

TARGETED KNOWLEDGE: INTERACTION AND RICH USER EXPERIENCE TOWARDS A SCHOLARLY COMMUNICATION THAT “LETS”

Gian Piero Pescarmona¹; Elena Giglia²

1 Dipartimento di Genetica, Biologia e Biochimica

Università degli Studi di Torino

Via Santena, 5 bis 10126 Torino Italy

gianpiero.pescarmona@unito.it

2 Sistema Bibliotecario di Ateneo – Università degli Studi di Torino

Via Verdi, 8 10124 Torino Italy

elena.giglia@unito.it

Abstract

All living systems share many properties including hardly predictable behaviours, due to the differences between individuals and the chaos in natural environments.

The reductionist approach to the interpretation of these phenomena suffers from the oversimplification of the factors involved in the quest of universal “scientific” explanations. The validation of scientific paradigms is based on the consensus of leading groups that decide what is true and what is not.

That means that all events - not only conflicting opinions but also conflicting raw data - not fitting with the scientific official truth were never published, and that supported indirectly the correctness of the experts’ choice.

With the advent of Web 2.0 and the freedom of publishing, the number of these not fitting events has dramatically increased.

Yesterday, data were supplied to the reader with the interpretation. Now the reader has to afford in each field a huge amount of data and opinions. Extracting from the garbage the information you need requires a strategy.

Strategy is a science by itself. In the specific case of knowledge the first step is to define knowledge. The aim of life sciences, medicine, social sciences is to modify the reality when it is no longer sustainable, whatever it could mean in every single situation. I have to know how my system works to

modify it. Knowledge is the information that allows me to succeed in my tasks.

Tasks must have an assessable target. All information useful and therefore processed to attain the target will be “targeted knowledge”. Information can be selected on the basis of their congruence with the rules internal to the system.

In Web 2.0 we found proper tools to test this approach. We implemented a web application - whose aim is an easier identification of the molecular basis of the diseases - structured in **Rules, Reports, Items, Pathways** and **Tools** referring and linking one another. The use of tags allows and fosters a free and personal use of information to create original knowledge. Users can follow and open innovative paths each time answering a different question, re-combining the fitting information.

Our application is an example of advanced Problem Solving: the patient as a whole, not as a single symptom, has to be understood as a part of the living world (Gaia, with its rules) whose components (Items, Pathways) are described in their multiple roles and connections.

The Web allows easy access to information, the program allows the network creation, the Rules drive the selection of the information and become more and more stable the more they evolutionary adapt to the reality. Something like the DNA, carrying sequences millions years old in an ever changing world.

Keywords: knowledge; knowledge management; information; rules; scholarly communication; Web 2.0; e-learning

1. Introduction

The contemporary knowledge landscape includes many actors, means and skills: men with their wishes and targets; information in all its forms (books, Web resources, word of mouth, blogs, social networking etc); technologies day by day better exploiting the richness and the potentiality of the Web as a platform of information and a channel of communication; the ability to select the right information matching one’s “query”.

In seeking to address these largely debated topics from a different point of view, a step beyond is requested to suggest an overall view, with some

*Targeted knowledge. Interaction and rich user experience
towards a scholarly communication that "lets"*

thoughts on knowledge, access to information, scholarly communication, Web 2.0 new tools, teaching and learning.

Knowledge

The first step is to define knowledge, notoriously an evanescent concept. Knowledge is a multipurpose word like "mother": anyone has his one, not comparable to the others. But, on the other side, knowledge is required only if you have targets, might you reach them or not.

The aim of life sciences, medicine, social sciences is to modify the reality when it is no longer sustainable, whatever it could mean in every single situation. I have to know how my system works to modify it. Knowledge is the information that allows me to succeed in my tasks.

Tasks must have an assessable target: to treat a disease, to increase the food intake in a population, to improve the school performances. All information useful and therefore processed to attain the target will be "targeted knowledge".

Moreover, in this era of overspecialization, we are facing an over-atomised knowledge, whilst our aim ought to be a "connected knowledge", a network culture of knowledge in which ideas and knowledge itself are blocks to be connected [1].

Access to information

This idea of an open network of knowledge lies upon the concept of the wider possible access to information as an «enabler of innovation» [2]. As Suber puts it, in a perfect consonance with our idea of a targeted knowledge: «Step one is getting access to texts or data, stage two is getting answers to questions» [3]. The Internet gave unprecedented means to reach and share information: it is a formidable «shortcut» both to connect people to information without barriers and to connect people to people and ideas to ideas, revising the Cartesian motto in "We participate, therefore we are" [4] to create a "common intelligence" [5].

Or, better, a "distributed intelligence": it became the more and the more true that, as the theory of complexity points out, the whole is greater than the sum of its parts and the real power is that of the connections between the nodes, not of the nodes themselves [6]. Global access to information means also that, in the network and within a context of distributed intelligence, it's easier to catch the creative momentum that stands at the edge of the chaos, to find a new path, to innovate. But here arises the question of the current paradigms, circuits and behaviours in scholarly communication.

Scholarly communication

Karl Popper stated that «the advance of science depends upon the free competition of thoughts» [7]. Is it possible today, when a minority of journals publishes the majority of the articles, and receive the majority of the citations? When often publication is synonymous of oblivion, and lots of articles are never accessed? [8]. And when the so called “winner’s course” – the trend to publish only spectacular results, often severely exaggerated, as demonstrated by further investigations – further on shrinks the already low number of highly visible journals [9]? And when there is no comparison between the huge and even growing availability of raw data coming from the output of research laboratories and the increasingly limited high prestige (and impact) venues for publications, or there is no place and no acceptance for negative results, which, on the contrary, helps fostering science if based on rigorous methods? [10]. And when a diffuse uncertainty directly stems from the few formal rules of reproducibility in the published studies? [11] And when the abnormal economic returns derives to commercial publishers from the “artificial scarcity” [12], and the claim that selectivity correspond to quality? Peer-review process, if seriously conducted, is a guarantee of quality, but more and more it had only become the seal of a hyperspecialistic clanic logic and a filter to block new ideas, or at least those “extravagant” from the current paradigms. Otherwise, as the case of Scott Reuben – the latest of a long series - demonstrates, peer-review is not a trustworthy index of quality: Reuben was considered an influential researcher in pain management; his studies published since 1996 in the best peer-reviewed journals altered the way millions of patients have been treated for pain during and after orthopaedic surgeries. Reuben has now admitted that he never conducted any of the clinical trials on which his conclusions were based [13]. Such a kind of “blind” peer-review, which sees only what it wants to see, which is more tied to interest –whatever they arise from, economics or prestige - than quality, rather might have fostered the current phenomenon of “herding” – or, to say it with José Saramago, people flocking under the shadow of an opinion like an umbrella [14] – that has lead to a stagnant conformism in science [15].

Moreover, the oversimplification of the factors involved in the interpretation of the “phenomena” led to the quest of universal “scientific” explanations. The validation of “scientific” paradigms is based on the consensus of leading groups that decide what is true and what is not out of a plenty of contradictory results. The scientific official truth comes out from a process of validated data selection. That implied that all events not fitting with the prevailing model up to the advent of the Web were never published and therefore they were not accessible both to researchers and to common

*Targeted knowledge. Interaction and rich user experience
towards a scholarly communication that “lets”*

people. Not only conflicting opinions but also conflicting raw data were not published; the lack of negative or contrary data supported indirectly the correctness of the experts' choice.

With the Web 2.0 and the possibility for almost everybody to publish free of charge observations and opinions, the number of events not fitting with the scientific literature has dramatically increased.

So, if you are looking for unmediated information, you have to read it in the blogosphere, and this brings us to the Web 2.0.

Web 2.0

«The best thing about Web 2.0 is that... nobody knows what the hell it really means. Even the ones who coined the term are still struggling to find a compact definition. And this is the true beauty and power of Web 2.0—it makes people think. » [16]

From Tim O'Reilly Web 2.0 Meme map [17] we highlight the facets that are functional to our path:

- importance of the Web as a platform – harnessing collective intelligence
- theory of the Long Tail – lots of contributors for few contribution
- architecture of participation – the user is a content creator, via blogs, wikis and so on
- mutual trust between users – see Wikipedia
- right to remix and reuse
- rich user experience
- tags, comments.

All these attitudes contributed to shape «Arancia», a Web application, and its instance, «Il Flipper e la Nuvola» [«The Pinball Machine and the Cloud»], the project of knowledge management we are going to discuss [18].

There is only a caveat to stress: it could be true that in the blogosphere you can find more free information – e.g. on the adverse effects of a drug, in a blog written by patients and not by pharmaceutical industries –, but the risk is to cope with a universe expanding to the infinite. Therefore it is important to contextualize this information, to give information a target, i.e. to move from information to knowledge to generate more knowledge [19].

The challenge is to embed the innovative openness of Web 2.0 in a new way of teaching and learning.

Teaching and learning

As we are presenting an application of a knowledge management tool in its incidental use as a learning tool based upon the Web 2.0 logic, the temptation could be to attribute the tag of “e-learning 2.0”. E-learning 2.0 is for sure more appealing than the mere transposition of a traditional class and the traditional passive way of transmitting knowledge represented by closed Learning Management Systems and static Learning Objects. The underpinning concept of an active learner and the emphasis on the content creation [20] might be the same, but, actually, our conceptual frame is quite different.

Proponents of e-learning 2.0 tend to stress:

- technological aspects: adoption of web 2.0 tools like wikis, blogs, podcasting might enhance the learning experience – but technology itself doesn’t add value to the content: a boring speaker will be boring also on podcast [21],
- social aspects: experiments with the use of Facebook, My Space, or even Second Life – but it can refer to the sphere of “learning to be”, and might be more useful in higher education [22]
- culture of sharing: the right of remix and reuse is highly agreeable, but for the vast majority of cases it is referred to in dealing with close, statics, prepacked Learning Objects, even though delivered by prestigious institutes like MIT (Open Courseware) – a great initiative in term of openness of education – or Open Educational Resources [23].

One affinity could be recognized in the user-centric infrastructure that ought to emphasize participation, but one can discuss which kind of participation we are talking about: in the JISC–founded CeLLS programme for collaborative e-learning in the Life Sciences, within an advanced scenario you can find again the idea of a structured Learning Object edited by an expert [24].

Interesting, in a sense like-minded projects from different fields are Flatworld knowledge and TALIA. Flatworld knowledge is a free online collection of textbooks, released under a Creative Commons license. A professor can adopt his/her textbook in the sense that he/she can edit a chapter, reuse the content, and also create a new book as a specific tool for his/her class. Learners can freely read online – print edition is by fee – and participate in the social network, posting comments, editing texts, rating contents edited by other users, or simply looking for other students connected at the time to make questions, to learn together [25]. TALIA is an open source software developed to integrate distributed digital semantic libraries in the Humanities. It works within the Semantic Web framework – so to ensure interoperability e.g. adopting RDF and OWL – and relies upon a relation-

*Targeted knowledge. Interaction and rich user experience
towards a scholarly communication that “lets”*

centric vision more than an item-centric one: by creating semantic links between digital objects, the system displays information using metadata and ontologies, each time following the different path set by the user [26].

Actually, in a conceptual frame, the shift ought to be from passive teaching as the delivery of the substance “content” from teachers to students to an active involvement of the learner, in a constructivist approach. The connectivist approach of George Siemens, cited by Stephen Downes – the father of e-learning 2.0 – sounds consistent with our idea of teaching:

Unlike constructivism, which states that learners attempt to foster understanding by meaning making tasks, chaos states that the meaning exists – the learner's challenge is to recognize the patterns which appear to be hidden. [...].

Connectivism is the integration of principles explored by chaos, network, and complexity and self-organization theories. Learning is a process that occurs within nebulous environments of shifting core elements – not entirely under the control of the individual. Learning (defined as actionable knowledge) can reside outside of ourselves (within an organization or a database), is focused on connecting specialized information sets, and the connections that enable us to learn more are more important than our current state of knowing. [...]

New information is continually being acquired. The ability to draw distinctions between important and unimportant information is vital. The ability to recognize when new information alters the landscape based on decisions made yesterday is also critical [27].

Moreover, in 2009 one has to take into considerations also the “net-gen” keywords: connection, multitasking, visual, fast, immediate, experimental, inductive, wired [28].

Also Christian Dalsgaard's vision, based upon social constructivism, has to be considered: individuals are encouraged to learn together via social software networked tools, starting from a problem to solve [29]. Resources the most various are not integrated in a LMS but only offered in an open environment as tools among which a learner choose the most fitting to his/her purposes to solve the problem, alone or in collaboration. The idea of «loosely joined technologies» [30] as a tool box for independent further construction is very attractive, as well as the concept that learning activities cannot be structured or pre-determined. This meets our vision of an empowering environment where learning cannot be managed but can be facilitated: an environment in which knowledge, through a rich user experience, «lets». The technology being just the enabler, the real driver is the method.

2. Methodology

Think globally, act locally is a famous sentence almost one hundred years old [31] that has been used in various contexts and perfectly describes how operators in the field of Medicine, Economy or Social Sciences should act.

Complex organism (a cell, a human body, a class, a country) has specific properties that it shares with the other member of its class, but its behaviour may be different in different local situations or environments. To be able to interact with complex systems we have to be able either to know the general properties of the classes (Think Global) either to modify the local conditions (Act Local).

In our finite world every organism is the result of an evolutionary adaptation to the environment with its spatial and energetic limits. Identification of the basic rules governing the organism is the first mandatory step on the path to its knowledge: e.g. what is a country, what is a human body, what is a virus; how they play according to the environment...

As they share the same environment, they have been supposed to live together as a super-organism called Gaia [32] that behaves as a single, self-regulating system comprised of physical, chemical, biological and human components. The interactions and feedbacks between the component parts are complex and exhibit multi-scale temporal and spatial variability.

Affording the description of such interconnected systems on the basis of relatively simple universal "scientific" paradigms may be misleading, as they force the researcher to "select" the data. As the data selection takes place at any step (technician → PhD student → Assistant Professor → Principal Investigator → Journal Referee) having in mind the prevailing paradigm to which conform, the published data represent only a small percentage of the whole.

One of the possible approaches to overcome this difficulty is the use of robust models to simulate the behaviour, at different levels of complexity, of living systems. The model is interactive: data fitting the model validate it; non fitting data are used to modify the model interactively. The model doesn't select the data, it learns from the data, and becomes more and more robust. The model proposed in our application is based on some very basic features shared by all living systems.

They are dissipative systems that do not conform to the second law of classical thermodynamics because they are not closed systems, but they continuously receive energy from the outside [33].

On the earth crust excess energy comes from sunlight. Photosynthetic organisms (plants, bacteria, algae) use radiant energy to move electrons from

*Targeted knowledge. Interaction and rich user experience
towards a scholarly communication that “lets”*

more to less electronegative elements leading to the present atmosphere, which is completely different from the original one surrounding earth before life. The most striking difference is the continuous increase of gaseous N₂ and O₂ in the atmosphere over the past 4 billion years. The large availability of a strong oxidant like O₂ allows survival of all the forms of life depending on respiration for energy production.

The complex interactions between different organisms into the earth system may be represented by a network of objects and interactions of extreme complexity. Applicative examples of such an approach are common in description of biochemical pathways [34] but any kind of interaction may be described in terms of positive or negative feedback, activation, inhibition and so on and at any level from molecules to populations. Different mathematical approaches have been used to modelling living systems; one of the most sound is the use of Petri Net [35] but others are valid as well [36]

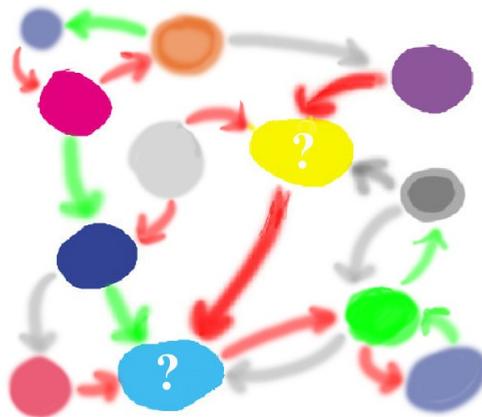


Figure 1: Any living and evolutionary system in a finite environment can be described as a set of nodes and interactions

In this world live men and sometimes they become ill. Physicians are expected to heal them, here and now. They have to act local, they should think global. Making a diagnosis of diabetes or hypertension and prescribing the corresponding drug can be really envisaged as thinking global? Or more probably it is a simple one-to-one connection?

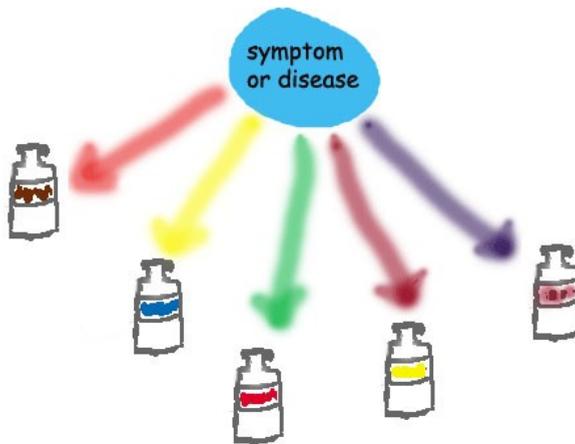


Figure 2: The usual steps of medical practice are: 1) identification of symptom or disease 2) prescription of a drug according to the suggestions of EBM.

The choice of the drug is no longer so much dependent on the physician choice on the basis of his personal experience but it is strongly suggested or even imposed by Health Services on the basis of the results of specific trials performed according to the rules of the Evidence Based Medicine. According to this practice patients not responding to or even worsening with the standard treatment (often a significant percentage) are simply labelled as non-responder. Evidence Based Medicine means

the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research. By individual clinical expertise we mean the proficiency and judgment that individual clinicians acquire through clinical experience and clinical practice [...] By best available external clinical evidence we mean clinically relevant research, often from the basic sciences of medicine, but especially from patient centred clinical [...] Without clinical expertise, practice risks becoming tyrannised by evidence, for even excellent external evidence may be inapplicable to or inappropriate for an individual patient.[37].

Clinical researches – even randomized clinical trials – tend to flatten differences between individuals, as they evaluate an average effect of a therapy on a selected population

Even though Sackett himself noticed that the risk of EBM was to be a “cookbook” medicine, and obviously rejected it, in many instances it is. Our

*Targeted knowledge. Interaction and rich user experience
towards a scholarly communication that “lets”*

logic is opposite: one cannot rely on statistical data referring to a “normal” patient, because, who is the “normal” patient?

Patients - as individuals, in their unique evolution - cannot be described by a simple label like “diabetes” or “hypertension” but by a set of links to aging, sex, diet, life style, obesity and by their former history. Every patient is a question mark in the spatio-temporal network of life on Earth (Fig.1).

To localize properly every patient we need a much deeper insight into mechanisms involved at different levels: molecular, cellular, hormonal, environmental and social. Most of this information is freely accessible on the Web (journal articles, systematic reviews, raw data, genetic sequences, institutional sites...), but often difficult to reach unless you are an expert of the field. A step by step guided access to these Web resources is one of the major tasks of our application.

The paths leading from the patient observation to the identification of the mechanisms involved have been preliminary built according to the vision of a complex system of objects and interaction, where you can think to “rules” as the behaviours - inherent to the system itself – adapting and at the same time creating the environment [38].

In such a scenario, information can be selected on the basis of its congruence with the proposed model/rules. The higher the number of information, doesn't matter how “scientific” they are, that fit the model the higher its reliability. Non fitting information has to be deeply analyzed for their real information content. Bias like advertising, personal interests, strong selection of the cases involved in trials or cohort studies lead to rejection of data that are otherwise accepted and used to modify the original model/rules.

In this perspective, information and rules interact and adapt, bringing to a thorough and dynamic knowledge of the patient, the symptom, the disease and their relationship. In the traditional scholarly communication system, governed by the concept of “scientific official truth” as stated by the experts, the reverse is true: the patient, the symptom, the disease have to be forced in a predefined, rigid schema in which everything must find a standardised collocation.

Techniques typical of Web 2.0 are proper tools to test this different approach to the knowledge. On the basis of our specific field of interest - the identification of the molecular bases of the diseases - we developed a web application that allows easy access, recording and modification of the required information.

«The Pinball Machine and the Cloud» is structured in **Rules, Reports, Items, Pathways** and **Tools** referring and linking one another. The use of tags and/or controlled PubMed MeSH terms to categorize allows and fosters a free

and personal use of information to create original knowledge. Users can follow and open innovative paths each time answering a different question, re-combining the existing information.

This is the richness added by the users: exploring a tag and its related material can lead to an unexpected point of view on the same symptom, or can change one's perspective on a disease. Change of view also means new targets.

The most striking feature of our site are the **Rules**, where the ontology of the living organisms in health and disease is accurately described. Medical textbooks usually analytically describe specific symptoms, treatments, surgery by organs or class of diseases. But a robust definition of the disease itself is lacking, although it could help a lot in understanding borderline symptoms, involving more organs and so on. Anytime complexity arises in the reality description. «Think Globally, Act Locally» is more and more true.

The main property of the **Rules** is that they are revisable: they are defined in a way they can be tested and eventually falsified so to be always valid in the context, according to Popper. At the very beginning they can be established by experts, but they will survive only unless not demonstrated false by users. The evolution of the rules is very similar to the biological evolution of molecules or whole organisms. Only the fittest to the environment survives; but if the environment changes also the pattern of survivors changes. As the pattern of information available change, also rules and methods of data mining have to change. Only the rules tested everyday are good rules and only if they are modified whenever they fail.

According to the same perspective – and to another Web 2.0 suggestion, «trust your users» - the concept of “reliable information” itself changes. Not the whole available information has to be validated, just the criteria to accept or reject them have to, depending on the target: information about adverse effects of a drug might be otherwise assessed by a patient association or a pharmaceutical company.

The underpinned logic is: different queries have different matching information sources. No expert can tell “which” source, the only valid criterion being the user's need and target. Web cataloguing and sites classification projects may help and avoid waste of time, but ultimately any target may require a specific pattern of search strategies to retrieve the information useful in a specific ontology.

The reality is represented by **Reports**, descriptions of clinical cases whose fate can be changed by a correct interpretation of symptoms, allowing a validation of the method. Each user edits with a simplified Wiki writing language its own Report and links it with the fitting involved **Item** or

*Targeted knowledge. Interaction and rich user experience
towards a scholarly communication that "lets"*

Pathway, and then can tag it or associate it to a MeSH term. That creates a tag cloud which allows unprecedented links and a critical reuse of the content. In the Web 2.0, a controlled vocabulary as MeSH is no longer a required assumption: folksonomies works as well, and mappings are possible [39].

Comments - both by learners and professor - shape a multi-sided scholarly communication, far away from the traditional one-way descending pattern, both in vertical – teacher/learner - and peer to peer – learner/learner. That also allows a shared control of the quality, as the content – edited by a registered user, responsible of his/her contribution - can be revised and commented by each user, in the same winning logic of Wikipedia, in a sort of open, diffuse peer-review (where we intend "peers" as P2P in the Net and not as subject experts).

In **Items** and **Pathways** the user generated content – dealing with diseases, drugs, proteins, metabolic paths ...– consists of texts, images, links to scientific literature, links to biomedical websites, in a creative and critical approach as learned during classes. Tag clouds also apply to the most linked and handled Web sites, generating a sort of shared validation. The easiness and readiness both in submitting and in searching and retrieving the content creates such a participative environment that the user experience really results enriched.

The information, or better, an interpreted gateway to the information is collected in **Tools**, **Items** and **Pathways**, where the link to the contents is categorized with an indexing visually very similar to classical textbooks, but structurally based on a relational database and easily modifiable if needed. The database is also searchable via Google independently from the type of indexing. Indexing itself carries a lot of information as different branches of learning usually aggregate differently the same set of contents.

On this line, in our application the Web 2.0 logic - the user is no longer simply a content consumer but a content creator - goes further and encompasses some of the Library 2.0 concepts, first of all the idea of meeting users' need when, where, and how they need it. Useful tips to improve the users' ability to search and retrieve pertinent information according to their query are presented among the Tools, such as a link to a biomedical gateway offers selected points of access to the Web. A skilled user will be able not only to retrieve what she/he needs, but also to select among the "information deluge" what actually matches his/her question. Moreover, services are seamlessly embedded in the context: a dynamic PubMed search is provided for each object, to keep up to date on the subject of interest.

3. Results

«The Pinball Machine and the Cloud», in its two years use as a learning tool (and more than 2000 pages published) in the course of Clinical Biochemistry at the University of Turin, demonstrates also its potential as a knowledge management implementation, functional to the systematic approach to medicine as discussed in the Methodology above.

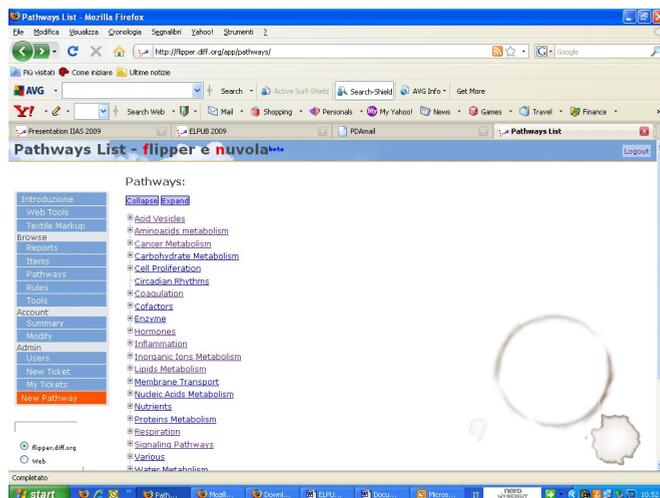


Figure 3: A snapshot of «The Pinball Machine and the Cloud»

A **symptom** (from [Greek](#) *σύμπτωμα*, "accident, misfortune, that which befalls", from *συμπίπτω*, "I befall", from *συν-* "together, with" + *πίπτω*, "I fall") is a departure from normal function or feeling which is noticed by a patient, indicating the presence of disease or abnormality. Physicians are expected to relieve symptoms as soon as possible. Medicine has a long story, thousands of years, and earlier physicians had no knowledge at all of chemistry, biochemistry, molecular biology, pollution etc. They only had symptoms and drugs, to counteract the effect of the disease.

The modern physician knows DNA, RNA, ATP, metabolism and in principle he should be able to understand why the patient suffers. But the old praxis **symptom** → **drug** (Fig. 1) is still the backbone of clinical practice. Drugs are usually very effective against the symptom, don't require additional tests for the patient and their administration don't require additional efforts from the doctor. The **old paradigm** is still the winner.

*Targeted knowledge. Interaction and rich user experience
towards a scholarly communication that "lets"*

But a symptom is also a **sign** [40] of something doesn't work properly in my system: the disease (the question mark in Fig. 2) may depend on either a defect in the patient either a dangerous change in the environment or both.

Today we may measure many parameters of both the patient and the environment and we can match the data with published pathways of most relevant metabolisms. The environment may be polluted by exhaust gas, pollens; the atmospheric pressure and humidity can change. The patient can be evaluated for either his/her genetic background or his/her metabolic status. And we can access all other information on the Web.

The new paradigm: we have to know the causes of the symptom before we treat it.

A simple example - better than a theoretical explanation - will illustrate how this approach works. In the following text the underlined words correspond in the «The Pinball Machine and the Cloud» to a link to an object – **Item, Pathway...** - where the topic is described according to the **Rules**.

The joints pain is one of the most frequent symptoms in people over 65.

The standard therapy is based on aspirin, NSAIDS and COX-2 inhibitors and it is associated with gastric discomfort requiring additional drugs (omeprazole derivative mostly) to protect gastric mucosa. Unfortunately every drug, as a function of its action mechanism, has more or less important side effects.

- **Omeprazole** inhibits the K⁺/H⁺ Exchanger responsible for acidity of gastric juice in gastric cells, but also a V-ATPase responsible for acidification of lysosomes.
 - **Gastric juice** acidity is required for Iron absorption
 - Lysosome acidity is required for
 - Macrophages killing of bacteria
 - Brain neurons regeneration by autophagy
 - Serum proteins digestion by every cells

On the basis of the literature the cost for the long range gastric protection includes a higher frequency of pneumonia and other infections, neuronal degeneration, hearth and skeletal muscle weakness and so on (everything fully predictable on the basis of previous information).

Upon the basis of this information, may be we are convinced it is worthwhile to understand why we have pain before starting with therapy.

Pain depends on the nerve ability to pump out of the nerve Sodium and Calcium, an energy consuming process that requires fast ATP synthesis.

ATP synthesis requires oxygen and glucose as substrate, cytochrome C, Coenzyme Q, NAD as components of cellular respiration. If any of these elements is lacking or scarce the ATP synthesis will decrease.

Oxygen supply will depend on:

- pO₂ in the air, lower in:
 - high altitude,
 - low atmospheric pressure,
 - high humidity,
- asthma
 - pollens
 - iron deficiency
 - calcium deficiency
 - Active Vitamin D deficiency
 - iron deficiency
- chronic bronchitis,
- sleep
- anemia
 - excessive blood losses
 - lack of
 - iron
 - Vitamin b12
 - FolicAcid

Glucose availability in blood:

- Carbohydrates intake
- Excess serum Insulin leading to prolonged hypoglycaemia
 - Genetic defects of pancreatic beta cells
 - Insulin injection in type I diabetes

Components of cellular respiration:

- **cytochrome C**
 - Iron
 - Serum Albumin
 - Thyroid Hormon
- **Coenzyme Q**
 - Thyroid Hormon
 - Statins lower to the same extent cholesterol and Coenzyme Q synthesis
- **NAD**
 - Can be introduced as a vitamin of group B
 - Vitamins B deficiency after oral administration of antibiotics

*Targeted knowledge. Interaction and rich user experience
towards a scholarly communication that “lets”*

- May be synthesized from tryptophan (Trp)
- High Trp : pork meat, legumes, milk
- Low Trp: beef meat, yoghurt
- It is reduced by activation of indoleamine dioxygenase (IDO) during infections

The written description (even if not exhaustive at all) looks cumbersome but on «The Pinball Machine and the Cloud» is easy to manage, being each of the underlined word an **Item** – e.g. “Iron” – or a **Pathway** – e.g. “Hormones” –, i.e. independent objects connectable by tags and linkable one another. Iron deficiency, for instance, is reported more than once creating a bidirectional connection between pathways apparently distant. So, the «Pinball» logic, with its network of links, is functional to a global view of the causes involved in a symptom of a specific patient: a different patient with different symptoms and a different personal history would have depicted a different schema of links.

In conclusion, joint pain may depend on many factors whose relative role may vary from patient to patient. When one single factor is involved is usually easy to identify it: when lung gas exchange is reduced to less than 60% pain is almost continuous and patient cannot lay in the bed and sleep. But when gas exchange is around 80%, pain may require also a mild anemia or a deep sleep (usually between 2 and 3 am). Alternatively pain may appear when climbing up to 1500 m on sea level and will disappear during holidays at seaside.

Other combinations are possible as well. A mild hypothyroidism (more than 40% of the women after menopause) will reduce the Cytochrome C and Coenzyme Q synthesis and hence ATP synthesis. A simple cold affecting air flow through the nose can be sufficient to trigger joint pain in this situation.

And why usually the pain is localized to the joints? Because joints are very rich in sensitive nerves able to detect any small position change to properly control the body position and movement. High sensitivity means high sodium and calcium influx, high ATP consumption, high metabolic rate. Any small metabolic impairment will affect the joints nerves earlier than any other nerves.

In this case the hidden rule was that all cells require ATP synthesis for their functioning. If we list the body cells according to their ATP needs in descending order we could get:

1. Joints nerves
2. Acoustic nerve
3. Brain cells performing cognitive functions

4. Thyroid
5. Skeletal Muscle

That would correspond to the appearance of the following symptoms when ATP synthesis is impaired

1. Joint pain
2. Tinnitus and Deafness
3. Cognitive Impairment
4. Hypothyroidism
5. Fatigue

Joint pain and deafness are treated by completely different specialist (never speaking each other) but share exactly the same causes when analyzed as a part of a system.

This was just an example out of tenths of how is possible, including all the instances of a symptom into a global discussion, to find out most of its possible causes and in some cases also their relative relevance.

4. Discussion

In the last two years about 2000 records were created in «The Pinball Machine and the Cloud». Most of these **Items, Pathways, Reports**, with the exception of the **Rules**, have been created by an interactive work of the students with the professor, where “interaction” stands for a real participation of the user/student in the choice of the relevant information, the creation of the content and the set of linking and relations with other records, the further adjustments according to the comments of the professor and/or other users.

The most prominent feature of this approach is the creation of a discrete type of knowledge in which every object described in the **Items, Pathways, Reports** (a disease, an enzyme, a drug...) have to be described only once and then linked to all the other pertinent objects. Upgrading the information about an object will automatically upgrade also the information content of the connected object.

The experience has shown that the identification of the object borders is the critical factor. Foreseeing what will happen in an obese or lean child during a Varicella Zoster Virus infection is only possible if I know the viral strategy to survive into the host (essential nutrients requirement), the metabolic features of the obese or lean, corrected for the age (availability of the nutrients essential for the virus). Nevertheless the student tends to describe the lean boy with the VZV (Patient 1) and the obese boy with the

*Targeted knowledge. Interaction and rich user experience
towards a scholarly communication that “lets”*

VZV (Patient 2) as 2 independent objects. According to our model we need more objects (6): boy, obese, lean, VZV, Patient 1, Patient2. Patient 1 description is linked to boy, lean, VZV and his history checked with the information in the linked records. If the information is sufficient to explain the clinical history we don't need to upgrade it, otherwise we have to search for additional information to record.

Apparently the system is complicated, but with large numbers it allows the automatic creation of few classes of objects with the same pattern of connections and increase the manageability of large collections of data.

Moreover, the continuous upgrading of the information content of the system may increase its efficiency without affecting its usability as the new information will be connected to the new object requiring it and in the mean time to its parent object updating it.

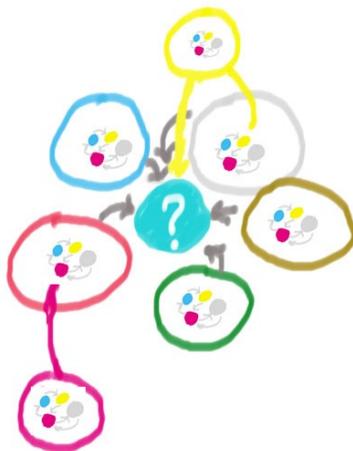


Figure 4: Any new information (yellow circle) incorporated into the system to solve a problem increases the system global knowledge

The Web allows easy access to information, the «The Pinball Machine and the Cloud» allows the network creation, the **Rules** drive the selection of the information and become more and more stable the more they evolutionary adapt to the reality. Something like the DNA, carrying sequences millions years old in an ever changing world.

5. Conclusions

Information versus knowledge was our starting point. Information is growing fast, knowledge in some case even decreases. Validation of information relies on its capability to improve users' performances. Only a previous definition of a testable target can allow validation.

In the Web 2.0 age a passive scholarly communication which merely transfers information should shift towards a deeper interaction, along with the idea of an academic teaching that "lets". The premise is a dynamic and not dogmatic concept of a knowledge evolving and modifying as the rules or the first hypotheses change. The main actor is a critical user – researcher, student or professor - who finds her/his path according to the target. Learn to know what you want is the first step to get it.

In our application we have applied these concepts to the patient analysis, as an instance of advanced Problem Solving: the patient as a whole, not as a single symptom, has to be understood as a part of a living world (Gaia) whose components (Items, Pathways) are described in their multiple roles and connections, upgraded anytime additional information is required to solve the problem.

As a matter of fact the Problem Solving of any complex system with similar features (Economics, Sociology, Psychology) can be faced with a similar approach, once provided a sound specific set of Rules defined from the beginning.

Disclaimer

Be aware that all medical information and clinical examples quoted here are intended only for illustration of the method and not for discussion of their medical issues. The author is not responsible of any medical use of the information herein supplied without any specific reference.

Notes and References

The text is the result of a long dialogue in which G.P.Pescarmona - creator of the Web application with F. Zamuner of NonSoloSoft – went into the

*Targeted knowledge. Interaction and rich user experience
towards a scholarly communication that “lets”*

conceptual frame and the medical expertise, while E.Giglia dealt with the information and knowledge management implications.

All web sites last accessed on April 5th 2009.

- [1] WILLBANKS, J. The future of science. Speech, in Open Access and research conference 2008, Brisbane, 24-25 Sept. 2008. Available at <http://www.oaklaw.qut.edu.au/files/Wilbanks.pdf>.
- [2] CLARKE, R. Business models to support content commons. Script-ed, 4 (1), Mar. 2007. Available at <http://www.law.ed.ac.uk/ahrc/script-ed/vol4-1/clarke.asp>.
- [3] SUBER, P. Open access and the last-mile problem for knowledge. SPARC Open Access Newsletter, Jul. 2008. Available at <http://www.earlham.edu/~peters/fos/newsletter/07-02-08.htm>.
- [4] BROWN JS., ADLER RP. Minds on Fire: Open Education, the Long Tail, and Learning 2.0. EDUCAUSE Review, 43 (1), Jan.-Feb. 2008, p. 16–32. Available at <http://tinyurl.com/ckg7us> .
- [5] SHIRKY, C. *Here comes everybody. The power of organizing without organizations*. New York : Penguin, 2008.
- [6] LEWIN, R. *Complexity: life at the edge of chaos*. New York : Macmillan, 1992.
- [7] POPPER K. *The logic of scientific discovery*. London : Hutchinson, 1959.
- [8] IOANNIDIS, JPA. Concentration of the most cited papers in the scientific literature: analysis of journal ecosystems, PLoS ONE, 1 (1), 2006, e:5. Available at <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0000005>.
- [9] YOUNG NS; et al. Why Current Publication Practices May Distort Science. PLoS Medicine 5 (10), 2008, e201. Available at <http://www.plosmedicine.org/article/info%3Adoi%2F10.1371%2Fjournal.pmed.0050201>.
- [10] YOUNG NS; et al. Why Current Publication Practices May Distort Science. PLoS Medicine 5 (10), 2008, e201. Available at

<http://www.plosmedicine.org/article/info%3Adoi%2F10.1371%2Fjournal.pmed.0050201>.

- [11] YOUNG NS; et al. Why Current Publication Practices May Distort Science. PLoS Medicine 5 (10), 2008, e201. Available at <http://www.plosmedicine.org/article/info%3Adoi%2F10.1371%2Fjournal.pmed.0050201>; IOANNIDIS, JPA. Journals should publish all "null" results and should sparingly publish "positive" results. Cancer Epidemiology Biomarkers & Prevention, 15, 2006, p. 186. Available at <http://tinyurl.com/ddnj3a>.
- [12] HESMONDHALGH, D. *Cultural Industries*, London: Sage, 2007.
- [13] WIKIPEDIA. Scott Reuben. Available at http://en.wikipedia.org/wiki/Scott_Reuben.
- [14] SARAMAGO, J. *O homem duplicado*. Lisboa : Caminho, 2003. Cited in IOANNIDIS, JPA. Concentration of the most cited papers in the scientific literature: analysis of journal ecosystems, PLoS ONE, 1 (1), 2006, e:5. Available at <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0000005>.
- [15] RZHETSKY A; et al. Microparadigms: Chains of collective reasoning in publications about molecular interactions. Proceedings National Academies of Sciences USA, 103, 2007, p. 4940–4945. Available at <http://www.pnas.org/content/103/13/4940.full?ck=nck>.
- [16] SIERRA, K. The best thing about Web 2.0. Blog post, Creating passionate users blog, Oct. 11, 2005. Available at <http://tinyurl.com/94rbm>; JENNINGS, D. e-learning 2.0, whatever that is. Blog post, DJ Alchemi, 18 Dec. 2005. Available at http://alchemi.co.uk/archives/ele/elearning_20_wh.html
- [17] O'REILLY T. Web 2.0 meme map. Available at <http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html?page=1>.
- [18] Available respectively at <http://arancia.diff.org/> and <http://flipper.diff.org/app/>. The name is a mix between the pessimism of

*Targeted knowledge. Interaction and rich user experience
towards a scholarly communication that “lets”*

the idea of the Pinball – how free are our choices as a descending ball? –
and the hope of the Cloud, its chaotic behaviour, its lightness.

- [19] DEWEY, J. *How we think. a restatement of the relation of reflective thinking to the educative process* (Rev. ed.), Boston, MA : D. C. Heath, 1933.
- [20] DOWNES, S. E-learning 2.0. E-learn Magazine, 17 Oct 2005. Available at <http://www.elearnmag.org/subpage.cfm?section=articles&article=29-1>;
MULDER, F. Bringing a global movement on Open Educational Resources in a new, European, learner-centered mode. EADTU Conference, Tallinn, Nov. 2006. Available at <http://tinyurl.com/cm0959>.
- [21] ROSEN A. Technology trends: e-learning 2.0. Learning solutions, 9 Oct. 2006. Available at <http://www.readygo.com/e-learning-2.0.pdf>; JISC. Next generation environments: understanding needs, unravelling complexities and applying practices. Papers from the Users and Innovation Programme Conference - JISC, Apr. 2008. Available at <http://www.jisc.ac.uk/publications/publications/nextgenerationconference08proceedings.aspx>; ANDERSON P. What is Web 2.0? Ideas, technologies and implications for education. JISC Technology and Standards Watch, Feb 2007. Available at <http://www.jisc.ac.uk/media/documents/techwatch/tsw0701b.pdf>.
- [22] BROWN JS., ADLER RP. Minds on Fire: Open Education, the Long Tail, and Learning 2.0. EDUCAUSE Review, 43 (1), Jan.-Feb. 2008, p. 16–32. Available at <http://tinyurl.com/ckg7us>.
- [23] MIT Open Course Ware. Available at <http://ocw.mit.edu/OcwWeb/web/home/home/index.htm>; OER. Open Educational Resources. Available at <http://www.oercommons.org/>.
- [24] ROBB, P; et al. Collaborative e-learning in the Life Sciences (CeLLS project). JISC Report, Oct. 2007. Available at <http://www.jisc.ac.uk/publications/publications/sfcbookletcells.aspx>.
- [25] Available at <http://www.flatworldknowledge.com/>; GRAY E; et al. Opening scholarship: strategies for integrating open access and open education, in CHAN, L, MORNATI S. ed. *ELPUB2008. Open Scholarship: Authority, Community, and Sustainability in the Age of Web 2.0 - Proceedings of the 12th International Conference on Electronic Publishing held*

in Toronto, Canada 25-27 June 2008, p. 435. Available at http://elpub.scix.net/data/works/att/435_elpub2008.content.pdf.

- [26] NUCCI, M; et al. A Semantic Web Powered Distributed Digital Library System, CHAN, L, MORNATI S. ed. *ELPUB2008. Open Scholarship: Authority, Community, and Sustainability in the Age of Web 2.0 - Proceedings of the 12th International Conference on Electronic Publishing held in Toronto, Canada 25-27 June 2008*, p. 130-139. Available at http://elpub.scix.net/data/works/att/130_elpub2008.content.pdf)
- [27] SIEMENS, G. Connectivism: a learning theory for the digital age. Blog post, E-learn space, 12 Dec 2004. Available at <http://www.elearnspace.org/Articles/connectivism.htm>.
- [28] PRENSKY, M. Digital natives, digital immigrants. *On the Horizon*, 9 (5), Oct. 2001, p. Available at <http://tinyurl.com/ypgvf>; MCDONALD, R, THOMAS, C. Disconnects between library culture and millennial generation values. *EDUCAUSE Quarterly*, 29 (4), 2006. Available at <http://tinyurl.com/cu8zo>; LIPPINCOTT, J. Next generation students and libraries, in OBLINGER D; et al. *Educating the next generation*, EDUCAUSE e-book, 2005, e:13.1-13.15. Available at <http://www.educause.edu/NetGenerationStudentsandLibraries/6067>.
- [29] DALSGAARD, C. Social software: e-learning beyond learning management systems. *European Journal of Open, Distance and E-learning*, 12 Jul 2006. Available at http://www.eurodl.org/materials/contrib/2006/Christian_Dalsgaard.htm
- [30] LEVINE, A. The word is out. Small technologies loosely joined – NMC 2004. Blog post, Cogdogblog, 2 Jun 2004. Available at <http://cogdogblog.com/2004/06/02/the-word/>.
- [31] The original phrase "Think Global, Act Local" first appears in the book *The Evolution of Cities* (1915) by Scots Planner and social activist Patrick Geddes; http://en.wikipedia.org/wiki/Think_Globally,_Act_Locally.
- [32] LOVELOCK, JE, MARGULIS, L. Atmospheric homeostasis by and for the biosphere- The Gaia hypothesis. *Tellus*, 26 (1), 1974, p. 2-10.

*Targeted knowledge. Interaction and rich user experience
towards a scholarly communication that “lets”*

- [33] PESCARMONA GP. The life context: cells, nutrients and signals, in CONDAT CA., BARUZZI A. *Recent Research Development in Biophysical Chemistry*. Trivandrum : Research Signpost, 2002, p. 69-90. Available at http://flipper.diff.org/static/files/1517/The_life_context_2002.pdf.
- [34] Reactome - a curated knowledgebase of biological pathways. Available at <http://www.genomeknowledge.org/>; Nature Pathway Interaction Database. Available at http://pid.nci.nih.gov/browse_pathways.shtml#NCI-Nature.
- [35] PELEG, M; et al. Using Petri Net Tools to Study Properties and Dynamics of Biological Systems. *Journal of the American Medical Informatics Association*, 12 (2), Mar-Apr.2005, p. 181-199. Available at <http://mis.hevra.haifa.ac.il/~morpeleg/pubs/PetriNetJAMIA.pdf>.
- [36] SCALERANDI M; et al. Local interaction simulation approach for the response of the vascular system to metabolic changes of cell behaviour, *Phys Rev E Stat Phys Plasmas Fluids Relat Interdiscip Topics*, 63:11901-11910, 2001.
- [37] SACKETT, DL. Evidence based medicine: what it is and what it isn't. *British Medical Journal*, 312, 13 Jan 1996, p.71-72. Available at <http://www.bmj.com/cgi/content/full/312/7023/71>.
- [38] PESCARMONA GP, et al. The Pinball Machine and the Cloud: Using Rules to move from Information to Knowledge, Third Italian IA Summit, Forlì, 20-21 Feb. 2009. Available at http://flipper.diff.org/static/files/1647/Pescarmona_IAS_2009_pdf.pdf; and PESCARMONA, GP [33].
- [39] WARTENA C, BRUSSEE, R. Instanced based mapping between Thesauri and folksonomies, *Lecture notes in computer science*, 5318 (2008), p. 356-370.
- [40] Available at <http://flipper.diff.org/app/rules/info/72>.