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TRIZ Future 2013

How to leverage the knowledge spiral and creative meta-rules to train on TRIZ thinking while rescuing the sinking Titanic?

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Abstract

After a first experiment presented to TRIZ Future Conference 2012 which objective was to teach simultaneously future teachers and students of 2 classes of a technical college, this paper will present a proposal which aims at extending the experiment to a larger group made of 10 colleges, 24 new teachers and about 300 students (compared to 1 college, 6 teachers and 60 students). To resolve the tackled problem (how to train without being trained) a specific pedagogy, named as "knowledge spiral" has been proposed and tested and has brought interesting benefits.

The matter is that while the number of people to be trained is enlarged, the number of resources is not extending. To the contrary it is even more restricted, and new constraints have to be considered:

- How to apply a pedagogy when the number of students is enlarged, could we used the same pedagogy, and how to adapt it?
- How to leverage the "knowledge spiral" with limited resources: especially less time to develop the competences?
- How to apply the "knowledge spiral" with geographical separated resources within the same time frame?

In these conditions, the new proposal could not be a direct homothetic transformation of the previously proposed one. Thus, a new model, again inspired by the "knowledge spiral" has been developed with the introduction of a fourth level of resources: expert, trained teacher, non-trained teacher, and student. This will, in a certain extent, enlarge the spiral.

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Another aspect, due to the new constraints, is the use of a generic problem to be solved for all the trained groups, this problem being used both to trained the teachers and proposed to students as a school case study. The case study will emphasizes the different concepts of TRIZ (contradictions, I.F.R., available resources, specific conditions…). This implies the expert to describe both the case, the method to solve it, and also to define the border of the case in order to make it understandable and usable for teachers (without the expert), but without restraining the domain of possible solutions for learners (both teachers and students). To fit these requirements, the proposal was to give teachers the meta-rules of a creative game, these meta-rules enabling the game to be applied in any context.

To reach the objectives, the well-known example of TRIZ applied to the rescue of people during the Titanic sinking will be used to develop the creative game. A first session will be directed with teachers, and then the teachers will put it in practice with their students. In order to motivate both the teachers and the students, a kind of competition will be proposed, first between the different teams inside colleges, and then a challenge between the best team of each college. To be relevant this competition will have to fit some pre-defined rules, as nature of problem to be solved, allocated time, team composition, innovative evaluation, and so on. For the evaluation, the already presented "radar" diagram will be used once more.

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1. Motivation

In the TRIZ Future Conference 2012 , we presented a first experiment which objective was to teach simultaneously future teachers and students of 2 classes of a technical high school.

Three main ideas were highlighted:

- A three-level knowledge spiral (Expert, teachers, students), to enable teachers to be taught at the same time that they had to teach students.
- The context of a "challenge of creativity for innovation" to stimulate learning and motivate students themselves with the Ideal final result that “everybody wins”.
- The dimension change for a positive evaluation: We introduced a 2D radar with opposed pairs of innovative criteria to evaluate the creativity of the group.

The positive results we obtained with this experiment encouraged us to extend it to a larger group made of 10 colleges, 24 new teachers and about 300 students (compared to 1 college, 6 teachers and 60 students). New contradictions appeared then in this new context: We had less resource in time, and more teachers and students to be taught.

What should be done?

The purpose of this article is not to compare how to teach TRIZ by means of a case study, compared to "classical" or "modern" TRIZ teaching at universities using lectures and also practices with case examples, as there are already many publications on these discussions.

Instead, the authors will try to solve the theoretical contradiction "how to teach a domain without knowing the subject", applying the TRIZ "knowledge spiral" process (like "Russian dolls") to the specific domain of teaching TRIZ to students by teachers without knowing TRIZ. Then the authors will focus on a proposed method of motivation of the teachers and students based on the "Titanic" case example.

2. State of the art

The authors were facing several problems to propose a way to teach several teachers who will have to apply a new problem resolution method with their groups of students:

- the time to teach the teachers was reduced,
- the teachers had to explore a new discipline,
- the teachers will have to propose a way to transmit “not acquired” knowledge to their students,
- a new pedagogy has to be proposed, when this situation has not been tackled yet in the literature.

The subject of teaching TRIZ has often been tackled, but mainly through the aspect of increasing the efficiency of a trained teacher to teach its students . Another aspect is the building of supports to help teachers in their way to teach TRIZ as the project TETRIS . But the authors have not found any documents related to the previously cited difficulties, in the specific case of training future TRIZ teachers. To overcome this set of difficulties, the authors made the choice to build a homothetic approach of their first experience, which has been described in . And, even if the results of a new pedagogy can only be judged afterwards, they built their new proposal referring to the “rules for good pedagogy” they found in literature.

2.1. The subject is a new domain for teachers

It is always difficult and stressing for teachers to explore new discipline, and to build for their students a relevant “pedagogic platform” covering many disciplines. However, cross-curricular works in schools have been promoted for the benefits they bring out. In (Savage 2012), these benefits have been recognized mainly for dimensions like enterprise, global dimensions and sustainable development, technology and media, and creativity and critical thinking. One of the main benefits of such an approach is that it helps young people to unify areas of learning and to “make sense of the world”.

To face the lack of self-confidence of teachers, which is due to the "lack of content knowledge and to the inability to employ a range of teaching and learning approaches appropriate to the theme" it is recommended to adopt a pedagogy with the following characteristics:

- the pedagogy should have an objective and open-minded approach,
- the pedagogy should use concepts as the intellectual building blocks, and uses categorization, organization and analysis of knowledge,
- the pedagogy should mainly be based on participatory and experiential teaching style,
- the pedagogy should refer to questions and issues that enable pupils to explore fundamental aspects of our lives.

Another particular aspect of the current project is not only the fact that the study aims at transferring transversal knowledge (know-how about problem resolution) but also that the teachers to be trained – and their students - are disseminated in several colleges, with different perception of what they have to do, and how to do it. One can recognized it at having different teachers from different disciplines. Thus the problem about homogeneity between disciplines occurs even more dramatically.

One approach that can be used, and on which authors built their proposal is the concept of connection in pedagogy to tackle this problem. Dillon, in (Dillon 2006), reminds that "working across and between disciplines are known as cross-curricula or integrative", it means that these topics are the combination of diverse components of perception. Then, Dillon defines these activities, across and between disciplines, to be inherently creative. "In educational terms, making connections between subjects, and working in cross-curricular modes, are recognized routes to teaching creatively and providing opportunities for both learning about creativity and undertaking creative activity".

To summarize, to help the teachers build an approach to teach a new subject to their students, the proposal of the authors have to fit the following set of requirements:

- it should not be too rigid, but should be goal-oriented,
- it should bring elements of knowledge blocks by blocks,
- it should be practical and mainly based on group-activities,
- it should be motivating both for teachers and students, and for this raise "strong questions",
- it should enable to make connections between the different tackled disciplines.

2.2. The teacher has to be self-confident with the subject

As one of the main stakes of the project is to propose a pedagogy that enables both teachers to teach, but also teachers to learn about the subject, the objective is to provide an environment in which the teachers could feel self-confident about what they will use and what they will transfer to their students. (Gore, Griffiths et al. 2004) presented a "Productive Pedagogy" as a framework for enhancing teacher education.

Based on the remarks of interviewed teachers about the lack of the system of education, they proposed this framework to focus more on the substance and purposes of teaching.

This framework is based on four principles:

- intellectual quality, which addresses the tackled knowledge, the deep understanding of it, the inherent problematic, and s.o.
- relevance, which addresses the integration of knowledge, its connectedness to the world, the problem based curriculum, …
- supportive classroom environment, which addresses the student control, the social support, the explicit criteria, self-regulation, …
- recognition of difference, which addresses the cultural knowledge, the group identity, …

So, to help teachers to be self-confident in their learning and teaching, the authors tried to build an approach which integrates these different dimensions, by clarifying the nature of knowledge, its role in the global context, and trying to build and environment in which exists an equilibrium between rules and self-regulation of students.

This need is re-enforced by the concept of self-study, both for teachers and students. The self-study concept "empowers professionals to examine, and be accountable for, their own practice as they articulate and generate knowledge useful to others." (Lunenberg and Samaras 2011)

Lunenberg and al. reminded that the creation of an optimal learning environment could be guided by the Vygotskian principles (Vygotsky 1981):

- social and cultural influences shape development,
- learning occurs during situated activity,
- cognition is socially mediated, especially through dialog,
- education leads, or completes, development.

Here also, the importance of the context, of the clarification of the role of teachers is emphasized, and authors tried to help them in this clarification through the proposed approach.

2.3. Activity and group-based approach

One of the last dimensions of the proposed pedagogy is the experimental and group work dimension of the proposed pedagogy. In (Blatchford, Kutnick et al. 2003) the benefits of group work is recognized mainly for conceptual development, thinking, reasoning and problem-solving (the topic of this article), where the acquisition of new skills or strategies is associated with practice-based tasks.

The article pointed out the dimensions that can either bring group work as effective either as uselessness. These dimensions are, among others: the quality of materials provided to learners, the incremental aspect of the learning to acquire robust and enduring habits of mind, and the motivation due to the social context in which the learning occurs.

Considering the social context, it appears that the numbers of members in each group, the nature of interaction between members, and the type of learning tasks have to be particularly focused on. To increase efficiency of interactions and also to provide good context by encouraging the motivation, it is recommended to consider students, in group work, as co-learners, and not considering them as students helping other students.

To evaluate the kind of pedagogy proposed in this article, the authors refer to (Conole, Dyke et al. 2004) in which an octahedron model is described to evaluate pedagogies.

This model is built out of 3 axes (see fig. 1):

- individual / social axis: considering either the individual as the focus of learning, or the learning as an explanation through interaction with others;
- reflection / non reflection axis: considering the basis of learning either as a conscious reflection on experience, or an explanation with reference to processes such as conditioning, preconscious learning and memorization;
- information / experience axis: considering the basis of learning either as based on a body of information, text, artifacts or body of knowledge, or arising through direct experience, activity and practical application.

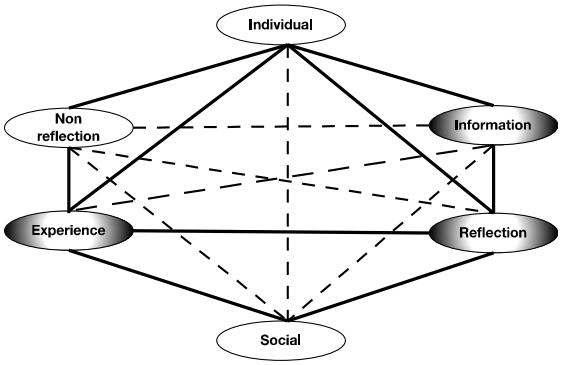

Fig. 1. Octahedron model for pedagogy evaluation (Conole, Dyke et al. 2004).

Based on this model, the authors categorize their proposed approach as being mainly based on information, reflection and experience; as a set of basis body of knowledge is delivered but will be acquired and understood through its application on case studies and by a reflective approach on the method. This categorization refers to reflective learning as described in (Dewey 1916).

3. Experimental

Compared to the traditional way of teaching (when teachers know the subject) with a whole unit divided into several topics (like Ideal Final Result, Size-Time-Cost operator, Miniatures men, Contradictions, Available resources, Laws of evolution, TRIZ methods, etc), the materials and course content will be discovered by the students and their teachers during the solving process related to the Titanic case.

The pedagogical method used for the teaching flow does not require specific skills (like when the subject is not mastered), as the teachers and their students will discover by themselves what problem analysis and problem solving methods and tools do they need, in such an urgency situation, to save people on the Titanic. Then the course material and TRIZ methodology are incorporated with course teaching and exercising, and the characteristics of such a pedagogy are a mix of the 3 approaches described in chapter 2.

To reach the objectives, the well-known example of TRIZ applied to the rescue of people during the Titanic sinking will be used to develop the creative game. A first session will be directed with teachers, and then the teachers will put it in practice with their students. In order to motivate both the teachers and the students, a kind of competition will be proposed, first between the different teams inside colleges, and then a challenge between the best team of each college. To be relevant this competition will have to fit some pre-defined rules, as nature of problem to be solved, allocated time, team composition, innovative evaluation, and so on. For the evaluation, the already presented "radar" diagram will be used once more.

3.1. Proposed process to “rescue the Titanic”

In order to focus on the tools of TRIZ without being limited by a lack of technological culture, the subject of study used in this case remained deliberately general and known to all, "how to save ALL passengers on the Titanic? ".

The transmission of knowledge and skills development is done by following the model of the "knowledge spiral" by expanding the spiral on 4 levels:

- An expert;
- Expert teachers (trained for 3 days on TRIZ at INSA Strasbourg by Denis Cavallucci), but never applied on a creativity project;
- Teachers untrained to TRIZ;
- Students.

The general organization was held following four steps:

- Choice of subject of study by the expert in consultation with a teacher, and planning of the different levels of challenge;
- Teachers' involvement: they were able to implement the process in almost the same conditions as students with an unknown subject in advance but in a short time, and they were supervised by an expert and a professor already trained;
- Students' involvement, supervised by a teacher, possibly with the help of a teacher already trained; at this stage of the process, each school selected a group by an internal jury to participate in the academic final;
- Academic final, where the winning group will be chosen by a high-level panel (expert and researchers, with colleges teachers).

For working with students, it was proposed to follow the following steps:

- 2 hours presentation of TRIZ tools that were each illustrated by Ideal Final Result, Size-Time-Cost operator, Miniatures men, Contradictions, Avalable resources, laws of evolution;
- 2 hours of research work in groups of 2-3 students, where diversity has been favored in the formation of groups; at that time, a teacher remained available to provide methodological support;
- 2 hours formatting media for the oral presentation of their project;
- 4 hours devoted to the presentation of the different projects for a class, with for each group:
    - A presentation time;
    - Questions and answers on their presentation;
    - Comments on the use of TRIZ tools in their presentation;
    - Use of the "radar" evaluation tool [8];
    - The involvement of students in the assessment.

3.2. Teachers are playing the students' role!

In order to be efficient during the Titanic exercise, the teachers were asked to read in advance at least 3 French TRIZ-related articles on (1) "A pedagogy of rupture" (4 pages) stating that incremental innovation or rupture result from fundamental research and technological developments (but also creativity) and that TRIZ logically takes place in a technology training; (2) "Duo teaching" (4 pages) claiming that the technical education program disrupts teachers' practices, coming with two new materials: the case study to discover the innovations, and the creativity project to live the process ; and (3) "The relentless pace of innovation..." (25 pages) remembering that the evolution of technical systems has been studied in France in the second half of the twentieth century, with a renewed interest linked in part to the spread of TRIZ which has, among its key concepts, eight laws of the evolution of technical systems.

To highlight the problematic situations to be chosen by the learners themselves and immediately solved in real-time (less than 2-hour workshop to let participants feel like it could be their story to rescue a group of

people during the 2-hour sinking of the Titanic) and to make the problem to solve more realistic, 2 videos are shown to the audience (1) the trailer of the Titanic film to see the atmosphere, with the human and material damage; and (2) a Paint animation that schematically shows the problematic situations without heroes and romance.

The problem of the “sinking Titanic” (see figure 3) is certainly quite different from the usual technical items used by the teachers with their students, but the solutions are based on TRIZ tools, so it is a good subject holder. Easy to understand by everyone, it is a perfect tool to stimulate a more creative state of mind to be adopted by the learners of innovation techniques.

The class of 24 teachers was divided into sub-groups of 4-5 participants and separated in different rooms with a paperboard to draw schemas (see figure 2), follow the 4-step method proposed by the TRIZ expert, and write their conclusions. The workshop itself lasted one hour (accelerated compared to the one for students, as teachers are already technical professionals and able to “jump” quicker in the situation to solve), and the feedback to the whole group took another hour to complete.

As a result, the use of the proposed resources and the sequence of tasks to be done helped smoothly to achieve the educational objectives with just a few basic rules for the creative game. Most teachers felt confortable with the workshop, some even agreed that they enjoyed imagining being the captain and possibly saving all passengers (at first they thought it was impossible, because the movie is so impressive that no other solutions could exist), and at least found TRIZ powerful...

The next step for these newly trained teachers is to play the game with their students, which is another story...

Fig. 2. Titanic teachers' workgroups

Fig. 3. The initial situation of the problem

4. Results and discussion

At this point, we are still waiting for the results, but a few trends are already clear:

- The approach is accepted by 4 teachers, entirely voluntary and without waiting for against-part, except new skills in both innovation and innovative educational approach;
- The spiral extends smoothly, but through teachers who are able to live a risk along with their students. In addition to TRIZ tools, these teachers also teach innovation spirit being live models for their students;
- We can rely on these teachers to gradually transfer their behaviour to their colleagues.

On the meta-rules aspect of the experiment, the authors were positively surprised to see how easy it was to explain the “Titanic case” to the audience, who immediately started to think abouth “who they are (officers, crew, passengers)” and “where they are (waiting on the deck, working hard in the machine room, or safe in the lifeboats)”. Based on the state of the art (chapter 2), the best rules and characteristics to identify an other “universal” case study are:

- goal-oriented, practical and mainly based on group-activities;
- motivating both for teachers and students, raising“strong questions”;
- bringing elements of interdisciplinary knowledge blocks by blocks;
- cultural knowledge, group identity, connectedness to the world;
- situated activity, socially mediated cognition, through dialog;
- approach based on information, reflection and experience.

There are obviously some difficulties of the proposed method, and more studies and experiments need to be done. Learning form experience while teaching seems valuable for teachers willing to “play the game”, it means taking the risk to be seen by their students not as “knowing the subject” but more as “mentors”. For teachers not interested to be “out of their comfort zone”, the classical pedagogy needs a lot of work done in advance, by the education system and the teachers; on the other side, the experimental shown that the students were happy to take their part, in real-time, and contribute to the building blocks of the course.

Step by step, more teachers know, use and teach TRIZ to their students. From 4 teachers in the first experiment, we grown up to 4 different high-schools in the academy this year and TRIZ is now spontaneously quoted by students, teachers and pedagogical inspectors as a solution to solve inventive problems.

We will present complete results during the 2013 TFC in Paris.

Fig. 4. Titanic students' presentations

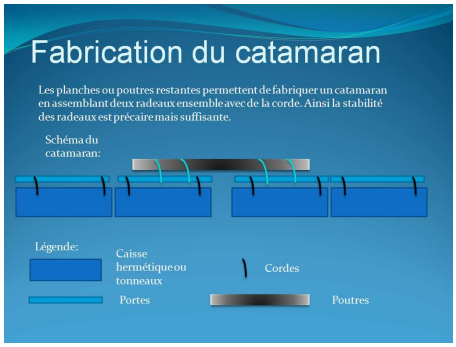

Fig. 5. Titanic challenge winner

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