FROM “TOOLS TO TELL” TO “TOOLS TO TEST”[1]

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Abstract:

The emphasis in this paper will be on the illustration and explanation of the concepts and terminology defining the research framework within which the research programme was developed. Having crossed a somehow wide field, which ranges from two extremes which could be identified as “experience” and “experiment”, has prompted us to a reflection on the similarities and distinctions between these two terms and also on the dimensions among which this diversity is expressed.

Research trajectory that started with the construction of a Role-Playing Game (RPG) to support local participatory decision-making about water management, continued with the development of an experimental protocol to test economic hypotheses exhibited by the RPG and developed into the analysis of the influence of context on players’ behaviour. RPG decomposition started from the definition of the concept of “context” that groups several informational dimensions: the game instructions; communication among players; and their involvement. In this presentation, only the two first dimensions are treated. They open perspectives to study the third one and the relations between these three attributes of the game context.

Key words :

Role-Playing Games, Water management, Experimental Economics, Context

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1. INTRODUCTION

During the last decades, participatory or bargaining approaches emerged in resources management legislation. To develop these approaches, resource managers have to take into account the diversity of viewpoints in a population for building a shared problem representation, which could be difficult to reach. Decision-making tools are made to support these participatory processes and role playing games (RPG) are used to exhibit stakeholders objectives and constraints. It is difficult to assess RPG results, because the complexity of the field where they are conducted is reproduced in the protocol, and then they are not repeatable in an experimental way.

This lack of repeatability for a RPG is the beginning of this study, which finally aims at understanding whether (and how) RPG could be a generic approach (i.e. a same tool for different field applications) and how RPG could be used complementarily with other decision-making tools.

Research trajectory that started with the construction of a Role-Playing Game (RPG) to support local participatory decision-making about water management, continued with the development of an experimental protocol to test economic hypotheses exhibited by the RPG and developed into the analysis of the influence of context on players' behaviour.

Having crossed a somehow wide field, which ranges from two extremes which could be identified as "experience" and "experiment", has prompted us to a reflection on the similarities and distinctions between these two terms and also on the dimensions among which this diversity is expressed.

We believe that there is scope for some clarification, which is needed at least for two reasons:

- on one side, there are a lot of works and different viewpoints about the so-called "participatory approach", so that some cleaning would be welcome;
- even more important, the terminology usually used in these works is not consistent across different disciplines. This fact emerged strikingly, for instance, during the meeting "Experimental Design for Resources Management Instruments" (Montpellier, 2008). Clearly, on issues like water management, which naturally involve the contribution of various disciplines, it is important to achieve a preliminary clarification on the different meanings that the same term displays.

The emphasis in this paper will be on the illustration and explanation of the concepts and terminology defining the research framework within which our programme was developed, aiming at giving al least partial answers to the questions raised above. RPG decomposition started from the definition of the concept of "context" that groups several informational dimensions: the game instructions; communication among players; involvement. In this presentation, only the two first dimensions are treated.

The text is organized as follows. *Section 2* illustrates and discusses the research framework, main terms and concepts. The research trajectory is described in *Section 3. Section 4* concludes and provides the way forward of this research program.

2. CONCEPTUAL FRAMEWORK

Claude Bernard (1865) distinguishes two kinds of sciences: observational and experimental ones. Observations and experiments are both investigations and reasoning made by scientists in order to improve scientific knowledge. According to Bernard, the main difference is that observations are comparisons made among natural phenomena while experiments are comparisons made on modified phenomena. Experimental facts are provoked by the experimenter who builds a protocol, by following preconceived ideas about expected results. Experimenters create this protocol in order to test theoretical hypotheses. He replicates it in order to gather data and, at the end of the experimental process, to compare the results.

Bernard however moderates this separation among observation and experimentation. At the end of the process, experimental results are observed by the scientist. Then Bernard specifies that experiments are not strictly different with observations: experiments could be considered as provoked observations. Therefore, observations could be seen as the central point in any scientific study, whatever the origin of the observed fact: natural or experimentally provoked.

Bernard presentes what he considered to be the reasoning of a complete scientist:

1) the scientist observes a fact
2) according to this fact, an idea arises
3) about this idea, the scientist reasons, builds an experiment, imagines and realizes the protocol
4) from this experiment, new phenomena appear that the scientist has to observe, and so forth

The following figure represents Bernard's experimental reasoning scheme

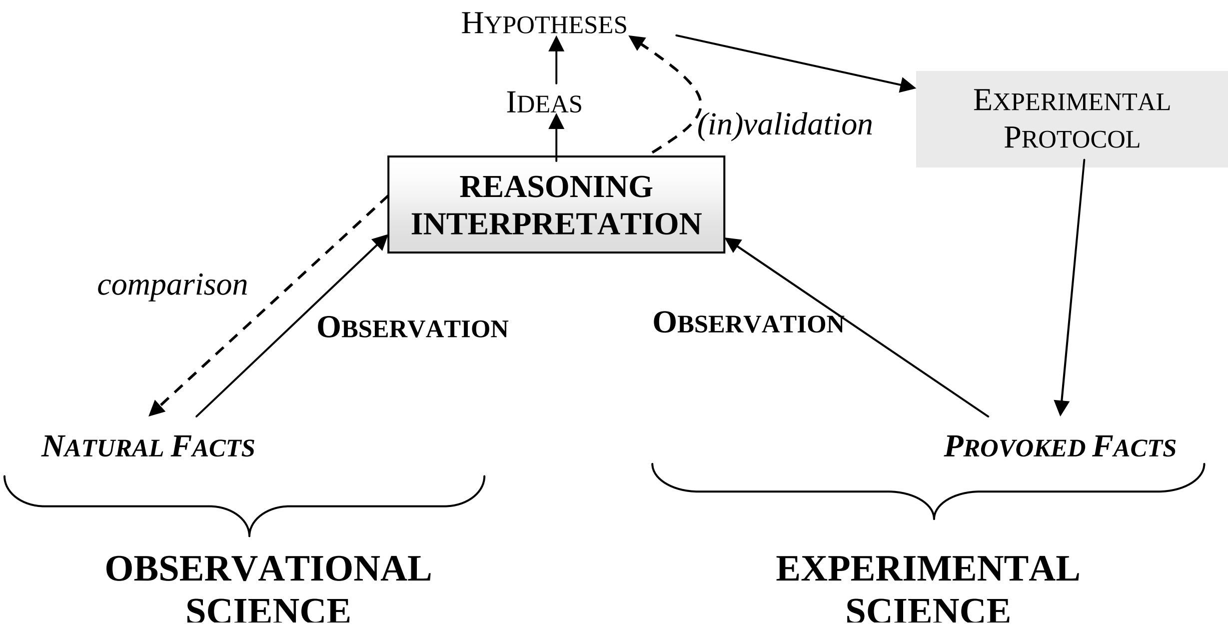

Figure 1 – Claude Bernard's distinction between Observational and Experimental Sciences

Bernard tries to define the terms "observation", "experience" and "experiments" by comparing each other. He distinguishes experiment from experience, which have exactly the same translation in French by the word *"EXPÉRIENCE"*. According to him, *experience* gets the general sense of education acquired by life practicing, giving the word *experiments* (plural term) the sense of provoked facts that provide such education and knowledge. Bernard also distinguishes experience from observation. *Observation* is the basis for "mind which reasons", while *experience* is the basis for "mind which concludes" at the end of the reasoning process initiated by observations. Therefore, *experience* could be obtained without doing *experiment*, particularly when experience is acquired after observing natural facts, as well as *experiment* could be conducted without improving *experience* when there is only observation of the results without comparison among observations and (in)validation of hypotheses.

This specification proposed by Claude Bernard underlies the distinction we propose, made among experiments, experience and real life. We attempt to define the frontier between the three situations. It seems important to clarify the concepts and terms that back our research trajectory: what are the research questions driving our steps? What is the significance of an *experience*? In what an *experiment* differs from an *experience*? Why do we need to create an experimental environment?

This section attempts to provide elements of clarification to the above questions and sets up a research framework within which our trajectory will then be positioned.

We all make *experiences* in every day life. From experiences we learn how to behave through a "learning by doing" process. We learn, then we improve our knowledge, i.e. our *experience*. *Experiences* are therefore all kind of particular situations that we daily face and who participate to our *experience* improvement. The simple reproduction of a phenomenon can be considered as an (artificial) *experience*, as conditions are created ad hoc in order to allow perception and observation of the “fact” (or the phenomenon) at least once. The observed phenomenon can also be measured through quantitative or qualitative analyses. Here is the frontier between *real life* and *experience* that Bernard has stressed: **artificiality**.

A further and crucial step towards the formalization of knowledge was made through the capacity of replicating the same experience in a reasonably controlled environment. In any sciences, an *experiment* has three principles:

1) It consists of setting-up a controlled environment in order to reproduce artificially theoretical conditions and parameters,
2) It insures that the study can be replicated afterwards.
3) It insures that the study can be repeated anywhere.

These three principles are consistent with the goal of experiments, which are an attempt to reach verity, i.e. an attempt to understand and to know the laws underlying the phenomenon considered by the experimenter.

These two characteristics (replication and control) represent the discriminatory criteria that transform an *experience* into an *experiment*. Even if they both participate in *experience* improvement, *experiments* are built in order to test hypotheses while *experiences* (natural or artificial uncontrolled situations) cannot be used to achieve this objective. Then, the “learning by testing” (i.e. experimental) process differs from the “learning by doing” (i.e. empirical) process by their methodology and objectives. While in *experience* the observer observes the “object”, i.e. the phenomenon, in *experiment* the experimenter observes the “observed object”, i.e. the object manipulated for the purpose of invalidating hypotheses.

The possibility to control (as much as possible) in a laboratory the variables used to describe a phenomenon is essential to be able to replicate this phenomenon ad libitum and to always reach the same result We might therefore suggest that the real criterion of distinction between an *experience* and an *experiment* is **control**, as whether this is possible, replication comes as a consequence. In other terms, an experience can be reproduced, but not necessarily maintaining constant (or modified in a controlled way) its parameters. Therefore its outcomes cannot be compared one another.

Summarising (Figure 2), we are not interested here in natural facts, but only in those that, after real life observations, are artificially reproduced, through the creation of artefacts or situations. Provoked conditions in social sciences are made through using table games, cards, or drama involving participants. These artificial environments allow people (those participating for instance in a game) to represent for themselves what happens, to interact each other and to measure the outcomes.

Participants go therefore through a “learning by doing” process and improve their knowledge on the reproduced phenomenon. The difference between a “real life” (natural) situation and an artificial one consists in the fact that the latter was intentionally provoked through the construction of an artificial environment and that, for this reason, can be performed at any time, anywhere and with any participant. In social science, such an *experience* is usually a **“tool to tell”**, as its objective is to facilitate knowledge dissemination and people’s interactions. An *experience* can also be reproduced, but with no total control on the parameters backing the representation of the phenomenon at stake. When control is possible, then we cross the boundaries between an “artificial *experience*” and an *experiment*. *Experiments* are **“tool to test”** as they usually are constructed to test scientific hypotheses in a controlled environment and, through the replication of the same protocol, to verify statistically the robustness of results.

The nature of data and information required to construct an artificial *experience* is substantially different from the one required for an *experiment*. As experiences are tools to tell, they tend to put participants into realistic situations as much as possible, by reproducing the environment by providing information (i.e. building the context). Through these experiences, participants would be facing the phenomenon at stake in their real life. Conversely, an experiment is a tool to test hypotheses and therefore the quantity of information (i.e. the level of context) required for its construction is very specific and related to the variables to control.

This information (i.e. the context) must be very precise and accurate on the aspects to be controlled and tested, but in order to reduce the elements of "noise", it should be reduced to the minimum necessary to conduct the experiment.

The following scheme (figure 2) represents the framework of the different concepts presented above.

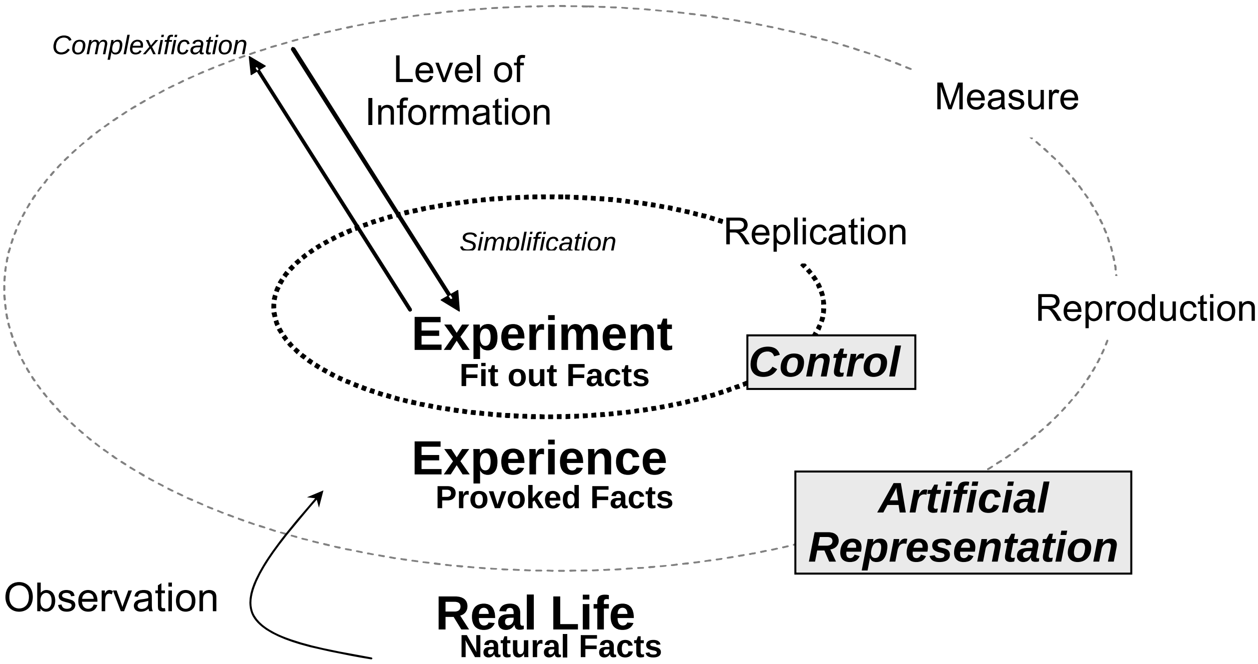

Figure 2 – Real life, Experience and Experiment domains according to the criteria of observation, artificiality, control, and level of information

Once the framework is defined, the different tools used by scientists from many disciplines that are involved in participatory approaches can be located along the frontiers. In participatory approaches, scientists could use tools like games, simulations or experiments. Each one has particular features, with advantages or limits according to the objective to be reached. Despite of this segregation among these three tools, experiments are however possible in gaming context when games are designed for a training purpose. Games could be conducted in an educational objective, and then are tools which follow strict rules and have definite objectives (cf. serious games, Michel 2009, Szilas and Sutter-Widmer 2009). In participatory games, which have an exploratory goal, the range of actions is wide for players who are free in their decisions. Therefore, it is more difficult to generalize the results obtained in this kind of games. The question is therefore: is it possible, in such a game, to define elements of control of the game.

3. RESEARCH TRAJECTORY

Our research trajectory follows the "centripetal" arrow named "simplification" of the level of information contained in the tool. It first started with the construction of a RPG built to support local participatory decision-making about water management. It continued with the development of an experimental protocol to test economic hypotheses exhibited by the RPG and developed into the analysis of the influence of context on players' behaviour.

3-1) First step in protocol degradation : from KATAWARE to KATGAME

A participatory RPG called **KatAware** (Farolfi and Rowntree, 2007) was developed within a project based on an approach called Companion Modelling (ComMod Group, 2003) to reproduce the functioning of a real catchment, the Kat River (South Africa), and allow local stakeholders (members of a Water User Association, WUA) to play around water management in order to :

- understand the complexity of the system;
- understand the relations between agents;
- understand the impact of different water allocation strategies on the water flows, the profits, employment and domestic users' satisfaction;
- build up a catchment strategy within the WUA.

In some ComMod experiences, like the one in the Kat River, the researcher starts building a first preliminary MAS (Multi-Agent System) model to explicit the theoretical "pre-conceptions" (Farolfi and Rowntree, 2007). The confrontation of this first MAS model with the stakeholders allows revising and re-building it, taking into account the field situation and the stakeholders' questions and remarks. This dynamic process leads to the construction either of a new MAS model derived from the previous one or a totally new one. Stakeholders learn collectively by creating, modifying and observing simulations (ComMod Group, 2003). RPGs are used in ComMod processes in order to facilitate stakeholders' participation and understanding of the MAS models. Local stakeholders take part in the design process of an RPG. Therefore, it is impossible to repeat the same experience with others players in order to gather and analyse data. Rouchier (2006) stresses that the first and most obvious limit of ComMod RPGs is "the lack of accumulation of a knowledge that could be generalized to more than one situation".

During a RPG session many social phenomena may be observed and some can be seen as 'exhibits', consisting in empirical regularities for which, at the time, there are no well-developed theoretical explanations (Sugden, 2005). The two RPG sessions played during the experience in the Kat allowed observing cooperation among the different players in the use of the water available from the dam situated upstream the catchment. This observation suggested an attempt of comparison between the results obtained through one of the two RPG sessions and a Cooperative Game Theory model calibrated on the same data (Dinar et al., 2008). However, since there was no control of parameters in KatAware sessions, comparison between the two approaches (RPG outcomes and Cooperative Game Theory model) was impossible. Repetitions were therefore needed. Consequently, the idea (according to Bernard's terminology) emerged to introduce control by building a "polished", though still contextualized game derived from KatAware, to facilitate additional experiments in order to test cooperative behaviour of agents around water allocation and subsequent payoffs sharing.

The resulting new set-up, based on KatAware and called **KatGame**, aimed at testing the Cooperative Game Theory hypotheses that lie behind these results. The following aspects were particularly targeted in our analysis:

1) Players' rationality (selfishness) and profit maximization;
2) Players' capacity to take advantage of the side payments in coalitions;
3) Players' behaviour in terms of resources (water, land) allocation within a coalition;
4) Players' choice to stay in partial coalitions or in a grand coalition;
5) Allocation of coalition's payoffs and comparison with the theoretical reference (e.g. the Shapley value[2]).

(a) KatGame features

In KatGame, many contextual features are derived from KatAware. Water is used for irrigation, domestic uses and ecological purposes. The subjects play the role of farmers. They have to make decisions implying the allocation of commonly owned water and the choice of cultivated areas. Payoffs are expressed in South-African Rands (ZAR).

The game simulates a water resource management situation. Water is stored in a dam. Unlike KatAware, where 7 different roles were played, with farmers and village managers, KatGame involves only three farmers. This simplification is a first step in the degradation process. Degradation is a word used by modelists and we own it. In our case, "degradation" means simplification and "de-contextualization" of the initial (and very complex) Role Playing Game, i.e. a proposition of a "coarser" or "poorer" representation of the experienced RPG situation, by identifying the main RPG features as a "core" of the game and by accepting to move away from the reality.

[2] Shapley value is built upon the following hypotheses: efficiency, individual and group rationality and for each player, Shapley value is equal to the mean of his marginal contributions to all the coalitions in which he takes part (Parrachino et al 2006).

The cooperative structure with 3 players, as proposed in the KatAware model, remains. The entire hydrological model is removed in order to obtain the lab protocol. The choice of keeping 3 farmers is inherited from the Dinar et al.'s Cooperative Game Theory model, where only three players interact (each one representing one subcatchment: Upper, Middle and Downstream). The three farmers in KatGame are cabbage cultivators (whereas they were either cabbage or citrus cultivator in KatAware). They can require water from the dam to irrigate more area than their initial endowment. The game is a one-shot round, like the Dinar et al's model, meaning that the farmers play only one period, corresponding to one year.

The Cooperative Game Theory model with 3 players requires three coalitional situations: 1) singletons (each player is considered as one individual); 2) partial coalitions (two players group together) and 3) the grand coalition (the 3 players are part of the maximum level of coalition). Within coalitions, side-payments are allowed. The side-payments theory is based on the assumption that "the coalitional utility function is expressed in units of a divisible commodity which stores utility, and which can be transferred without losses to the players" (Parrachino et al., 2006). Payoffs of a coalition can be divided among the members of the coalition in any possible way. As in "transferable-utility games" (Parrachino et al., 2006), it is possible to transfer money (i.e. the divisible commodity) among players in order to reallocate the profit gained through the coalition. This transfer represents the compensation that players of a coalition are ready to pay to one of them when this one accepts to leave to the others his own resource for a better valorisation.

KatGame presents the same framework with the three phases. During the **first phase**, the three farmers play as singletons. They choose the area to cultivate and the corresponding water required without communication with the other farmers. During the **second phase**, two farmers play together in a partial coalition whilst the third farmer still plays alone. The partial coalition is presented to the farmers as an "informal group". The farmers forming the partial coalition choose together the area cultivated by each one and the amount of water they required. At this stage, the two farmers involved in the partial coalition have to anticipate the water consumption of the third farmer (out of the coalition) who would be likely to require its maximum amount of water from the dam. The profit obtained by the partial coalition is common between the two farmers and side-payments[3] are allowed. The second phase is composed of three independent rounds:

Round 1: farmer 3 plays alone whilst farmers 1 and 2 play in a coalition.
Round 2: farmer 2 plays alone whilst farmers 1 and 3 play in a coalition.
Round 3: farmer 1 plays alone whilst farmers 2 and 3 play in a coalition.

Finally, in the **third phase**, the three players play together in a grand coalition. The same cooperative principle as in the second phase with two farmers is generalized to the group including all the farmers. The grand coalition is presented to the players as an "irrigation board", and consequently the farmers in the board manage collectively the water available from the dam.

After having played the three phases, the players receive the results from each phase in terms of profit. On the basis of these results, they choose whether they prefer to be in a coalition or not and, if all the players want to be in the grand coalition, they are required to share the corresponding payoff.

This game was tested in a classroom with students and with researchers in economics[4]. There was no visual separation among players. The room did not get the usual characteristics of an experimental lab which normally allows anonymity among players and control for the experimenter. Moreover, in some sessions, players were grouped into teams. In such a case, each team (composed by two persons)

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[3] The side-payments theory is based on the assumed assumption than "the coalitional utility function is expressed in units of a divisible commodity which stores utility, and which can be transferred without losses to the players". If a coalition can obtain a total utility, this utility can be divided among the members of the coalition in any possible way. It is possible to transfer money among the players in order to reallocate the profit gained through the coalition. Such games satisfying these assumptions are called "transferable-utility games" (Parrachino I., Zara S., Patrone F. – 2006 - Cooperative Game Theory and its application to natural, environmental and Water resource issues: 1. Basic Theory, World Bank policy research working paper 4072).

[4] Two test sessions were conducted in Pretoria (South Africa), the first with students (12th of June 2007) and the second with researchers (18th of July 2007). These sessions provided some very important lessons to improve the protocol.

played the role of one farmer. Team building gave the possibility for experimenters to open discussions between players within a same team, in order to observe the negotiation process developed when making a decision, and then in order to capture more information about their behaviour.

The following table summarizes the framework of the game.

Common framework of the game			
Phase	**Name**	**Round**	**Description**
1	**SINGLETONS**		Farmers 1, 2 and 3 played alone
2	**PARTIAL COALITIONS**	**1**	Farmers 1 and 2 played together; Farmer 3 played alone
		2	Farmers 1 and 3 played together; Farmer 2 played alone
		3	Farmers 2 and 3 played together; Farmer 1 played alone
3	**GRAND COALITION**		Farmers 1, 2 and 3 played together

Table 1- KatGame framework

(b) General observations and lessons

The Cooperative Game Theory model makes the assumption of players rationality, who are profit takers[5]. By comparing the results of the test session with the theoretical results obtained through the model, it can be observed that in some versions of KatGame, unlike in the theoretical model, the result is not super-additive[6]. Complexity of the water allocation rules could explain why players did not play "rationally", as expected in the Cooperative Game Theory model. This point is central for the next step, when running experiments in a lab.

The protocol was not completely definite to be conducted in an experimental environment. Some context aspects remain to be simplified. Firstly, the duration and the high complexity level of the game does not allow many repetitions during one session, being a strong barrier decreasing data gathering possibility. Secondly, the experimenter has a strong role in the design of water allocation rules, while in experimental environment experimenter has to be as neutral as possible. As water allocation rules depend on the experimenter intervention in KatGame, comparisons among sessions are impossible. Thirdly, coalition formation impacts on the payoff structure (that could be "non super-additive", as stated above). Each group of 3 players can obtain different outcomes, and then the results can not be compared "ceteris paribus" (in that case, payoff structure changes among groups and sessions), being also a constraint in data gathering. These three limits of KatGame inhibit any test of hypotheses, requiring the design of a new tool: KatLab.

3-2) Second step in protocol degradation : from KATGAME to KATLAB

KatGame had still the characteristics of a partially contextualized RPG, and is considered as an experience rather than an experiment. KatGame had several phases to be played (singleton, partial coalition and grand coalition) in order to build the payoff framework. This made replication and **control** difficult and suggested to simplify further the protocol. KatLab was then constructed to be conducted in a laboratory. KatLab corresponds to a second step in the simplification of the level of information. It was built in order to cross the boundary between *experience* and *experiment*, by focusing on the main discriminatory characteristic: **control** of parameters.

KatLab consists of a "one shot" game, where three players are given the results of a super-additive Cooperative Game Theory set-up. They choose 1) whether or not to stay in the grand coalition and 2) if they have chosen to stay within the grand coalition, the distribution among them of the payoff. This

[5] The participants did not receive monetary rewards at the end of the test.

[6] Let N be a finite set of n players in a transferable utility game. Let S and T be subsets of N (S and T are coalitions). Let v be a real-valued function defined over all the subsets of N. In the present experiment, v is the payoff obtained.
A transferable-utility game is super-additive if for all S, T included in N, with $S \cap T = \emptyset$
$v(S \cup T) \geq v(S) + v(T)$

distribution (chosen by the players) is then compared with the theoretical reference provided by the Shapley value.

The initial objective remains, i.e. the test of Cooperative Game Theory hypotheses, with a new question that has arisen after the design of KatGame. The context simplification of KatGame, according to the willingness to control parameters and to import the game from the field to the lab, made central the following questions: what are the main characteristics of the context in any game? Once the main characteristics are identified, what are the influences of each one on players' behaviour? Could the scientist give prominence to a "game core", i.e. a minimalist structure that can not be modified without changing the whole nature of the game?

(a) Context and Information

Experimental economists answer that the minimalist structure of the game has to be as simple as possible, with abstract protocols and instructions, in order to control all the parameters (Binmore 2001, Eber and Willinger 2005). The philosophy could be resumed to the following sentence: the lower the number of parameters involved in the game, the more efficient is the control. Moreover, as experiments are built in order to test hypotheses derived from theory (or from a preconceived idea, using Bernard's terminology), and since theory is universal and described in absolutely abstract terms, then abstract protocols provide the possibility to test hypotheses in "theoretical conditions".

However, Sugden (2005) stressed that from the beginning, experimenters have been criticized for their methodology, and more particularly for the 'artificiality' of the laboratory experiments, unlike field experiments, which are more concrete. Laboratory environments exclude features of the world that are crucial for the workings of real economic institutions. Abstract context of experimental tasks removes cues that, in the field, help people to orient themselves, and the social norms that guide interaction in the field are not adequately reproduced in the laboratory. In spite of the experimental economics methodological requirement, context is then introduced by scientists in protocols. This context introduction is motivated by different objectives (or needs):

- Evaluation of context impact on agents' behaviour.
- Willingness to be closer to the players' reality by introducing context cues.
- Willingness to make the actions at stake in the game more complex, while abstract instructions does not allow "fun" tasks.
- Context gives legitimacy to the game and allows appropriation by the players (when stakeholders) by facing realistic situations.

By introducing context, the experimenter seeks to go toward realism or tries to introduce a kind of control on players understanding and motivation that he loses when tasks are too abstract.

Harrison and List (2004) describe an auction experiment in which agents tend to pay goods they buy at a higher level than expected by auction theory. They speak about "winner's curse". This deviation from theoretical predictions disappears if the experiment is conducted with experienced agents (traders). Harrison and List define the notion of "*context-specific experience*". They conclude that the highlight of the winner's curse phenomenon in student sample (without "auction-specific-experience") has not to be generalized out of this specific situation, because context influences behaviour by itself. Therefore, this result stresses that when studying behaviours, context has not to be totally removed, rather it has to be understood.

Harrison and List (2004) stated a classification of experiments according to the context level introduced in the protocol. They distinguish:

- *Conventional lab experiment that* is the classical experiment used in experimental economics, basic level, in which protocols and instructions are abstract, run in a lab, with students.
- *Artefactual field experiment, which* is a first contextualized level, keeping some *Conventional lab experiment* features: protocol and instructions remain abstract, but are not run in the lab with students. It takes place in the field with local stakeholders.
- *Framed field experiments that* are played in the field, with stakeholders, like an *Artefactual field experiment*, but protocol and instructions are contextualized.
- *Natural field experiment*. Agents are observed in their natural environment without realizing that they are participating to an experiment.

At this point, the question is to define what is the context of a game. We could define the context in terms of information: quantity but also quality of this information, characterized by:

» **information hold** by the agents ("past life", or experience), or *informational storage*,
» **information provided** to the agents in the game instructions, or *informational flow* from the experimenter to the agents,
» **information exchanged** among agents through communication, or *informational sharing*, depending on the media features, and based on the information contained within the instructions.

While experimenters have a full control on information provided by the instructions, they cannot fully manage nor the information hold by the agents neither the one exchanged among them (when communication is allowed). Agents' experience could be interpreted as a prism, which deviates initial information flow sent by the experimenter through the instructions. Each agent has her own prism, and then the same initial information contained within the instructions could provoke different interpretations. By reducing the quantity of information in game instructions, and by controlling its quality, experimenters limit agents' experience interference in the results. Heterogeneity of behaviours derived from different interpretations of a same context is then managed.

Gilboa and Schmeidler (1997) propose a representation of information hold by agents. According to their model, knowledge is a database which stores the history of the whole situations lived in the past. Within his personal database (represented by a matrix), each agent selects the situations (i.e. the vectors) which are similar to the situation the agent is facing. In front of each situation, the agent acts, and each action produces a result. The agent chooses the action which has led to the best result in similar situations lived in the past.

Context introduction in economic protocol can create heterogeneity in players' behaviour if compared with conventional lab experiment results, conducted with abstract protocols (Velez et al. 2009). However, Harrison and List's concept of "context-specific-experience" stresses the existence of some homogeneity of behaviours in front of context cues. By running the game with stakeholders from the same field, who usually face the same situations and have the same perception of simulated situations which reproduce their everyday life, this heterogeneity in behaviour is limited. Information provided by the experimenter is deviated by similar prisms.

The decomposition of the context in a protocol (as a quantity and a quality of information) leads to identify four elementary attributes:

1. The first attribute "**INSTRUCTIONS**" is the level of information ***provided*** by the instructions. The influence of this information (when they are present within the instructions) is usually treated in the literature under the name of "framing effect" (Tversky and Kahnemann 1981, Wang 1996, Eber and Willinger 2005, Kuhberger and Tanner 2010).

2. The second attribute "**COMMUNICATION**" considers the fact that the players can ***exchange*** information about the instructions, using a media (via face-to-face communication around a table, or through computerized exchange), and then the players modify their understanding of the game (Cardenas 2003, Carpenter et al. 2004, Ostrom 2006). This essential attribute in RPG can be strictly controlled in a laboratory. The lower level of information for this attribute is obtained in laboratory, by locating players in boxes, without any possibility neither to see each other nor to speak together. Under this condition, the observation of the outcome obtained at the end of each period is the only way of communication among players (when players are grouped and when the outcome depends on the group members' behaviour).

3. The third attribute "**PERIODICITY**" takes into account periods repetition, which participates to the ***learning*** process (i.e. information acquisition) about the game by the players. By accumulating information on other players' behaviour, one player could modify his own behaviour all along the game repetition (Eber and Willinger 2005). The one-shot game provides the lower level of information through learning process. By repeating identically several times the exactly same periods or by building dynamic games (i.e. situation of the game at period *n* depends on the results obtained during the previous period *n-1*), players can store information and then they can improve their experience.

4. Finally, the fourth attribute "**PLAYERS**" considers the level of information brought by the participants when coming into the game. Players' ***experience*** (i.e. the information hold, or already acquired in "similar" past situations) and involvement conditions the interpretation made by the players about the information provided in the three other contextual attributes. Experience has an impact on behaviour (Selten 1988, Gilboa and Schmeidler 1997, Harrison and List 2004, Eber and Willinger 2005, Brañas Garza 2006).

Each attribute participates to the complexity of the game (cf. figure 3). The experimental methodology allows a control of each attribute in order to assess the influence of each one on agents' behaviour. We make the hypothesis that an experiment can have different levels of contextualization (Wang 1996). The influence of each contextual attribute has to be tested separately, by isolating each one from the others. By considering a game in its minimal level of contextualization, more complexity could be obtained by changing some features of each contextual attribute of the game. Comparison of results from playing the different versions (with different context levels) of Kat Lab is likely to provide elements of response to the research questions.

Game features: level of complexification

Information level: Provided by **INSTRUCTIONS**	*Information level*: exchanged among players **COMMUNICATION**	*Information level*: accumulated along the experiment **PERIODICITY**	*Information level*: experience, players' interpretation **PLAYERS**
Tversky & Kahneman 1981 *Wang 1996*	*Cardenas 2003* *Ostrom 2006*	*Eber & Willinger 2005*	*Gilboa Schmeidler 1997* *Ostrom 2006*

Figure 3 – Decomposition of context on few basic components (attributes)

Each attribute will be tested, keeping constant the 3 others, in order to assess its impact on behaviours. Context in "instructions" is tested first, in constant conditions in term of communication (not allowed), periodicity (15 periods), with students. Secondly, "communication" is tested, keeping constant the context in instructions (abstract), periodicity (15 periods), with students.

(b) KatLab features

The problem treated is based on KatGame context (itself resulting from the degradation of KatAware context). It concerns the allocation among users of a resource that we shall identify (in the more contextualized version of KatLab instructions) as available water stored in a dam. To handle this problem, we take as a reference the results of Cooperative Game Theory with transferable utility, as used from the beginning of the degradation process.

Within the group of 3 players, various situations are possible, as indicated in table 2 below:

Each member of the group remains independent	Player A earns 75 000 ecus Player B earns 100 000 ecus Player C earns 200 000 ecus
The players A and B join together	A-B association earns 175 000 ecus Player C earns 200 000 ecus
The players A and C join together	A-C association earns 275 000 ecus Player B earns 100 000 ecus
The players B and C join together	B-C association earns 350 000 ecus Player A earns 75 000 ecus
The 3 members of the group join together	A-B-C association earns 500 000 ecus

Table 2 – KatLab frameword.

We suppose that the grand coalition is automatically formed (while in KatGame, the players were placed in all coalitional situations). In order to simplify the game, the intermediate situations (i.e. the partial coalitions) are not possible. Then automatically at the beginning of each period, the 3 players play together within the grand coalition. Information related to partial coalitions is given only for mutual knowledge. The instructions ignore the term "coalition" to whom we refer as "association" or "group".

To facilitate the playability of the experiment, various choices for the grand coalition payoff sharing (i.e. the 500 000 ecus) are proposed through cards. At each period, the players have to choose among the 7 following propositions:

	Card 1	Card 2	Card 3	Card 4	Card 5	Card 6	Card 7
Player A	498 000	117 000	1 000	100 000	166 666	1 000	75 000
Player B	1 000	142 000	1 000	150 000	166 666	498 000	100 000
Player C	1 000	241 000	498 000	250 000	166 666	1 000	200 000

Table 3 – The cards proposed to the players.

Cards 1 to 6 are based on different sharing rules for the grand coalition payoff (500 000 ecus):
- according to the Shapley value, in card 4.
- equalitarian (each player receives exactly the same amount), in card 5
- selfish (based on ultimatum game predictions), in cards 1, 3 and 6
- equalitarian sharing of the surplus[7], in card 2

Card 7 does not propose a grand coalition payoff sharing. It is the status quo card, letting the choice to the players to not participate to the grand coalition and then to remain independent. Thus the choice of card 7 is the non-cooperation choice.

All the players play simultaneously every period and take only one decision: each player of the group chooses only one card. If the 3 players choose the same card, they receive the amount indicated on the card. If there is no coordinated answer on the same card, they receive the values obtained as singletons (reminded in card 7).

A session is comprised of 15 identical periods. At the end of each period, the individual choices and the card "solution" which fixes the individual earnings are shown in the screen of the 3 players of the group (but not the results of the other groups), before beginning the next period. The players learn during the successive sessions the preferences of the other players in their group. This can facilitate the research of a coordination on an allocation (i.e. on a card)

Six treatments were built. One session was played by treatment. There are 6 treatments, thus 18 × 6 participants = 108 subjects were mobilized for the experiment. The 18 players who participated to a session were distributed into 6 groups of 3 players (the group composition remained fixed for all the session). We obtain 6 groups of independent data per session (and also per treatment). Players participated only to one session and thus played only one treatment ("between subject" procedure). They were paid in euros (€) at the end of the session according to their performance, which depends on the choices they have made throughout the game.

The participants were chosen in a base of "subjects" supplied by the Experimental Economics Laboratory from Montpellier (L.E.E.M). The students (Bachelor's degree) who are registered in the base came from the different universities of Montpellier. We consider that students' samples are homogeneous (Eber and Willinger 2005) and composed by subjects with same experience about the context we are studying.

The abstract treatment (treatment 0.0) only asks the players to choose among the seven cards the one which is closest to the favourite allocation, for themselves and for their partners within their group of 3 players. For the five other contextualized treatments, the protocol basis is exactly identical. The difference is situated at the level of the instructions, to which additional information is added, firstly within the instructions, at different levels, and secondly by allowing communication.

[7] v(A) + v(B) + v(C) = 375 000 ecus ; v(ABC) = 500 000 ecus ; the surplus of the grand coalition with respect the singletons is S = 500 000 – 375 000 = 125 000 ecus, equally shared among the 3 players, i.e. 41 666 ecus for each one, added to the singleton payoff, that is v(A) + 41 666 = 116 666 ecus rounded to 117 000 ecus for player A, v(B) + 41 666 = 141 666 ecus rounded to 142 000 ecus for player B and v(C) + 41 666 = 241 666 ecus rounded to 241 000 ecus for player C.

		Instructions			
		Abstract	**Water : sentence only**	**Water : farmers**	**« no-Water » : salaries**
Communication	**Without**	Treatment 0.0	Treatment 0.1	Treatment 0.2	Treatment 0.3
	With	Treatment 1.0		Treatment 1.2	

Table 4 – Number correspondence for each treatment

Instructions at treatment 0.1 contain only one additional sentence when compared with instructions at treatment 0.0: "the experiment is articulated around a water management issue".

Instructions at treatment 0.2 have a more important level of contextualization. The explanation of the sentence introduced in treatment 0.1 is provided. Players know that they are farmers who irrigate their superficies. Their environment reminds the KatGame (and KatAware) context, under degraded shape, with presence of a dam and the possibility to form coalitions in order to optimise the stored water uses. The asymmetric roles of players A, B and C are explained by differences of specific production functions for three different types of farmers.

Treatment 0.3 has the same level of contextualization than treatment 0.2, but refers to a firm organization context. Players are described as salaried employees, who have possibility to cooperate in order to optimise their earnings. The asymmetric roles of players A, B and C are explained by efficiency differences related to their “seniority” and experience.

The context gradation between treatments 0.0, 0.1 and 0.2 allows us to measure the impact of water evocation within the instructions (via the “intermediate” treatment 0.1), and to measure the influence on players’ behaviour of the information provided in the instructions (via treatment 0.2). Treatment 0.3 is a comparison session, in order to assess the influence of water evocation on behaviour, by contrast with another context chosen out of renewable resource management references.

(c) KatLab results

KatLab is built to provide elements of response to understand the influence of contextual game attributes on behaviour, focusing on water context impact. Five hypotheses are tested to answer this question.

(H1). Grand Coalition payoff sharing according the Shapley value is the majority choice

(H2). Information addition within instructions induces a “noise” on players’ perception and on their behaviour, which is observable through the results: choices are concentrated on the same card in treatment 0.0 while choices are dispersed on several cards in treatment 0.2

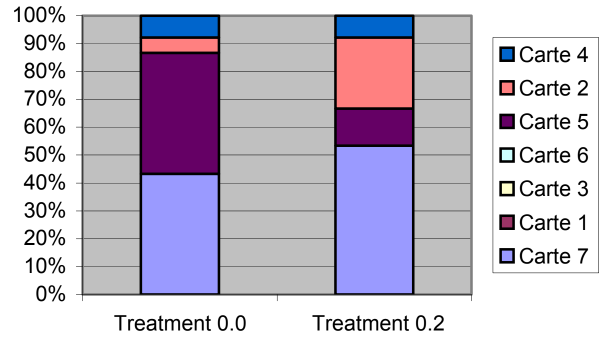
(H3). Water context induces better coordination than other contexts

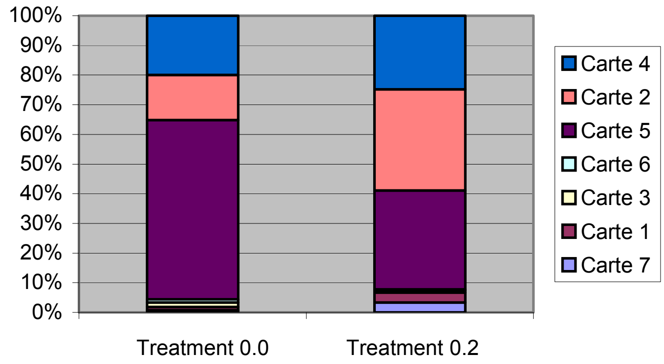
(H4). Communication allows the players a better coordination, and then more cooperation among players

(H5). Communication reduces the “noise” in the results

The evaluation of attributes influence on behaviour needs isolation and variation of each one, keeping constant the others. This section is organized by presenting the sequential attributes variations: 1) instructions effect, with communication at the lower (and controlled) level; 2) communication effect, with instructions at the lower (and controlled) level; 3) instructions effect, with communication attribute at the highest contextual level, and; 4) the evaluation of water evocation by comparison with “no-water” context in instructions.

i. Instructions effect, without communication





Group results (90 observations)							
Card number	*7*	*1*	*3*	*6*	*5*	*2*	*4*
Treatment 0.0	39	0	0	0	39	5	7
Treatment 0.2	48	0	0	0	12	23	7

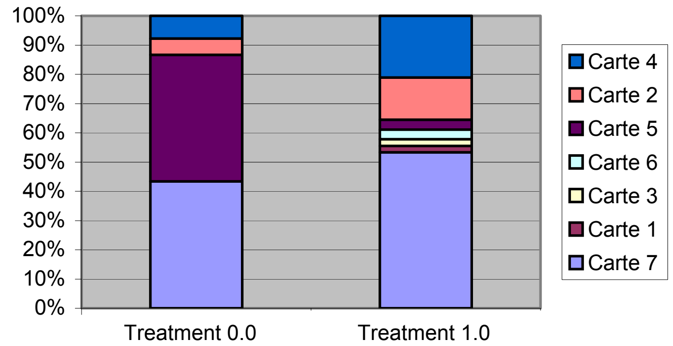
Card 5 appears far fewer at treatment 0.2 if compared with treatment 0.0.

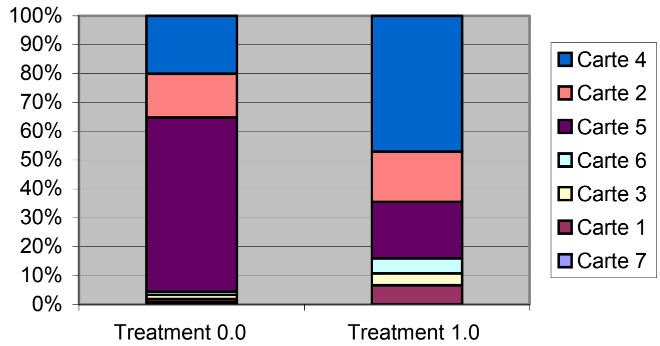
Players' choices (270 observations)							
Card number	*7*	*1*	*3*	*6*	*5*	*2*	*4*
Treatment 0.0	2	3	4	3	163	41	54
Treatment 0.2	9	9	2	1	90	92	67

The majority choice is focused on card 5 at treatment 0.0, invalidating hypothesis H1 which anticipated a majority choice on card 4.

At treatment 0.2, choices on cards 2, 4 and 5 are somehow closed, without significant differences. "Water" context introduction is a noise for the players (students): hypothesis H2 is not invalidated.

ii. Communication effect, with abstract instructions





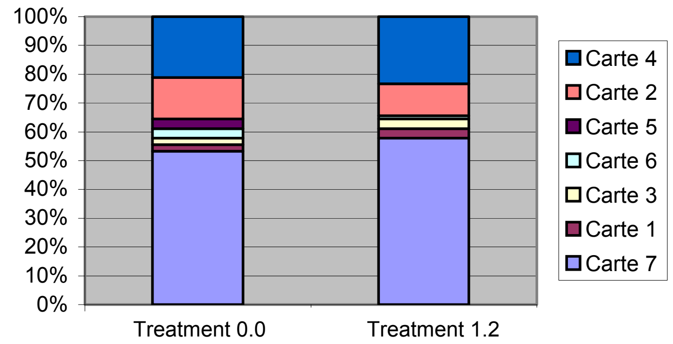
Group results (90 observations)							
Card number	*7*	*1*	*3*	*6*	*5*	*2*	*4*
Treatment 0.0	39	0	0	0	39	5	7
Treatment 1.0	48	2	2	3	3	13	19

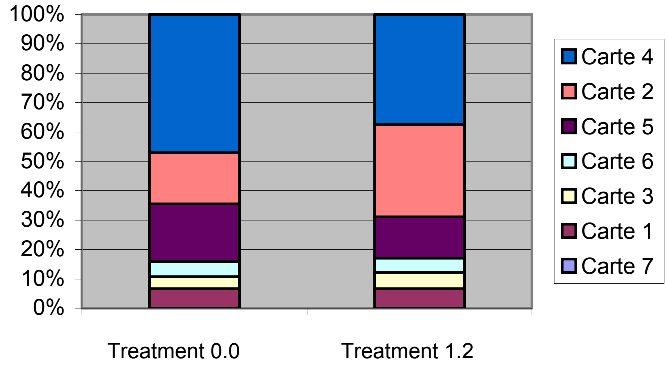
Card 7 appears more frequently at treatment 1.0 than at treatment 0.0, invalidating hypothesis H4 which states that communication improves coordination and then cooperation. Extreme cards, which are not observed in the results at treatment 0.0, appear at treatment 1.0.

Players' choices (270 observations)							
Card number	*7*	*1*	*3*	*6*	*5*	*2*	*4*
Treatment 0.0	2	3	4	3	163	41	54
Treatment 1.0	0	18	11	14	53	47	127

Card 4 is the majority choice at treatment 1.0 (with communication), but at a same level as card 5 at treatment 0.0 (without communication). Communication removes the focal point (from card 5 to card 4), but does not reduce the noise, invalidating hypothesis H5.

iii. Instructions effect, with communication





Group results (90 observations)							
Card number	*7*	*1*	*3*	*6*	*5*	*2*	*4*
Treatment 1.0	48	2	2	3	3	13	19
Treatment 1.2	52	3	3	1	0	10	21

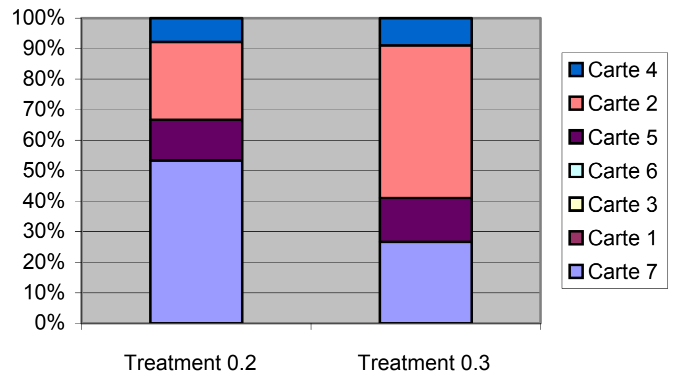
Players' choices (270 observations)							
Card number	*7*	*1*	*3*	*6*	*5*	*2*	*4*
Treatment 1.0	0	18	11	14	53	47	127
Treatment 1.2	0	18	15	13	38	85	101

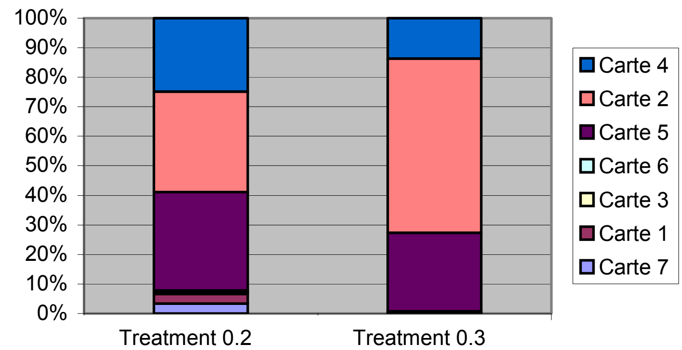
There is no significant difference in the results and the choices.

Communication, in this coordination game, has a stronger effect on players than instructions effect (water: farmers), to such an extent that instructions effect disappears.

This observation has to be contrasted with results of experiments conducted later with farmers, who would have to be more sensitive to water context than students had been in this experiment.

iv. Water vs no-Water





Group results (90 observations)							
Card number	*7*	*1*	*3*	*6*	*5*	*2*	*4*
Treatment 0.2	48	0	0	0	12	23	7
Treatment 0.3	24	0	0	0	13	45	8

Players' choices (270 observations)							
Card number	*7*	*1*	*3*	*6*	*5*	*2*	*4*
Treatment 0.2	9	9	2	1	90	92	67
Treatment 0.3	0	0	1	1	72	159	37

Same frequency for cards 4 and 5 at both treatments, while frequency of emergence for card 2 is double at treatment 0.3.

Coordination, valuated by frequency of emergence for card 7, is better at treatment 0.3 ("no-water"), invalidating hypothesis H3.

"No-water" context seems to provide the players (students) a common representation, with a focal point on card 2. This common representation could explain the better coordination at treatment 0.3 than at treatment 0.2.

This result has to be contrasted with the one of experiments conducted with farmers in the field.

4. CONCLUSION

The interest of this paper consists in the attempt to provide a first conceptual framework within which the various steps of the research trajectory could be identified. The definition and clarification of concepts and terms required for the construction of the framework might be useful to produce at term a common basis for researchers involved in social experiences and experiments in the field of common pool resources management.

Our research trajectory can be introduced in this conceptual framework as indicated in figure 4. KatAware was a RPG developed and played with local stakeholders in order to enhance their knowledge and facilitate discussions about water allocation strategies. The objective of KatAware was to create an artificial environment similar to the real one and allow participants making a common experience about water management. The willingness to test Cooperative Game Theory hypotheses emerged from the observation of KatAware results conducted the research team to develop KatGame, a contextualized protocol derived from KatAware. Due to its complexity and still high level of contextualization, KatGame proved difficult in terms of replication and control. KatLab was therefore constructed as an extremely simplified protocol derived from KatGame and aimed at controlling all variables of the experiment in the laboratory and replicating it as much as required in order to get statistically verifiable results.

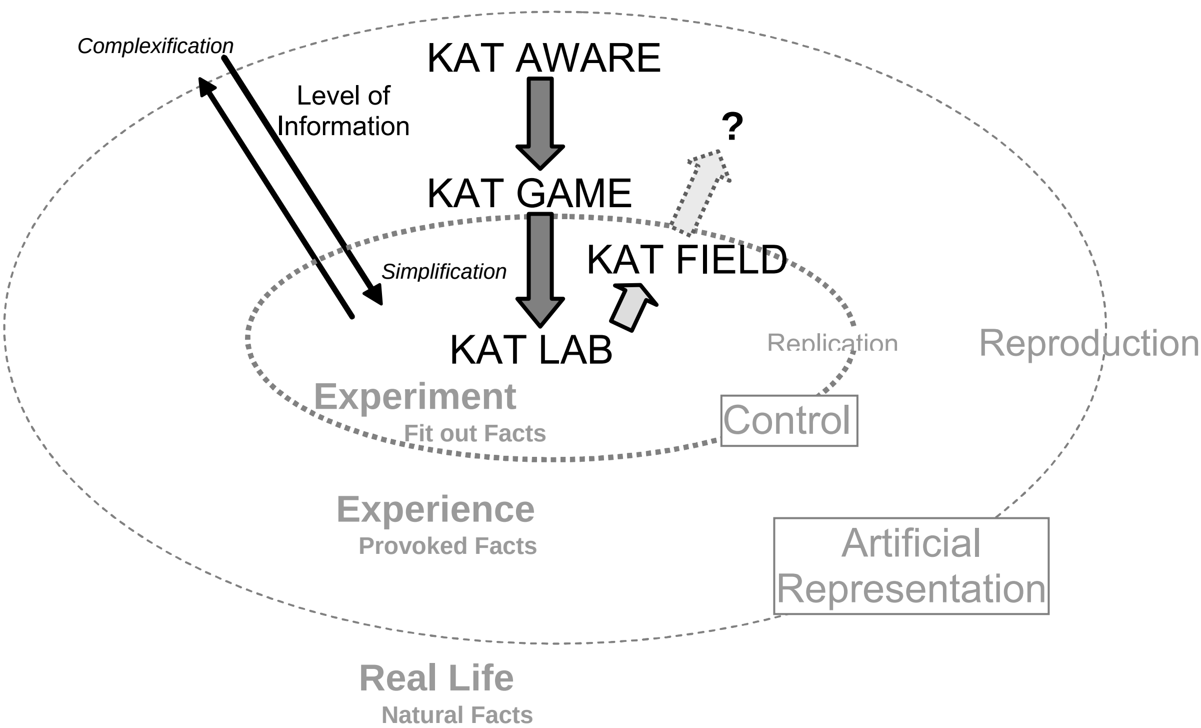


Figure 4 – Our research trajectory within the proposed conceptual framework

It is interesting to observe that the objectives of the three tools (KatAware, KatGame and KatLab) are different and reflect the evolution of the research questions emerged all along the programme: KatAware was a RPG aimed at improving stakeholders' knowledge and negotiations; KatGame was a first attempt to simplify the RPG into a laboratory tool to test hypotheses emerged during the RPG sessions and previously formalised into a Cooperative Game Theory model; KatLab is a further step into the experimental environment, the protocol is extremely simplified and does not only aim to test economic hypotheses, but also (and rather) to understand the impact of context into players' behaviour by comparing results of sessions played in the abstract set-up (treatment 0.0) with results of sessions played in contextualized ones.

Answering this question can have heavy consequences in the near future on the development of tools to facilitate stakeholders' water governance and common decision-making. The study of the influence of context may allow understanding whether the management of the commons requires dedicated protocols or, conversely, a "universal" and generic protocol exists. If protocols about the management of the commons (e.g. water) can be de-contextualized, then standard methods could be transferred from one place to another and at different times. Conversely, results could show that methods are strictly dependent from the issue at stake. But whatever the conclusions arose at this stage, results are obtained with students whereas the tools we want to improve involve stakeholders. Therefore, after having tested the attributes "Instructions" and "Communication", the attribute "Players" has to be studied, in the field, by using a new protocol version. This protocol is named KatField, and will be composed by the same 6 treatments than KatLab.

Until this stage, the research trajectory remained centripetal. The transition from KatLab to KatField is a new (reverse) direction, as Harrison and List (2004) have already proposed, starting from a conventional lab experiment to a framed field experiment through an transitive step: the artefactual experiment. By comparison with Harrison and List's approach (cf. figure 5), we also start from a conventional lab experiment (KatLab, treatment 0.0) but the artefactual experiment (i.e. the 5 other KatLab treatments) does not remain abstract in term of instructions and is not conducted in the field with stakeholders as Harrison and List's one. Rather, the artefactual experiment is developed in the lab with students in order to maintain control when testing contextualization influence. Once this influence evaluated, the protocol is transferred to the field, leading to the framed field experiment (KatField) with same characteristics as Harrison and List's one. The originality consists of passing by a different transitive step between the conventional lab experiment and the field experiment. The final point of this reversal trajectory (centrifugal, cf. figure 4) could meet the initial point, i.e. a return to a RPG design, starting from the field experiment outcomes.

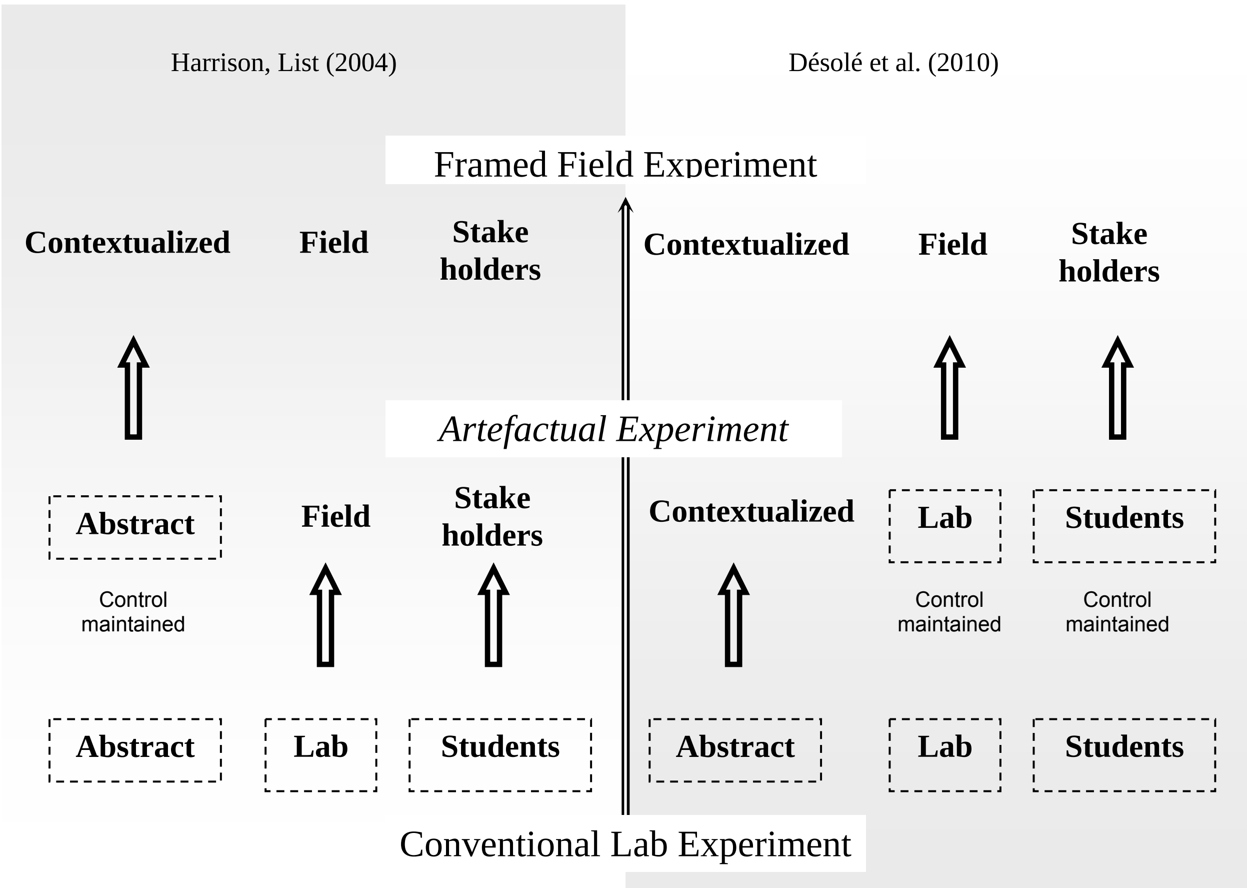


Figure 5 – Comparison between two different transition from the lab to the field

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