

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/318274652>

ENACTING DIVERGENT LEARNING DYNAMICS IN TEAMWORKING: THE CASE OF TECHNOLOGY BATTLES

Conference Paper · July 2017

DOI: 10.21125/edulearn.2017.2416

CITATIONS

0

READS

42

3 authors:



Matteo Bonifacio

Università degli Studi di Trento

62 PUBLICATIONS 794 CITATIONS

SEE PROFILE



Lorenzo Angeli

Università degli Studi di Trento

2 PUBLICATIONS 0 CITATIONS

SEE PROFILE



Milena Stoycheva

Sofia University "St. Kliment Ohridski"

7 PUBLICATIONS 2 CITATIONS

SEE PROFILE

Some of the authors of this publication are also working on these related projects:



EIT Digital Online Education [View project](#)

All content following this page was uploaded by [Lorenzo Angeli](#) on 07 July 2017.

The user has requested enhancement of the downloaded file.

ENACTING DIVERGENT LEARNING DYNAMICS IN TEAMWORKING: THE CASE OF TECHNOLOGY BATTLES

Matteo Bonifacio¹, Lorenzo Angeli¹, Milena Stoycheva²

¹ *Università degli Studi di Trento (ITALY)*
² *Junior Achievement Bulgaria (BULGARIA)*

Abstract

Demands over teaching methods have drastically evolved in the last decades. In particular, due to the increasing emphasis placed by the need to foster innovation, HEIs are called to frame learning environments accordingly, equipping students with skills and competences able to allow for some sort of innovative thinking. However, it is questionable if traditional educational contexts are able to cope with such a challenge. Indeed, it appears that their very design principles are much more conducive to what we here refer to as “convergent thinking”. This form of thinking is focused more on confirming and consolidating existing knowledge rather than challenging and critically questioning it. Such a logic contrasts with both innovation related literature and practice, which emphasises the pivotal role played by the exploration of new knowledge as opposed to its incremental exploitation. Drawing on a theoretical analysis, this contribution identifies the key principles of a “convergent” classroom and, conversely, proposes conceptual counterparts in order to design a classroom able to enact divergent knowledge dynamics. If the principles for such a divergent model are those of equivocal ambiguity, counterfactual and controlled conflict, convergent learning is instead based on their semantic opposites: unequivocality, factuality and conflict avoidance. An instantiation of these design principles will provide, deductively, a possible methodology (“Technology Battles”) inspired by debates in the English House of Commons. This methodology is contextualized in the experimental setting of the Innovation and Entrepreneurship minor of the EIT Digital Master School. Finally, some broader observations will be made, providing some considerations on how this analysis can contribute to a wider debate on the role of HEIs in contemporary knowledge societies.

Keywords: team working, innovation theory, divergent learning dynamics, higher education reform, new pedagogical methods.

1 INTRODUCTION: THE NEED TO ENACT DIVERGENT THINKING IN THE CLASSROOM

Teaching methods have drastically evolved in the last decades. Education has taken under its hood the role of actively engaging students and trainers, and this has been especially seen in Higher Education (HE). In particular, due to the increasing speed in knowledge generation, learning goes beyond the acquisition of technical notions, and includes important elements of “meta knowledge” or “soft skills” such as social skills, creativity, critical thinking. In short, this unfolds in an increasing interplay between the capacity to master “content” (notions and technical knowledge), and “process” skills, addressing the need of “teaching how to learn” due to an accelerating knowledge obsolescence.

As suggested by many authors, and first and foremost by James March [1], knowledge creation can be described in terms of a twofold dynamics. According to the scholar of Herbert Simon, organizational knowledge creation occurs along a continuous trade-offing between two qualitatively different learning processes. On the one hand, by means of knowledge “exploitation”, the current world view is incrementally consolidated throughout a retrospective justification of the present state of affairs. On the other hand, however, such a consolidation is complemented with knowledge “exploration” that, through a critical assessment of existing assumptions and interpretations, prospectively builds new, divergent knowledge options. Indeed, such an opportunity stems from a specific configuration of the world and the environment, which is said to be, more than uncertain, ambiguous. Ambiguity is referred to by many cognitive scholars as a situation in which multiple, alternative and even contradictory interpretations of the world can be enacted [2, 3, 4, 5].

As anticipated, this scientific framing has been evidenced by many authors according to different fields of inquiry. Indeed, exploitation/exploration represents just one of many such dualities that can be used to explain the structural and epistemological dynamics of an organizational environment. For example, in R&D environments, Boland and Tenkasi referred to the double-faced process of perspective making

and perspective taking [6]; in the field of organizational psychology, Argyris and Schön produced the key distinction and analysis related to single and double loop learning [7], where the second loop is a form of learning that iterates on top of the first loop: a form of learning about learning (meta learning); in business literature, a constant reference has been made about the distinction between incremental and radical innovation [8, 9]; and finally, when analyzing the scientific process, the seminal work of Thomas Kuhn [10] refers to the dichotomy between normal and paradigmatic science, where the former is seen as happening within a paradigm, and the latter as a paradigm-shifting endeavour.

While this analysis has been mainly looking at a wide range of organizational settings, it is interesting to note that one of the main knowledge organizations of society has been left out from such perspective by educational researchers and pedagogists: the classroom. The classroom environment, when considered as a context where new knowledge is not just exploited but also explored, can indeed be framed in a similar way. Traditional educational contexts, hereby referred to as “convergent classrooms”, share the fundamental notion of approaching knowledge as an endeavour of experimental replication. The laboratory (here intended in its broader definition [11]) of convergent classrooms can take different forms, such as a frontal lecture or a more inductive, bottom-up class, and extends to learning activities which are designed both for single students and groups (team working).

Our inquiry, however, will be focused on the enactment of “divergent classrooms” in HE, whereby a divergent classroom is one requiring students to explore multiple, potentially contradictory, world views.

These two perspectives of the classroom help us in defining the broader concept of team working in HE through *divergent thinking* (or DCE - Divergent Case Enactment team working): an approach to learning that is mainly concerned with exploration, and which puts critical thinking (intended as the ability to reopen for debate the fundamental meta-knowledge underlying an existing knowledge body) at the forefront of the educational effort.

The very enactment of this divergent dynamic, however, is problematic. Indeed, addressing and living in ambiguity challenges and disrupts cognitive and social dynamics which construct our norms. These challenges can be grouped and simplified as the issue of the so-called “exiting out of the comfort zone”. For example, JS Brown [12] underlined how this dynamic challenges our social identities, and our consolidated organizational practices and routines [13, 7]. In the field of education, however, no pedagogical methodologies have been developed to enact these exploratory dynamics, and namely divergent thinking as a mean for learning in the classroom.

This contribution aims at presenting and discussing a possible pedagogical method to fulfill and enact this learning requirement, while contributing to bridge this gap. In particular, it will propose an educational methodology for teamworking in the HE context and attempt a first level generalization of the core principles underlying this methodology.

This contribution is structured as follows: section 2 will explore current approaches to team working in higher education, and how they are more strongly mapped to convergent learning; section 3 will give a first level grounding of the principles that can be put at the roots of a divergent approach to learning; section 4 will illustrate a first, concrete methodology that applies the provided theoretical framework; sections 5 and 6 will discuss the results of this application and draw conclusions and opportunities for further research and refinement of this concept.

2 STATE OF ART: CONVERGENT CLASSROOMS AND OPPORTUNITIES FOR EXPLORATION-DRIVEN EDUCATION

The mainstream pedagogical approach to team working in HE, as well as in professional schools, has been focused, up to now, on the logic of “case studies” (CCS - Convergent Case Studies team working). This logic is not far from a laboratory’s experimental approach and refers to different options that, due to space and scope constraints, will not be further discussed here such as analysing, discussing or presenting a given case. It can be argued for the sake of generalization that CCS typically proposes concrete instantiations of a relevant problematic situation and chiefly, in the current educational trend, business cases. Nowadays, CCS is widely implemented in top HE institutions and is said to be, by prominent business schools such as those of the MIT, Harvard and Cambridge, as the key pedagogical method for collaborative and problem-based learning [14]. CCS, however, appears to be deeply rooted on what has been defined previously a “convergent” approach to education, teaching and learning in the classroom.

In this case, the “convergent” dynamics stem from the analytical nature of CCS. In general, it can be observed that: a) the trainer provides to the students a “case” (defined, as explained above, as a concrete instance of a problem); b) students are asked to identify and reconstruct the facts and events that led to the case’s success or failure, often in an inductive manner (i.e. teamworking) [15, 16]; c) the evaluation of the learning performance, which might be either an assignment or a presentation, is based on an assessment of the ability to best justify the validity of the case (being it a “given” success or failure). This represents an exercise of “filling the blanks” (thus converging) between the case’s beginning and the world as it currently stands.

This methodology is able to achieve many relevant and necessary steps of the learning process, but has an issue towards sparking innovative and critical thinking. Indeed, going back to J. March, CCS can also be seen as an exploitation-based pedagogy, where the space for enacting alternative and even conflicting scenarios in ambiguous contexts is limited. As a matter of fact, CCS generates new knowledge mainly by means of an incremental process of consolidation and verification of a given assertion (“the case”). This form of exploitation still ensures that learning is enacted but also has a tendency to allow for cognitive fallacies such as competence traps [17], superstitious learning [18], or path dependencies [19]. In a sense, these can be framed in what Taleb [20] called from a logical perspective the fallacies of induction, in which past experience is the main driver of understanding and interpretation, and knowledge is implicitly believed to be a necessary, and eventually all-comprising, progression.

The current absence of exploratory learning methodologies and divergent thinking in HE does not imply that these are theoretical concepts detached from practice. Indeed, in the last decades, the business environment especially has been applying divergent methods to foster a stronger attitude to radical/disruptive innovation [21, 22]. In the HE context, however, divergent thinking has at most been attempted in the form of “creativity” exercises or in the context of innovation-related courses. These display an underlying expectation that students will produce novel ideas (since these are the root of innovation), without providing, on the other hand, a sound and structured engagement method. As anticipated, divergent learning is not a spontaneous process and such an intuitive approach denies the need to address the social and cognitive factors that hamper innovation to take place, such as risk avoidance, social compliancy, peer recognition, and the need to confirm group identities [23, 24, 25].

In short, it can be said that DCE experiments in HE share a common bottom line: unfettered exploration is not fostered in practice, either by context or by design.

In general it can be observed that, as summarized in Table 1, convergent thinking is explored both “within and outside” the class, while divergent thinking is more often addressed in the realm of practitioners under the wide methodological umbrella of organizational learning [26, 7]. As a result, today’s classroom appears to be bound to develop along the lines of convergent thinking.

Table 1. Where convergent and divergent learning have been explored

| | | |
|--------------|-------------------------|--------------------|
| In class | Case Study Team Working | NO EVIDENCE |
| Out of class | Incremental Innovation | Radical Innovation |
| | Convergent dynamics | Divergent dynamics |

3 THEORETICAL FRAMEWORK: DESIGN PRINCIPLES FOR A “DIVERGENT” CLASSROOM

In order to design a class setting able to foster divergent knowledge creation, it can be useful to challenge the key aspects that characterize convergence in classroom learning. For descriptive purposes, these can be elaborated as (i) unequivocality, (ii) factuality and (iii) conflict avoidance.

To further detail these three fundamentals, **unequivocality** refers to the belief that each knowledge body, be it a case description, a manual or a theory, has a univocal interpretation, constituting a given and unquestionable truth; hence, the inquiry work does not require falsification, but rather verification. **Factuality** relates to how every fact necessarily follows from the other in a logic of confirmation and incremental accretion. In this sense, it can be said that factuality creates a logic of supremacy of induction in the exploitation and verification of the given knowledge. Such a verification occurs through

the collection and composition of existing facts. Finally, **conflict avoidance** implies that collective or team work is intended only in a cooperative sense, implicitly assuming that the development of conflictual interpretations and statements hampers the knowledge creation work. Hence, knowledge creation is assumed to be successful only if generated through collaboration and allowing for converging interests and views.

If these three qualities are proposed as characterizing of a convergent knowledge creation process, we hereby propose that their semantic inversion might define some key design principles to enact a knowledge divergent dynamic. These are (i) equivocal ambiguity, (ii) counterfactuality and (iii) controlled conflict.

In this framing, **equivocal ambiguity** can be seen as a cognitive situation or context in which multiple interpretations of the same facts are possible [27]. In such a setting the criteria of exclusivity for which if one view is admissible, then another is ruled out fades in the background. Alternative and contradictory views become possible and encouraged [3] moving the value judgement away from verification/falsification and towards plausibility. Examples of equivocally ambiguous situations can be found in any and all political debates: political parties construct arguments which support their world view, but opposing parties still can provide rebuttals and counterarguments, with neither party holding an objective “truth”, and voters choosing, in the end, by means of persuasion.

Counterfactuality refers to a general cognitive attitude where reasoning is often developed by placing a counterfactual event into a logical inference. Namely, a counterfactual [28] is a fact that contradicts the current state of affairs, such as “In the sequence $A > B > C$, I observed that B happened after A, and thus C followed. But if X had happened instead of B, then Y would have followed, as a totally different outcome from C.” This cognitive attitude has also been observed and defined by Lewis as one generating alternative world scenarios [29], each of which represents a novel space for exploration. As an example of counterfactuality, we can look at scientific research: the act of altering the starting conditions of an experiment and the observation and recording of how the outcome changes represents a clear-cut example of an enacted counterfactual.

Finally, **controlled conflict** refers to a social dynamic in which different individual or collective actors engage with each other not to seek agreement, but to claim the supremacy of an interpretation over another. In our framework, conflict is controlled in the sense that it is expressed only dialectically and not by other means of power (e.g. violence, sabotage, etc.). Hence, controlled conflict is still a collective dynamic rooted in a form of social order, but in which knowledge creation is not achieved out of compromise, but rather of divergent confrontation. Controlled dialectical conflicts can be found very frequently in our media: moderated debates and panel interviews clearly show both the conflictual element and that of control.

Our research hypothesis is that these design principles can be applied in developing a learning environment able to foster and enact divergent learning, as shown in Fig 1.

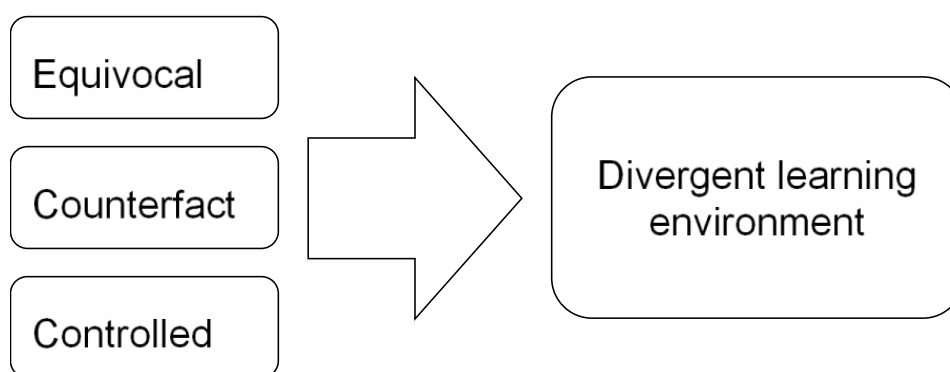


Figure 1. Our three proposed pillars for creating a divergent learning environment

In the following section we present our attempt to instantiate this theoretical framework in a concrete pedagogical method, that here we name Technology Battles.

4 A FIRST INSTANTIATION EXPERIMENT: TECHNOLOGY BATTLES

An instantiation of the previous theoretical framework provides, deductively, a possible methodology which is contextualized in the experimental setting of its test case. In this contribution, such a test case refers to a number of courses belonging to the Innovation and Entrepreneurship (I&E) minor of the EIT Digital Master School [30]. A historical summary of methodological field tests can be found, at the end of the section, in Table 2. As anticipated, this methodology is here named “Technology Battles” for the reasons outlined below.

In order to generate a class setting able to allow for the three suggested design principles, we adopted a dominant metaphor, or said differently, a boundary object [31], which allow participants to intuitively stick to some groundfield rules (rigidity), while allowing for levels of interpretative flexibility (plasticity). Such a metaphor conveys in a simple fashion the key dialogical design principles and, at the same time, leaves room for further adaptation and interpretation. “Battles” are, at the bottom line, in-class debates, or enacted controlled conflicts, that refer to the English House of Commons as a life example. The House of Commons has been chosen as a reference by its virtue of representing well the principles of equivocal ambiguity, counterfactuality and controlled conflict. Here, the two main parties offer diametrically opposed views around a topic at stake for debate (**equivocal ambiguity**) with no middle ground for compromise. The topic can only be addressed by means of dialectics, thus representing a form of **controlled conflict**. Dialectics evolve around the constant and systematic propositions of counter-facts, namely, facts that counteract the statement of the opponents (**counterfactuality**). These features are also embedded in the very infrastructure of the confrontation, where representatives of the two parties face each other (conflict) and the center is occupied only by the rule keeper (control), the President of the House. For this reason we here refer to “Battles” while “Technology”, as we will see, refers to the specific knowledge domain in which the learners are involved (ICT).

Shifting this metaphor to the classroom, students are divided by the trainers in paired groups of 4-8 people, and challenge the other group with the goal of convincing the audience (the rest of the class) that they represent the “correct” solution to a shared problematic situation. This situation, which constitutes the content of each battle (hereby “battleground”) is drafted by the teaching team, with a focus on three educational dimensions:

- 1 A counterfactual-based scenario originated by a “what-if” question, where “what-ifs” are a generally accepted expression to refer to historical counterfactual scenarios. This allows students to detach from history and reality, promoting the exploration of the alternative worlds that stem from the counterfactual. Counterfactual can be placed in the past, such as “What if Steve Jobs had been cloned?”, but also in the future: “What if humanity decided to move to Mars in 2020?”.
- 2 A vertical/domain-specific priority to bind tightly each battle to the subject-matter of the students’ studies. As said, in the cases presented in this paper, the field of study of the students is ICT, thus qualifying the Battle as technological. As an example, the technical ground could be “privacy vs security” or a confrontation between QWERTY vs DVORAK keyboards.
- 3 An horizontal priority that gives each battle a broader interdisciplinary view, to go beyond a merely technical debate and open up to multidisciplinary content. In the cases presented in this paper, the horizontal priority is typically social or related to climate change. Such a choice is done in order to keep the problem and solution space as open as possible. As an example, a debate over migration or ageing population might open up to socio-economic observations, or an otherwise technical subject such as copyright could be approached from an ethical standpoint.

Once the battleground has been defined, the two groups are given an out-of-class shared meeting to discuss and negotiate the “rules of engagement”. As “generals” agreeing on what “weapons” are allowed and what are forbidden, students are given an opportunity to redefine the battleground jointly, ruling out aspects that might lead the discussion away from the mainline content (i.e. focusing it too much on the counterfactual/fictional element) and altering the setting to be more favourable to their world view (e.g. agreeing not to discuss ethical implications). At the end of this meeting, each battle is ready to be carried out in class, and students are given time to prepare their and strategy. In this phase, they are assisted by appointed “critical minds”, students either internal or external to the groups which provide defensive points to each team, informing them about their weak points, where they are attackable, and how to best defend. This allows teams to be always challenged to think critically.

Closely following the English House of Commons model, each group chooses one spokesperson who will deliver the opening statement for the group. She takes upon herself to represent the views of her team, going beyond her personal identity and beliefs. Once both groups have made their statements, time is given for cross-examination and questions from the audience. Towards the end of the timeslot, groups are asked to deliver their closing statement. As a conclusion, a jury (i.e. the electors/voters) proclaims the winner of the confrontation. Figures 2 and 3 briefly summarize a typical preparation flow, exemplified on a class slot of two hours.

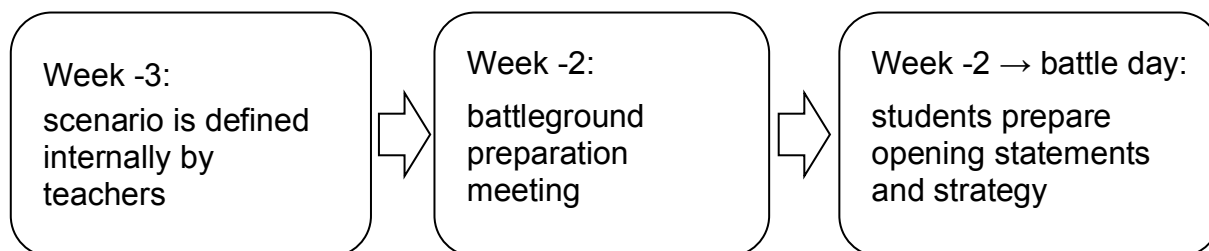


Figure 2. Preparation before the battle. This assumes a regime of one battle/week

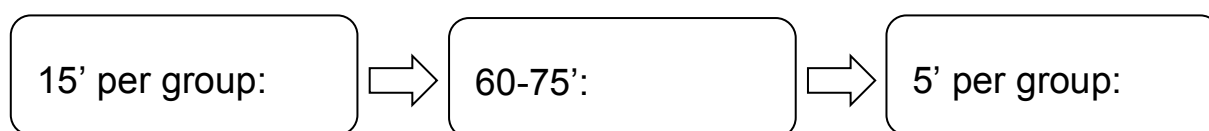


Figure 3. Class timings during the battle in a hypothetical timeslot of 2 hours

At the end of each battle, the “parties” are asked to jointly write a “battle report” in which they detail and conciliate the two views they were assigned. Such a conciliation is expected to be more than a mere summation of the two parts: in this sense, it should represent a step of synthesis rather than compromise. This aspect will be briefly addressed in the discussion and conclusions. The battle report, being the outcome of the two views at stake and following reconciliation, is where the divergent thought is concretized and takes a more defined shape. It is the step in which students are asked to make use of the lessons learned, interiorizing that equivocal ambiguity is a normal feature of the world context and that conflict, if controlled, is a knowledge generation moment. In this sense, it proves that only allowing for new scenarios, contradictions can be solved.

Table 2. Summary of methodological field tests

| Course Name | Academic Year | # of students | Key Points |
|---|---------------|---------------|---|
| “I&E Basics” - UniTN (EIT Digital syllabus) | 2013 | 100 | First introduction of the “tech battles” concept |
| “I&E Basics” - UniTN (EIT Digital syllabus) | 2015 | 120 | At half course, introduction of counterfactual element and horizontal/vertical priorities |
| EIT Digital Winter School - Trento | 2015 | 15 | First small-scale implementation, tighter time constraint (one week) |
| EIT Digital ARISE event - Sofia | 2016 | 20 | One-day event, done outside the space of a proper classroom |
| “I&E Basics” - UniTN (EIT Digital syllabus) | 2016 | 170 | Complete run, with much higher numbers |
| TEDD course | 2017 | 14 | Smaller-scale implementation, with students from a different background |

5 DISCUSSION AND OBSERVATIONS: EXPECTED AND UNEXPECTED RESULTS

Results of the application of this methodology have been promising, even if the methodology is still in an experimental stage. Due to the complex nature of the experimental setting and its social dynamics, results have been considered from a qualitative perspective. The main observations stem from the interplay of the three design principles that have been proposed.

The exploration of equivocal ambiguity led to the consideration of plausibility as a novel epistemological criteria, as opposed to the dichotomy of verification/falsification. While verification relies on the positivist narrative that knowledge discovery is a constant process of proving the truth value of an assertion, and falsification binds it to the possibility to falsify a scientific claim, the battle winner has been neither the group able to assert the truth of its interpretation, nor the one able to falsify the claims of the other. Given the time constraints and, more deeply, the intrinsic condition of ambiguity, successful interpretations were those that proved to be more convincing, persuasive, sound and well exposed also by means of different media. In a word, winning interpretations were those that appeared to be more **plausible**. This aligns well with the proposed theoretical framing, whereby ambiguity can be resolved only by means of intersubjective agreement and social construction [32]. In the class, every position could have been argued, but rather than seeing this as a problem, this fact has been embraced as a generator of the much-sought divergent knowledge. If, at the bottom line, an observation can be made, is that students did understand in practice that, aside from our social tendency to think of ourselves as truth/false driven cognitive entities, plausibility occurs in our very life experience in most circumstances, be them technical, political or social.

The design principle of controlled conflict has shown unexpected social behavioral patterns, and, if it could be said so, cognitive gains. Socially, the mandatory nature of the conflictual/confrontational setting led groups to situations in which internal contradictions were forced to emerge, convergent and compromising attitudes needed to be constantly compensated with critical counter arguments, and questioning gained a supremacy over answering. This last point is worth an observation: while traditional convergent learning poses an emphasis at questions as knowledge seeking moments (i.e. as drivers towards answers), in this setting questioning became a constructive practice able to exercise the capacity to disagree and respect disagreement as a key productive moment. Indeed, some of the positions that the students have expressed could only be generated in a setting in which each statement is cross-examined, questioned and criticized multiple times, since the very goal of each team was to defend/attack, rather than assert, a clearly subjective perspective. Furthermore, as a learning tool, it has made students able to address such a complex social dynamic in, somehow, a simplified fashion. Since the “party” to stand for was a given, a series of ethical/moral value judgement rooted in personal beliefs had to be put aside in order to “do the job”. Said differently, given the task at stake, personal identities had to be challenged from the very first moment.

Finally, counterfactuals have created, possibly as a side effect, an ability to focus on learning as a double loop, rather than a single loop, commitment. We observed a systematic shift from a dialogue rooted in technical competence to one able to exploit important meta-skills, such as participation, confrontational attitude, ability to question and challenge implicit assumptions, and advocacy as a means to construct new social configurations. Hence, it has been observed that the key learning for the students was not much in an accretion of their technical knowledge, but rather in a deeper understanding of how the content specific to the instantiation connects with other topics, both within the discipline and in an interdisciplinary perspective. Such a “connectivity” was allowed by the creation of “meta-grounds” (creating the above-mentioned “horizontal priorities”), which could more easily allow for switching from a domain knowledge to another. As an example, many battles have been debated on core ethical issues, and have given rise to many questions that revisited not only the scenario, but previous assumptions the students had with respect to the world and other social and economic issues. This ability to give rise to new questions and enact new hypothetical worlds in line with what has been described by Lewis [29].

Another point of observation relates to how the randomness in forming groups and assigning sides of the argument generates an exploration/exploitation dynamics internal to the groups. It has been observed that each group faces the implicit requirement of quickly and continuously switching between the two mindsets. On the one hand, an exploitation-driven reflection is carried out in order to justify the position each student has been (randomly) given, especially since the single members of the group might strongly disagree with their assigned position. On the other hand though, with the help of the “critical minds”, the students need to examine how their arguments look like from the perspective of

their opponents, going back to exploration. In this sense, we observe that the exploration/exploitation dynamic occurs at least on a bidimensional basis; along the class battle confrontational chronology, but also along the process of intra-group consensus building.

Having said that, the main practical challenge in successfully deploying this methodology appears to be in building a relationship of trust between students and teachers in applying such an unconventional methodology. The lack of familiarity from the side of the students caused courses to be subjected to “slow starts”, since students felt a degree of disorientation with respect to how they were supposed to engage in the class. This appears to be in line with the theoretical observation on the higher contextual difficulty of divergent thought, in this case given especially by risk avoidance and group identity.

Other salient variables that can affect the success of the methodology appear to be class size, length of the course, and time given to students to prepare for battles. In this sense, once more, some key tradeoffs must be undertaken. For example, we have observed that the time which is given to students to prepare their case should be carefully balanced to be long enough to give time to elaborate a more complex thought, but not so much that students can start iterating and approaching their own argument in an exploitative mindset.

6 CONCLUSIONS: FROM THE CLASS TO THE ROLE OF HEIS IN CONTEMPORARY SOCIETY AND BACK

In this paper, we have defined what we call convergent and divergent thinking. We have shown how divergent thinking has been applied to many knowledge generating contexts, but the classroom has been left behind. To bridge this gap, we proposed three design principles that could be adopted with the goal of facilitating this new unexplored applicative ground. A concrete instantiation, application and implementation in the context of an EU wide network of HEIs has been presented, along with reflections on the experiments which have been carried out with respect to the three methodological principles and other class dynamics.

The theoretical grounding of this contribution proposes, however, some considerations that, we believe, go much beyond the actual design of a classroom to allow for divergent thinking.

Why not consider a university classroom as one of the key knowledge fabrics of contemporary societies. This statement holds on some substantial premises as well as consequences. As a ground premise, HEIs are widely and unanimously claimed to play a pivotal role in boosting sustainable innovation allowing, as their core mission, for the systematic creation and transfer of new knowledge. Taking the EU as an exemplary playground, it has placed a number of instruments including the EIT, as fundamental in the making of the so-called Knowledge Society [33].

On the other hand, these very statements are always followed by a strong critical consideration and consequence: if HEIs are to play such a role, it needs to be deeply reformed [34]. What these reforms are about can be discussed at length, but this is not the place to do so. However, a very straightforward and somehow naïve consideration can be made. If universities are to deliver innovation, they need to be innovative; and in order to be innovative, they need to embrace and allow for innovation in their very vital functions, from governance to management and, undoubtedly, to education: the very reason why they were invented and still resiliently exist. Indeed, these modern monasteries took on board the mission to agnostically pass knowledge from generation to generation, culture to culture, across boundaries and throughout social turmoils.

Although this line of reasoning might sound very complex, our good news is that both the premise and consequence that we wish to propose are rather simple, if not again naïve. If a) the contemporary knowledge endeavour is much more about innovation rather than conservation; b) innovation is also and predominantly about divergent thinking; c) HEIs are called to become key innovation engines and d) classrooms are the core knowledge fabric of HEIs, we infer the following: in order to reform universities from within their inner circuits, classes should be also reformed in the same spirit, allowing for exploration and divergent thinking. This step is vital if they are to play their part in matching the paramount expectations placed onto this important social enterprise.

Going back to our contribution, we definitely do not have any pretence to fulfill such a tremendous task. On the other hand, we wish that our preliminary work, which looks like more like a question mark than a solution, could contribute to some divergent thinking for education policy makers, academics

and pedagogists in reflecting on how the so called “classroom” can match the expectations of a socio-economic environment which is loudly calling for that.

To put in the terms of Ashby's law of requisite variety: “The greater the variety within a system, the greater its ability to reduce variety in its environment through regulation.”. Said differently, in order to cope with the variety of contemporary environments, classrooms should embrace at least a similar level of internal variety. With the Battles we attempted to put some variety in that class. Indeed, sometimes the experience has been messy, but it has proven to be at least enjoyable for both trainers and students. We hope that future research and practice will propose and test alternative and even contradicting designs and methods to foster this variety. In a sense, if we are to embrace equivocal ambiguity, we look forward to alternative interpretations willing to engage in a battle with our contribution... of course, to be fought within the regulated conflict battlefields of an academic conference or journal.

ACKNOWLEDGEMENTS

The authors wish to give their special thanks to Andrea Capaccioli and the I&E Team: Andrea Guarise, Angelina Batasheva, Galena Pisoni, Giulia Corsi, Gert Guri, Malvina Ilieva, Maurizio Marchese and Monica Cosi. The authors also wish to express their gratefulness towards the students of the TEDD course: Francesca Perri, Agnese Del Zozzo, Giorgia Bissoli, Anna Zanoni, Anna Regolini, Valeria Volpini, Liubov Golikova, Sabrina Cuoco, Talia Sbardella, Oscar Bottes, Ilaria Franch, Giulia Carmeci, Marisa Monteiro Vaz, Marco Tosato, Giulia Scapin.

REFERENCES

- [1] March JG. Exploration and Exploitation in Organizational Learning. *Organization Science*. 1991;2(1):71–87.
- [2] Weick KE. Enacted Sensemaking In Crisis Situations[1]. *Journal of Management Studies*. 1988;25(4):305–17.
- [3] Daft RL, Weick KE. Toward a Model of Organizations as Interpretation Systems. *The Academy of Management Review*. 1984;9(2):284.
- [4] March JG. *The ambiguities of experience*. Ithaca: Cornell University Press; 2010.
- [5] Weick KE. *Sensemaking in organizations*. Thousand Oaks, Calif.: Sage; 2009.
- [6] Boland RJ, Tenkasi RV. Perspective Making and Perspective Taking in Communities of Knowing. *Organization Science*. 1995;6(4):350–72.
- [7] Argyris C. Single-Loop and Double-Loop Models in Research on Decision Making. *Administrative Science Quarterly*. 1976;21(3):363.
- [8] Ettlie JE, Bridges WP, O'keefe RD. Organization Strategy and Structural Differences for Radical Versus Incremental Innovation. *Management Science*. 1984;30(6):682–95.
- [9] Christensen CM, Baumann H, Ruggles R, Sadtler TM. Disruptive innovation for social change. *Harvard business review*. 2006 Dec 1;84(12):94.
- [10] Kuhn TS. *The structure of scientific revolutions*. Chicago, IL: The University of Chicago Press; 2015.
- [11] Latour B. *Science in action: how to follow scientists and engineers through society*. Cambridge, MA: Harvard University Press; 1987.
- [12] Brown J, Duguid P. Organizational Learning and Communities of Practice: Toward a Unified View of Working, Learning, and Innovation. *Knowledge and Communities*. 2000;:99–121.
- [13] Lave J, Wenger E. *Situated learning: legitimate peripheral participation*. Cambridge: Cambridge University Press; 1998.
- [14] Prince M. Does Active Learning Work? A Review of the Research. *Journal of Engineering Education*. 2004;93(3):223–31.
- [15] Prince MJ, Felder RM. Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases. *Journal of Engineering Education*. 2006;95(2):123–38.

- [16] Prince MJ, Felder RM. Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases. *Journal of Engineering Education*. 2006;95(2):123–38.
- [17] Levinthal DA, March JG. The myopia of learning. *Strategic Management Journal*. 1993;14(S2):95–112.
- [18] Zollo M. Superstitious Learning with Rare Strategic Decisions: Theory and Evidence from Corporate Acquisitions. *Organization Science*. 2009;20(5):894–908.
- [19] Hunt SD, Morgan RM. The Resource-Advantage Theory of Competition: Dynamics, Path Dependencies, and Evolutionary Dimensions. *Journal of Marketing*. 1996;60(4):107.
- [20] Taleb NN. *The Black Swan: the Impact of the Highly Improbable*. London: Allen Lane; 2007.
- [21] Senge P, Kleiner A, Roberts C, Ross R, Roth G, Smith B. *The dance of change: the challenges of sustaining momentum in learning organizations*. New York: Currency/Doubleday; 1999.
- [22] Nonaka I. A Dynamic Theory of Organizational Knowledge Creation. *Organization Science*. 1994;5(1):14–37.
- [23] Maanen JV. Observations on the Making of Policemen. *Human Organization*. 1973;32(4):407–18.
- [24] Wenger E, McDermott RA, Snyder W. *Cultivating communities of practice: a guide to managing knowledge*. Boston, MA: Harvard Business School Press; 2010.
- [25] Orr JE. *Talking about machines: an ethnography of a modern job*. Ithaca, NY: ILR press; 1996.
- [26] Senge PM. *The fifth discipline: the art and practice of the learning organization*. New York: Doubleday/Currency; 2006.
- [27] March JG. Bounded Rationality, Ambiguity, and the Engineering of Choice. *The Bell Journal of Economics*. 1978;9(2):587.
- [28] Goodman N. The Problem of Counterfactual Conditionals. *The Journal of Philosophy*. 1947;44(5):113.
- [29] Lewis DK. *On the plurality of worlds*. Malden (Mass.): Blackwell Publishers; 2013.
- [30] Master School [Internet]. // EIT Digital. 2017 [cited 2017May18]. Available from: <https://www.eitdigital.eu/eit-digital-academy/master-school/>
- [31] Leigh Star S. This is not a boundary object: Reflections on the origin of a concept. *Science, Technology, & Human Values*. 2010 Sep;35(5):601-17.
- [32] Berger PL, Luckmann T. *The social construction of reality: A treatise in the sociology of knowledge*. Penguin UK; 1991 Mar 28.
- [33] Communication to the Spring European Council, Working Together for Growth and Jobs. A New Start for the Lisbon Strategy. Communication from President Barroso in agreement with Vice-President Verheugen. COM (2005), {SEC (2005) 192} {SEC (2005) 193}, 24 - final.
- [34] Communication from the Commission to the Council and the European Parliament - Delivering on the modernisation agenda for universities - Education, research and innovation COM/2006/0208 final