flows among the members of a collaborative learning group and between them and the external information/knowledge sources? Which stages of the collaborative process have the highest knowledge and information flows, respectively? These are the questions which the experiment described in this paper seeks to answer.

The experiment involved 66 students from the University of Turin. After attending a couple of lessons on online communities of professionals and doing some basic reading, they were asked to develop, in small sub-groups, an artefact (using a wiki) to summarise what had been learnt.

The students were also asked to make a quantitative and qualitative estimate of the information and knowledge flows which took place in the three different phases of studying, structuring and collaboratively developing the artefact.

The stages with the highest knowledge flow index were found to be the study and structuring stages, while information flows were mainly in the actual writing of the artefact.

**INTRODUCTION**

Research into collaborative learning has often concentrated on the following key aspects: (a) choice of collaborative strategy (Diaper, & Sanger, 1993; Lazakidou, 2010; Zhang, Ayres, & Chan, 2013); (b) assessment of the learning results produced by that strategy (Macdonald, 2003; Brodie, & Irving, 2007; Strijbos, 2011); (c) assessment of

how far the strategy has stimulated students' active participation, as measured by their contribution to the development of the pre-set product of the collaborative process (Trentin, 2009; Judd, Kennedy, & Cropper, 2010).

Relatively little research has instead so far been done on the flows of information and knowledge within a collaborating group, and to what extent these flows are conditioned by (a) the collaborative strategy adopted, (b) the management of this strategy, (c) the technological and non-technological tools used to develop it, and (d) the space within which the process develops.

These aspects become more important when the space within which the collaborative process develops is a hybridisation of physical (institutional and non-institutional) spaces and spaces which are instantiable through mobile and web technologies. De Souza and Silva (2007, p. 262) give the following definition of *hybrid space*, which can be usefully applied to our experiment:

*“Because mobile devices create a more dynamic relationship with the Internet, embedding it in outdoor, everyday activities, we can no longer address the disconnection between physical and digital spaces. I name this new type of space ‘hybrid space’. Hybrid spaces are mobile spaces, created by the constant movement of users who carry portable devices continuously connected to the Internet and to other users.”*

### **The importance of studying information/knowledge flows**

When proposing learning group activities in a *hybrid learning space* (HLS) to students, it might be useful to find answers to the following questions: (a) what amount of information and/or knowledge flows in the interaction, both among the members of a collaborative learning group and from them and the external information/knowledge sources; (b) which stages of the collaborative process have the highest indexes of *knowledge flow* (KF) and *information flow* (IF), respectively (Nissen, 2002; Trentin, 2011a; Oliver, 2013)? And, once the phases/activities of a collaborative process producing the highest KF have been identified, how can it be potentiated to optimise the collaborative approach and enhance the peer learning process?

Starting from these underlying considerations, the experiment described below sought to answer the following research questions:

- what types of flow develop within learning groups at different stages of a collaborative strategy?
- to what extent do KFs and IFs develop respectively?

### **Experimental premise**

Although much has been written and hypothesised about the conceptual difference between *information* and *knowledge*, two problems still need to be solved (Yeager, 2005; Jones, 2010):

- the lack of clear criteria for understanding when there is a flow of information and when there is instead an actual flow of knowledge at any given moment of the cognitive process;
- the high level of subjectivity in discriminating between information and knowledge. In other words, even when agreement is reached as to the above-mentioned criteria, their application continues to be subjective, i.e. no-one is able to decide better than the person directly involved when acquired information remains just that and when instead it is transformed into actual new knowledge.

For the latter reason, in the experiment described below we decided to ask the students themselves to give their quantitative and qualitative estimates of the type of flows that passed through their groups.

In order for this choice to lead to reliable results, one essential condition had to be guaranteed, i.e. that students were instructed beforehand as to the difference between KF and IF. The ideal context for this was offered by the course *Network Technology and Knowledge Flow 2012* (NT&KF-2012), in the last year of the second-level degree in “Public and Political Communication” at the University of Turin. The main aim of the course was in fact to understand how network and mobile technologies could foster and potentiate KF at an organisational level.

After attending a couple of lessons on online communities of professionals (COPs) and studying some basic reading about the specific topic, they were tested (with a multiple-choice test) on their understanding of the key aspects of IF/KF, and on their ability to distinguish one from the other. In the following stages of the experiment, only the qualitative/quantitative estimates of IF/KF furnished by students who had scored at least 70 out of 100 in the test were taken into account. In this way, lack of knowledge on

this topic could not jeopardise the reliability of the data produced by the students and used for the experiment.

### **THE THEORETICAL BASES OF THE EXPERIMENT**

Before directly addressing the theme of KF/IF, students' ideas on the respective meanings of *information* and *knowledge* had in some way to be standardised.

For this purpose, the DIKW (Data, Information, Knowledge, Wisdom) model was used (Rowley, 2007):

- *Wisdom* is the recognition that knowledge patterns arise out of fundamental principles and the understanding of what those principles are;
- *Knowledge* is represented by patterns among data, information and possibly other knowledge. These patterns do not actually constitute knowledge until they are understood;
- *Information* is represented by relationships between data and possibly other information;
- *Data* is an item or event out of the context with no relation to other things.

For the specific aims of the experiment, most attention was obviously given to the *information* and *knowledge* planes, their mutual influence, and above all the process by which information is transformed into new knowledge.

In a *hybrid learning space* (HLS), a large portion of interactive flows is supported and sometimes governed by mobile and network technologies (NMTs). Students were thus advised to analyse the KFs/IFs from the points of view of both computer-mediated communication (CMC) and communication theories.

### **Communication theory and information flow**

Figure 1 shows the diagram of a communication system as conceived by Shannon and Weaver (1949): an information source, an information codification and transmission

unit, a transmission channel with noise interference<sup>1</sup>, an information receiver and decodification unit, the destination of the information.

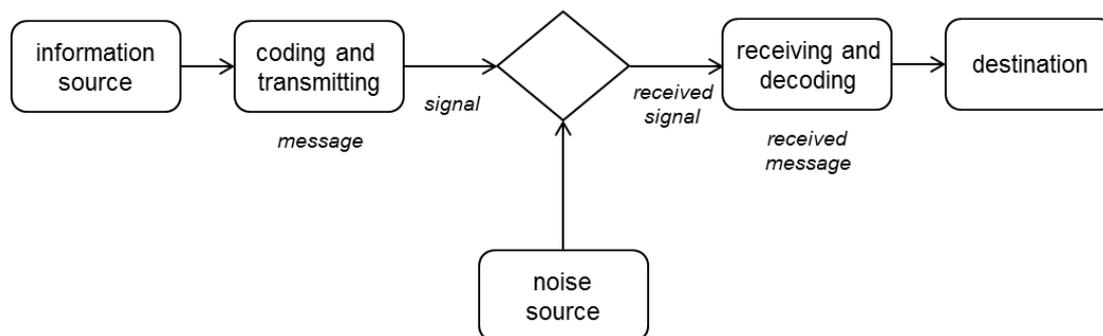


Figure 1 – Communication flow according to the model of Shannon and Weaver (1949).

This type of communication is at the basis of both dialogic interaction (instant messaging, sms, e-mails, forums, social networks, etc.) and artefact-mediated interaction (documents, wikis, concept maps); in other words, every time a piece of information needs to be first coded then decoded in order to pass through the technological channel.

Apart from its need for codification, the process illustrated in Figure 1, information transmission, does not differ greatly from the flow of a liquid from one container to another. This is why it is often defined as an *information “flow”* (IF).

### **From information flow to knowledge flow**

While Figure 1 adequately represents an IF process, it is inadequate for representing KF processes. In fact, the mechanisms for the acquisition of new knowledge resemble less the decanting of a liquid from one container (the sender’s head) to another (the receiver’s head) than a process of absorption, integration and systematisation of the received information into the receiver’s own pre-existing cognitive structures, which are the result of personal experience, earlier knowledge, etc.

Therefore, for a better representation of a KF process the scheme of Figure 1 should be extended as shown in Figure 2 (Trentin, 2011b).

<sup>1</sup> In communication theories the concept of “noise” is understood in a broader sense. Besides the actual physical noise introduced by technology (e.g. electromagnetic perturbations), it includes noise caused by the following: semantic factors (i.e. different interpretations of the meaning of what is being communicated); entropy and overabundance of information transmitted; difference in interlocutors’ cultural levels; technical jargon of the specific communication context, etc.

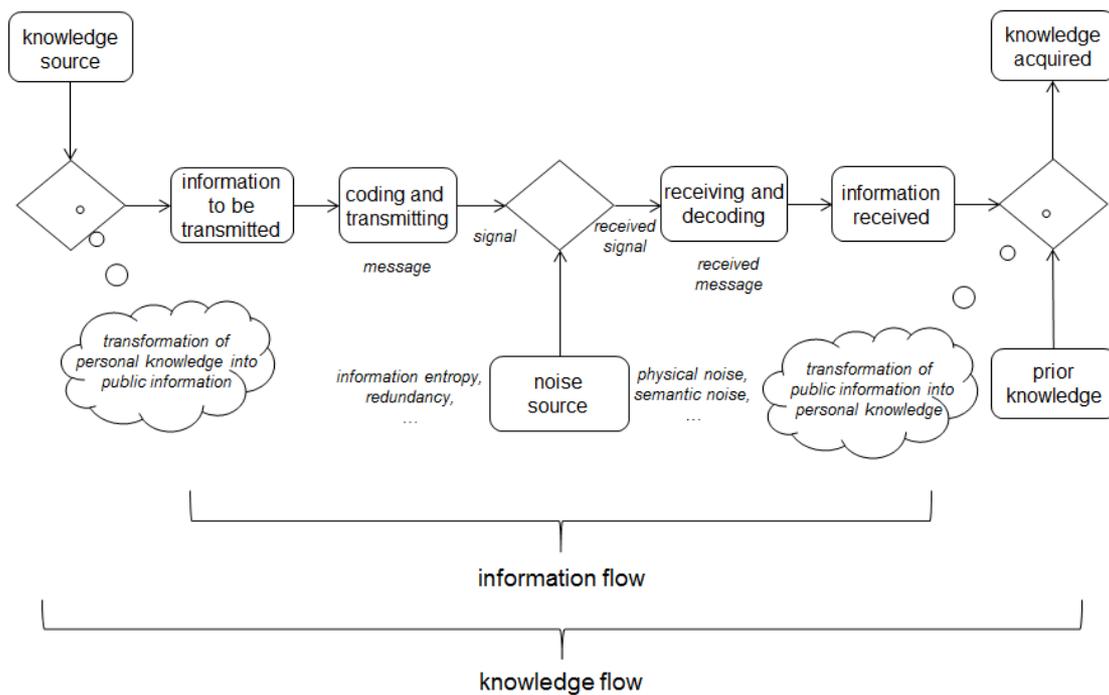


Figure 2 - From Information Flow to Knowledge Flow.

The key point is thus to create the conditions for stimulating the process of *assimilation* and *accommodation* (Piaget, 1977), by proposing both individual and collaborative learning activities, problem-solving and artefact development, etc. (Trentin, 2010).

An interesting way of fostering collaborative knowledge building (Scardamalia, & Bereiter, 1994; Stahl, 2000) is the integration of face-to-face and online interactions within the virtual community environment, in other words applying what Cress and Kimmerle call the *co-evolution model* (Cress, & Kimmerle, 2008), centred on the use of technologies which favour social interaction.

Such social interaction increasingly tends to develop in hybrid spaces, i.e. where the increasing portability of mobile technologies and increasing frequency of social media use tends to annul the clear distinction between onsite and online, producing a kind of interpenetration of the two in a single a-dimensional space which we often define in fact as “hybrid”.

## The possible dimensions of KFs

Figure 2 gave a possible representation of the KF process from the point of view of technology-mediated communication theories. It may now be useful to consider the intrinsic features of these flows and their contribution to *knowledge maturing* processes (Kaschig, Maier, Sandow, Lazoi, & Barnes, 2010). In Figure 3, different types of KF are identified (Trentin, 2011b):

- the *Formal* -> *Informal* axis identifies the context in which the flow is developed. Activities pertaining to a direct educational action, e.g. e-learning, belong to formal KF, whilst use of NMTs to access and share either explicit Web knowledge or tacit knowledge stimulated by interactions within online communities belongs to informal KF;
- the *Vertical* -> *Horizontal* axis identifies the direction in which the KF spreads. The flow is vertical when the knowledge is taken from an authoritative and certified source (a specialised information source, an expert); the flow is horizontal when knowledge is made to circulate within a community.

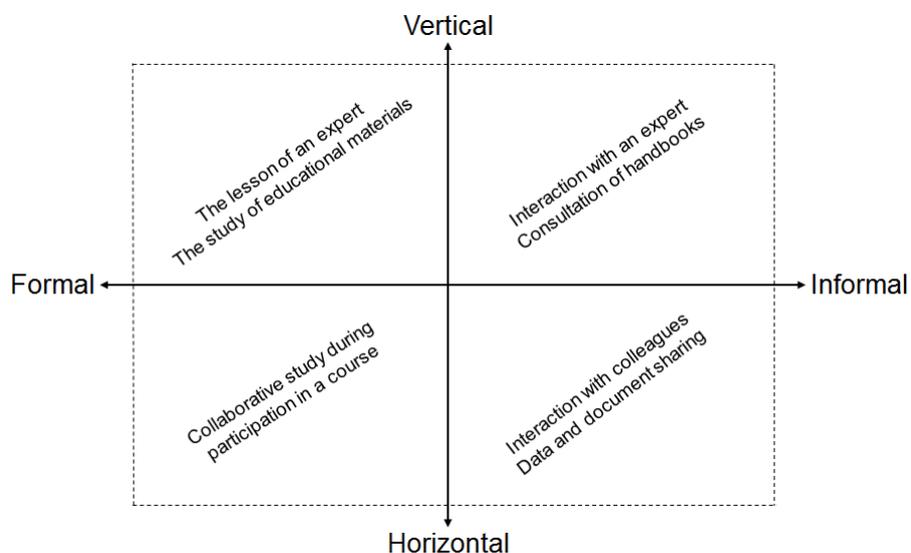


Figure 3 – The possible dimensions of KFs.

Four main squares may be identified where the axes cross (Trentin, 2011b):

1. *Formal/Vertical KF*: the lesson of an expert, the study of materials proposed by the teacher within a course, etc.;
2. *Formal/Horizontal KF*: collaborative study during participation in a course, etc.;

3. *Informal/Vertical KF*: occasional interaction with an expert, independent consultation of handbooks and authoritative documental sources, etc.;
4. *Informal/Horizontal KF*: peer interaction among colleagues outside a programmed and managed educational course, collaboration in professional problem-solving, etc.

## **DEFINITION OF EXPERIMENTAL SETTING**

Sixty-six (66) students (38 female, 28 male) enrolled in the NT&KF-2012 course participated in the experiment. Most of them were aged between 23 and 25 years, 16 of them between 26 and 34 years; 14 of these 16 were already working in medium-high profile jobs.

No particular criterion was followed in the composition of the learning groups except for equal distribution of students with working experience over the various groups. This was to ensure that there was at least one member within each group who could create a bridge between what was to be studied theoretically and the operational practice required in the working world.

The NT&KF-2012 course had a six-monthly duration and included moments of online activity alternated with 2-hour classroom activities. The latter were mostly dedicated to (a) students' requests for clarification from the teacher, (b) the completion of distance collaborative activity and in our case, (c) the individual compilation of the data sheets.

The experiment was conducted during one of the last modules, precisely "Module 4 – Online communities of professionals".

### **Course technologies**

The BYOD (Bring Your Own Device) (Siddiqui, 2014) approach was adopted in the course, helped by the students' personal possession of adequate technological devices.

In fact an initial investigation revealed that of the 66 students:

- 86% owned smartphones (100% at least a mobile);
- 15% owned tablets;
- 96% owned PCs (desktops and/or laptops);
- 53% owned laptops.

Moodle was used as the Learning Management System (LMS), since it is the reference platform for distance courses at the University of Turin. However, because of the specific aims of the NT&KF-2012 course and the experiment, Moodle was not the only network space within which the online activities described here were developed. The LMS mainly served as a meeting point for the class, where students could find: the teacher's indications and support for the development of the (individual and collaborative) study activities; basic support materials; and brief tutorials on the use of Web 2.0 resources, which were helpful for developing some of the collaborative activities proposed. The test for assessing students' ability to discriminate between IFs and KFs before the beginning of the experiment was also managed through the same LMS.

It was agreed to use two channels for interpersonal interaction: a formal and an informal one. The formal one centred on the reference forum established for each learning module, used mainly to receive the teacher's indications and support. The informal one was instead chosen by the students, who were left free to use the communication technology which best suited their daily habits (instant messaging, social network environments etc.).

It should be pointed out that in the previous three learning modules, all the students had gained experience on both the method (networked collaborative learning) and the tools (wiki and concept maps) which would then be used during the experiment.

Thus the method and the technologies used during the experiment were wholly "transparent", allowing students to concentrate on the content and activity proposed during the experiment.

### **Notes on the experiment**

The experiment consisted of a collaborative study activity to be developed in an HLS. The space could be defined as "hybrid" not so much because there was an intersection of physical and virtual spaces, but rather because of the "always-on" connection (De Souza and Silva, 2007) among students. This functioned during their interaction (a) inside the classroom, (b) in extra-classroom spaces (on the same university campus or in any other physical space where they could study alone or in groups) and (c) in the virtual spaces (sometimes also used during classroom activities).

The final output envisaged for the collaborative activity was an artefact (to be precise a wiki) which summarised what had been learned in the study of one of the key topics in the syllabus of the NT&KF-2012 course (Online Community of Professionals).

A mixed collaborative/cooperative strategy was used to conduct the experiment, combining:

- a *shared mind* approach (Schrage, 1990) through the application of the “pyramid” method in the study stage and the stage of collaborative planning of the artefact structure;
- a *division of labour* approach (Schrage, 1990) in the cooperative writing stage for the actual creation of the wiki.

For the collection of experimental data and information, students were asked to make a quantitative and qualitative estimate of the information and knowledge flows which took place during the various stages of the proposed study activity, both in the study stage and during the structuring and collaborative development of the artefact.

#### **THE EXPERIMENT AND THE DATA COLLECTION**

In the experiment (Trentin, 2014), the “pyramid” method was chosen for its particular structure. This structure was in fact found to be helpful in making distinctive analyses of the flows characterising each moment of the collaborative process among students.

The “pyramid” collaborative model (Biuk-Aghai, 2003) is one of the so-called *collaborative learning flow patterns* (CLFPs), i.e. those widely-used criteria for structuring the flow of learning activities involved in collaborative learning situations (Hernández-Leo et al., 2006).

To sum up, the “pyramid” model ensures that:

- each individual participant studies the problem and proposes a solution;
- groups (usually pairs) of participants compare and discuss their proposals and, finally, propose a new shared solution;
- those groups join larger groups in order to generate new agreed proposals;
- all the participants agree on a definitive solution.

## Use of pyramid method in the first step of the experiment (shared mind)

Table 1 shows a summary of the general script, based on the pyramid method which was applied to the study activity of the first part of the experiment, defined here as *shared mind*.

Table 1 – Summary of the script applied to the collaborative activity in *shared mind* mode.

<i>Activity</i>	<i>Organisation</i>	<i>Resources used</i>
<i>Introductory lesson of teacher</i> [2h] on study topic with explanation of the methods for carrying out the experiment and of the tools used for data collection.	<ul style="list-style-type: none"> <li>• Face-to-face intervention and discussion on organisational rules of next step.</li> <li>• Division of students into 8 learning groups of 8-10 members each.</li> </ul>	
<i>Stage 1 of the pyramid</i> [5 days]: individual study of material provided by teacher, online search for further material and summary of what they have learnt with structured representation using concept maps.	<ul style="list-style-type: none"> <li>• Individual activity without interaction with other students except through the module forum moderated by the teacher.</li> <li>• Network activity aimed (a) at integrating the material provided by the teacher with other material from the web, (b) at pinpointing COPs, classifying them according to some parameters agreed on with the teacher.</li> <li>• Individual development of the map.</li> <li>• Teacher role: waiting for requests (<i>pull mode</i>).</li> </ul>	<ul style="list-style-type: none"> <li>• Forum for teacher support on LMS.</li> <li>• LMS from which to access material uploaded by the teacher.</li> <li>• Any other type of NMT to access other web document resources and the COPs.</li> <li>• A Google Form to collect and classify the COPs intercepted.</li> <li>• Mindomo<sup>2</sup> online editor of concept maps.</li> </ul>
<i>Stage 2 of pyramid</i> [2 days]: comparison in pairs of the structured representations and agreement on a single representation.	<ul style="list-style-type: none"> <li>• Division of each learning group into pairs.</li> <li>• Wholly online activity.</li> <li>• Sharing of individual maps and materials found on the web by each student.</li> <li>• Teacher role: waiting for requests (<i>pull mode</i>).</li> </ul>	<ul style="list-style-type: none"> <li>• As above, with addition of any other synchronous and asynchronous NMT for interacting 1:1 with one's partner in the pair and for sharing information and documentation (via DropBox, Google Drive, etc.) found on the web by each one during previous step.</li> </ul>
<i>Stage 3 of pyramid</i> [3 days]: group comparison in pairs (4-5 groups of pairs for each learning group) of the maps produced by the single pairs and agreement on one map.	<ul style="list-style-type: none"> <li>• Whole group activity to compare the 4 maps produced by the single pairs.</li> <li>• Online activity for preliminary viewing of the productions of the other 3-4 pairs and first exchange of opinions preparatory to classroom meeting.</li> <li>• Final face-to-face comparison [4h] with the 8 groups operating in</li> </ul>	<ul style="list-style-type: none"> <li>• As above with addition of any other synchronous and asynchronous NMT and web service for group interaction and sharing (via DropBox, Google Drive, etc.) of information and documents found on the web by each member of the group in the previous steps.</li> <li>• NMTs continue to be used also</li> </ul>

<sup>2</sup> <http://www.mindomo.com/it/>

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parallel.	during face-to-face group work.
<ul style="list-style-type: none"> <li>• Teacher role: waiting for requests (<i>pull mode</i>). Occasionally <i>push</i> in the case of maps with serious conceptual errors.</li> </ul>	

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### **Cooperative writing in the second stage of the experiment (division of labour)**

The concrete aim of the activity was the creation of a wiki by each of the 8 groups involved. In order for the teacher to have better control of the process, all groups were asked to proceed in the same way in (a) organisation of the group work and (b) the actual writing of the wiki.

#### ***Organisation of group work***

A chief editor was appointed for each group. He/she had first of all to extrapolate an index of topics (8-10 chapters of at least 3 paragraphs each) from the map shared by the group (see Step 4 of the previous paragraph), with the aim of simplifying the division of labour for the subsequent collaborative writing of the wiki. This exclusively online activity was divided into 3 steps:

1. a first proposal of the index by the chief editor;
2. group discussion of the proposal and convergence on an agreed version;
3. validation of the index by the teacher, who then sent any comments, suggestions and corrections to the single groups. This was to avoid any serious errors which might negatively condition the development of the document.

PBWorks<sup>3</sup> was the environment chosen for the development of the wiki. The “comments” box on the homepage of the wiki under construction was used both for discussion of the index by the group and posting of suggestions and corrections by the teacher.

Lastly, the chief editor assigned a chapter of the index to each member of the group.

#### ***Cooperative writing of the various parts of the wiki***

The following indications were given about how to proceed in the cooperative writing:

- a) *Development of the various parts of the wiki* – Working individually, the group members developed the chapter of the text assigned to them and thereby created a branching hypertext document (“cluster”) following a top-down approach

(Trentin, 2014). In preparing each page, they were advised to proceed step by step (from ‘substance’ to ‘form’): write out the summary; mark the hot-words to be linked to the pages with more detailed information; format the page.

- b) *Links to pages created by others* – To prevent co-writers concentrating exclusively on their own part of the text, they were required to browse the whole hypertext for pages compiled by others which might be conceptually linked to one or more pages in their own page “cluster”. This activity meant that co-writers examined the conceptual links throughout the work, thus fostering a more complete overall vision. The co-writers were encouraged to perform this task while they were actually developing their pages and not to leave it till last as a mere final refinement. Reading the pages of co-authors as they evolve not only sparks new ideas and suggests improvements for the student’s own text, but also helps to avoid duplications, especially when two or more students work on conceptually close subject-matters. This also leads to a gradual transformation of the hypertext structure from hierarchical to reticular.
- c) *Peer-review* - Once the different chapters of the shared document had been written, the co-writers were asked to peer-review 2-3 clusters of pages other than their own and suggest to their colleagues how to integrate and improve their texts. This collaborative interaction is facilitated by the “comments” function associated with each wiki page, through which short dialogues can take place among the different co-authors/users of the hypertext.

The active contribution of each single member of the group in points (b) (browsing other pages) and (c) (peer review) was assessed according to the suggestions in “Using a Wiki to Evaluate Individual Contribution to a Collaborative Learning Project” (Trentin, 2009).

### **Collection of experimental data**

The collection of the experimental data was carried out directly by the students. They were asked to give a quantitative and qualitative estimate of the information and

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<sup>3</sup> <http://www.pbworks.com/>

knowledge flows which took place in the different stages of the proposed study activity, both during the structuring of the artefact and during its collaborative development.

For the data collection, two tools were selected and used in “blind” mode in relation to the other members of the group:

- a worksheet prepared for each student on Google Worksheet to collect quantitative information on the types of flow;
- a form prepared with Google Form to collect qualitative information on the contents of the flows.

Both tables and forms were compiled individually in class at the end of each activity of the collaborative study. This was to avoid any conditioning in the assessments of the flows.

### ***The worksheet***

The worksheet had two simple tables for each of the 5 key moments of the collaborative study:

- the first table was composed of 4 cells, each corresponding to one of the 4 quadrants of the diagram in Figure 3; this table was used for the percentage quantification of the intensity of the various KF components;
- the second table, composed of 2 cells, was used for the approximate estimate of the relative percentages of KFs and IFs

The data from the students’ worksheets were collected in run-time into a single table which was used by the teacher as a kind of overall control panel.

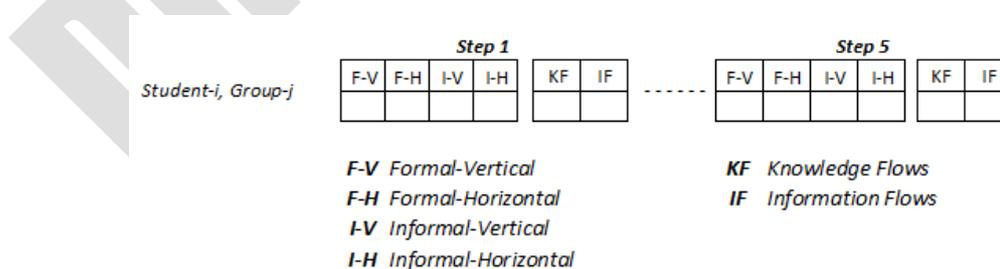


Figure 4 – Line of the table/control panel corresponding to student i of group j.

### *The form*

At the same time as compiling the portion of the worksheet corresponding to a particular stage of the proposed activity, students were also asked to answer the questions on the following form (Figure 5), in order to gather information on the specific contents of the different types of flow.

**Knowledge flows, qualitative analysis**

For each item indicate the main contents of the corresponding flow type

Step #

Formal/Vertical KF

Formal/Horizontal KF

Informal/Vertical KF

Informal/Horizontal KF

Individual study and working out of concept map  
 Comparison of maps in pairs and development of single agreed map  
 Comparison of maps in groups of 8 and development of single agreed map  
 Wiki development  
 Peer review

Figure 5 – Form used by the students to collect qualitative information about flow contents.

### **ANALYSIS OF THE COLLECTED DATA**

The following summary emerged from processing the rough data collected in the teacher's table/control panel. The data considered came from 52 of the 66 students enrolled in the NT&KF-2012 course, i.e. from those students who had obtained a score of at least 70 out of 100 in the initial test assessing their ability to distinguish between IF and KF.

Step	form/ver				K F	
	form/ver	form/hor	inform/ver	inform/hor	KF	IF
Individual study and working out of concept map	68,2%	2,8%	27,9%	1,1%	68,4%	31,6%
Comparison of maps in pairs and development of single agreed map	12,3%	77,1%	9,7%	0,9%	66,3%	33,7%
	12,8%	66,2%	20,2%	0,8%	74,9%	25,1%
Wiki development	41,1%	25,7%	33,2%	0,0%	14,9%	85,1%
Peer review	18,7%	58,4%	22,9%	0,0%	40,8%	59,2%

Shared mind

Division of labour

Figure 6 – Summary of the data collected with the Google Worksheets.

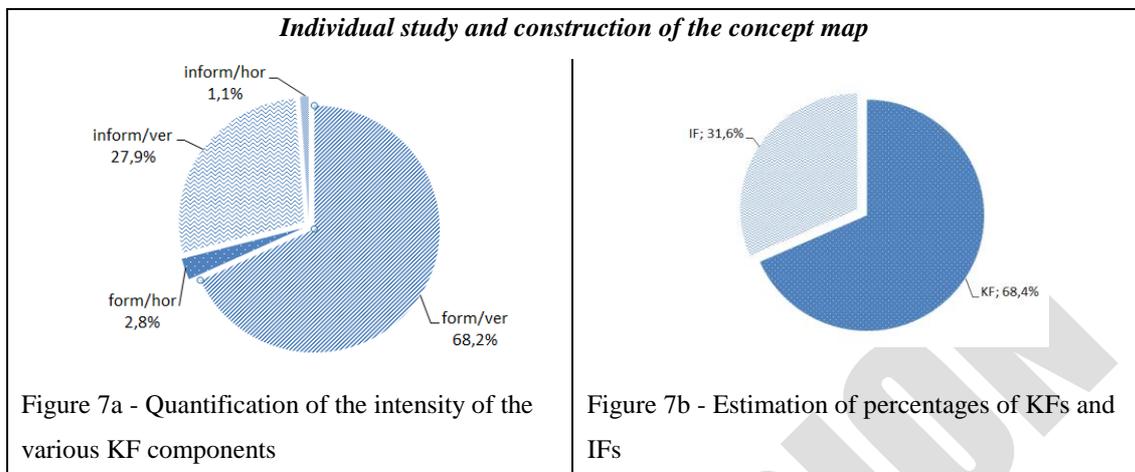
We will now analyse these data in detail, together with the qualitative responses collected with the Google Forms.

## Phase I – Shared Mind

### *Step 1 – Individual study and construction of the concept map*

In this step of the activity, students perceived a decisive prevalence of formal/vertical flows, which was accounted for by the study of the materials made available by the teacher and of the information and documents individually acquired on the web, also by the contemporary development of the required concept map.

The informal/vertical flows deriving from the study of COP features based on parameters agreed with the teacher (knowledge domain, type of interaction, approach to community memory management, COP dimension, geographical extension covered, etc.) were perceived as being of a lower percentage.



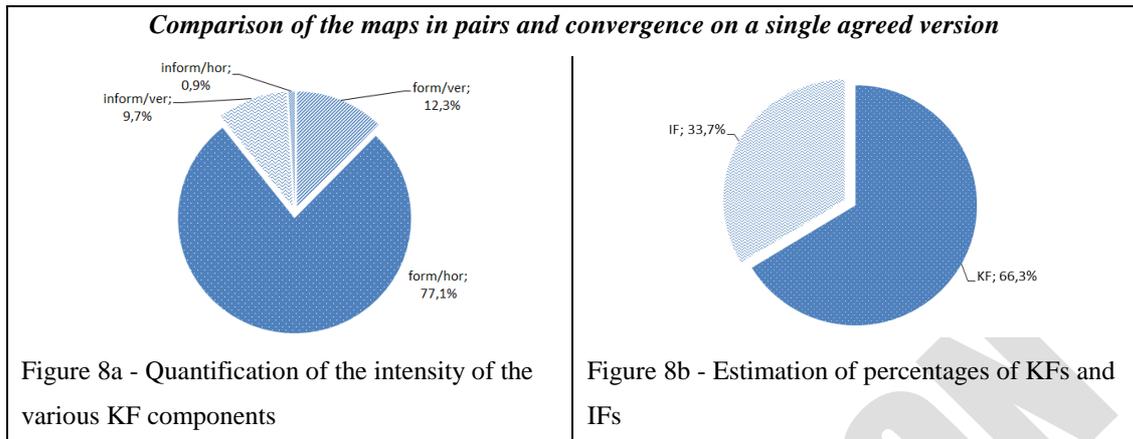
Given the strictly individual type of work required, the horizontal flows were minimal, generally limited to:

- sharing of the questions to and explanations by the teacher on the module forum (formal/horizontal flow);
- interaction when possible with the community members of the COPs analysed on the web (informal/horizontal flow), in order to acquire more details about them.

### ***Step 2 – Comparison of the maps in pairs and convergence on a single agreed version***

According to the students, this step was characterised by a high formal/horizontal flow rate. In other words, the comparison of the respective maps and the convergence on a single agreed one for each pair allowed students to exchange viewpoints and hence refine and integrate the knowledge acquired during the previous individual work (Step 1).

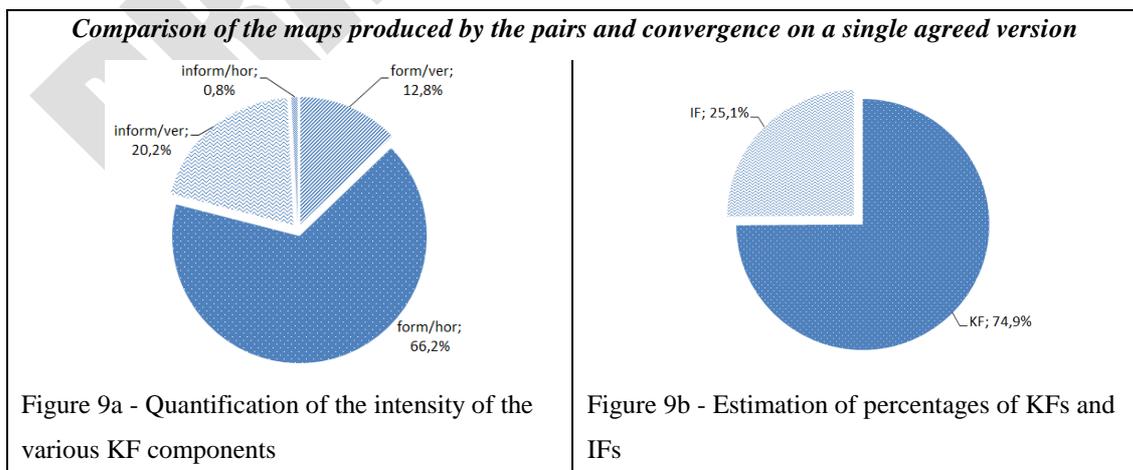
Vertical and horizontal formal flows were fairly rare and generally derived from the rereading of materials used in the first work step; also from the online search for further information on the COPs.



The informal/horizontal flows were minimal and essentially due to sporadic interactions with members of the COPs intercepted by the two components of the student pair, generally asking for clarifications of specific aspects of the COP and its mission.

***Step 3 – Comparison of the maps produced by the pairs and convergence on a single agreed version***

In this case too a prevalence of formal/horizontal flows was perceived, with an increase in the vertical informal ones as compared to the previous step. According to the students, this increase was due to the examination of the documentation and the information retrieved online by the other pairs during the previous steps (1 and 2).



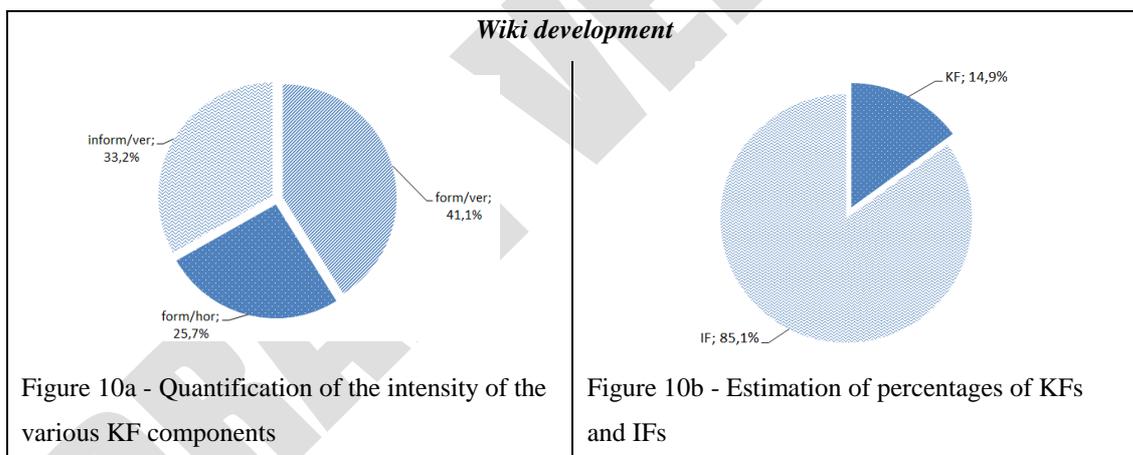
Informal/horizontal flows were practically absent, for the same reason as in the previous point.

The quantitative differences between the KFs and IFs perceived by the students were significant. In other words, it was the interaction that occurred during the critical comparison of the different maps, aimed at reaching agreement on a single shared version, that seems to have been the main generator of flows among participants. These were mainly knowledge flows, since it was on these that the process of co-construction/integration of mutual knowledge was based.

## Phase 2 – Division of labour

### *Step 4 – Wiki development*

In this step each student had the task of developing a cluster of the wiki. For this, students made wide use of the contents of the community repository, which was made up both of basic materials supplied by the teacher and of documents and information collected on the web during the previous steps.



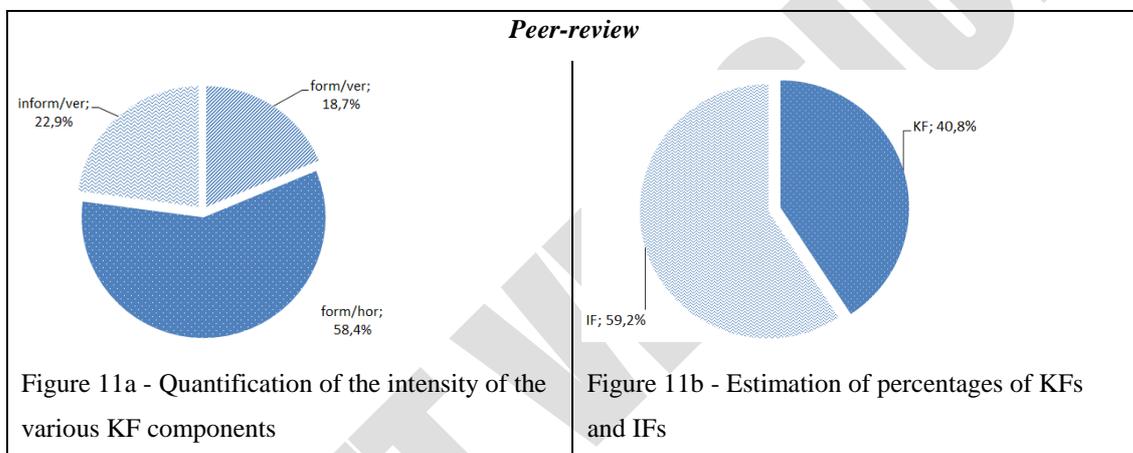
The result was (a) a prevalence of vertical over horizontal flows; (b) the almost total absence of informal/horizontal flows; and (c) a modest presence of formal/horizontal flows between students who had the task of developing closely-linked topics (interaction aimed mainly at avoiding duplications and at suggesting links among their various pages).

For the same reasons, the proportion of KFs to IFs was this time completely inverted since, as we have said, the flows were mainly determined by the circulation (not the

reworking) of the documents and information collected and summarised in the previous steps.

### *Step 5 – Peer-review*

In the peer-review step there was a fairly large increase in formal/horizontal flows, mostly due to reviewers' comments and the reactions of the authors of the reviewed pages. In other words, as in the steps involving the comparison of the concept maps, discussion focussing on the reciprocal analysis of the documents and (in the case of disagreement) on the exchange of argumentations, was perceived by students as a clear moment of co-construction/integration of reciprocal knowledge.



Here too the vertical flows were identified mainly in the re-consultation of the materials present in the repository of the group during discussions. This was particularly true when there was marked disagreement between the author of the cluster and the corresponding reviewer.

According to students' perceptions, in this step too IFs prevailed over KFs, albeit to a lesser extent. This conclusion is based on the same considerations as for Step 4.

## **DISCUSSION**

Before discussing the results of the analyses carried out on students' perceptions, it is important to summarise some preparatory stages of the experiment:

- acquisition by the students of a common theoretical basis regarding KFs and IFs, to guarantee an informed though subjective analysis of the flows;

- acquisition in the three previous learning modules of both the method (networked collaborative learning) and the tools which would be used during the course of the experiment (concept maps and wikis).

It is also useful to summarise some important methodological aspects of the experiment, namely:

- use of the mixed type of collaborative/cooperative strategy, consisting of a *shared mind* phase (based on a “pyramid” approach), and a *division of labour* phase (for the construction of an artefact);
- use of concept maps to facilitate the *shared mind* step;
- use of a wiki environment to facilitate the *division of labour* in the production of the final document (cooperative writing and interaction among authors);
- students’ perceptions were recorded with the help of tables and forms at five key moments of the collaborative study proposed by the teacher.

We will now try to provide concise answers to the two research questions underlying the whole experiment, based on the analysis of the data furnished by the students.

***RQ1 - In a collaborative strategy, what types of flow develop within the learning groups at the various moments of the process?***

The types of KF perceived by the students seem to have been greatly influenced by which of the two main experimental approaches (*shared mind* and *division of labour*) was being used. The *shared mind* step mainly produced horizontal flows deriving from the activity of comparing first individuals’, then pairs’, concept maps; also from the discussion aimed at agreement on a single map.

Discussion of the concept maps in pairs seems to have been the moment with the highest intensity of horizontal KFs.

The same type of flow also prevailed in the peer-review step, the concluding step in the wiki development. In fact this step inherited the features of both the *division of labour* stage (each student had to review 2-3 clusters of pages other than their own), and the *shared mind* stage (discussion, comparison and agreement on a common solution where possible).

Vertical flows were particularly notable during the initial compilation of the maps and the development of the wiki pages. In the former case in fact the greatest need was to access both the material made available by the teacher and the authoritative web sources, i.e. whatever was necessary for studying the topic and producing a first version of the concept map. In the latter case (the development of the wiki pages), the main need was to acquire and process documents in order to enrich the wiki in accordance with the structure agreed on by the group. In fact this step, as we will see with regard to the second RQ, was characterised more by IFs than by KFs.

### ***RQ 2 – To what extent do KFs develop and to what extent IFs?***

From reading the analyses, the stages of study and structuring of the artefact clearly emerge as having the highest rate of KFs. IFs instead predominated in the actual building of the artefact, and mostly derived from the sharing of factual material and from the collection and sharing of information from the web.

This is the summary of the flow mapping as perceived by the students at different collaborative moments.

It might be said that the specific approach to collaborative study adopted in the experiment, the hybrid space in which it was developed, and the network resources used to support it, all made it easier to identify those moments of the process when there was a greater intensity of KFs than IFs. It also proved effective for analysing the division of the KFs into the different components of the reference model at those same moments.

## **CONCLUSIONS**

It is difficult to assess the dynamics governing knowledge flows without directly involving the main actors of that process. This is why we asked the students themselves to express their personal perception of the flows generated during the collaborative activity proposed to them.

Although the students were instructed and assessed as to the theoretical principles of information and knowledge flows (I/KFs) before proceeding to the experiment, their assessments were nonetheless inevitably still strongly subjective, this subjectivity also being conditioned by the students' differing degrees of understanding of the theories underlying KI/F dynamics.

As pointed out at the beginning of the article, understanding where and how KFs are concentrated in a collaborative process may be important for deciding at what points in the process these flows should be potentiated to enhance peer learning.

The experiment might be said to have shown that KFs mainly develop in the initial study of the sources and in peer interactions of comparing, explaining, discussing disagreements, and negotiating an agreement.

It should be stressed that in a formal learning process, which is typical of higher education, peer interaction aimed at collaborative learning necessarily involves an initial moment of individual study of the chosen topic, where each student gathers information and then offers his/her active contribution to the group task. This contribution is mainly based on the sharing of what he/she has learnt during the individual study and, clearly to a lesser extent, on personal experience and previous (albeit partial) knowledge of the study topic.

Thus the next step of this research will logically be to conduct a similar experiment in a different context, the organisational one, where we will try to map the proportion of KFs to IFs during collaborative problem-solving within a COP. The idea is to verify whether and to what extent individual professional experience influences the composition of the flows; specifically whether, to what extent and where informal/horizontal flows (which are almost wholly absent in the experiment carried out in the higher education context) influence the collaborative process.

Finally, another future experiment might usefully involve the adoption of a different approach to collaborative learning, again in the higher education context. An attempt would thus be made to understand if, how and to what extent the variation in approach affects the directions, intensity and types of flows.

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