Teacher-training, ICT, creativity, MOOC, Moodle - What pedagogy?

TEACHER-TRAINING, ICT, CREATIVITY, MOOC, MOODLE - WHAT PEDAGOGY?

Slavi Stoyanov, Peter Sloep, Marion de Bie, Vérénice Hermans

Open University of the Netherlands

INTRODUCTION

As part of the Handson ICT[i] project we need to design a teacher-training MOOC course on applying Information and Communication Technologies (ICT) with support of creativity techniques. The course should utilize learning-by-doing learning approach and run within a MOODLE LMS. This paper, applying design-based research methodology, describes our experience in developing this course through series of design iterations and evaluations. The research questions we address are as follows: What are trends and challenges of teaching creativity with ICT as indicated by literature and good practices? What are pedagogical approaches relevant for HandsonICT MOOC? What changes need to be made to address the participants experience with the HandsonICT MOOC as suggested by the first pilot of the course? What are the lessons learned with the design and evaluation of the Handson ICT MOOC? We first make an overview of the findings from a systematic literature review and a screening of good practices in regard to teacher-training in creativity and ICT. Then we discuss different learning theories and instructional design approaches, and especially how they can be implemented in a MOOC for teaching creativity and teaching creatively using ICT tools. In the next step we describe different versions of the HandsonICT MOOC course. Finally, we conclude with some lesson learned.

TRENDS AND CHALLENGES IN TEACHING CREATIVITY WITH ICT

A systematic literature review across databases such as Academic Search Elite, ERIC, PsychINFO and Google Scholar was carried out to identify issues, trends and challenges with regard to teaching creativity with ICT. Combinations of terms such as creativity, teaching and technology were used, allowing for searching not only by keywords but also within the full text of the articles and applying related words. The search was restricted to peer-reviewed articles in the period of June 2008 until June 2013. The procedure yielded 507 papers. Although this was a relatively conservative approach to the selection of relevant papers, in actual fact many more articles were analysed as the study included not only first but also second-order meta-analytical research. Some additional sources were added as a result of cross-referencing. All abstracts were screened applying a set of exclusive criteria, namely: (a) cognitive aspects of creativity (b) creativity related to specific subject-matter such as music, creative writing or history research; (c) technology but not ICT, (e. g. robotics) and (d) STEM (Science, Technology, Engineering and Math) initiatives. After this screening process, 28 papers remained for a further analysis of their full texts.

Summary of findings

Most of the teachers in Europe support the idea that creativity is a fundamental skill to be developed in schools and they believe that ICT can be used to foster it. A relatively large proportion of teachers in Europe have received training in innovative pedagogies or methods but it is not the case with training in creativity and using ICT for educational purposes (Cachia, Ferrari, Ala-Mutka, and Punie, 2010).

While social learning with Web 2.0 tools has been enthusiastically accepted by many teachers, innovative and evidenced-based examples have not been implemented into the real schools' practice on a large scale (Redecker, Ala-Mutka,Bacigalupo, Ferrari and Punie, 2009).

Teachers are often burdened by a steep learning curve to keep pace with new technologies (O'Brieti, Aguinaga, Hines and Hartshorne, 2011).

---

[i] http://handsonict.eu/project/

Constant technological evolution requires that teachers not only be fluent with current technologies, but that they develop a mindset for learning new technology in ways that promote flexibility, autonomy, and creativity, and learn how to learn with technology (Shaltry., Henriksen, Lun Wu and Dickson, 2013).

The current situation in teaching, which is characterised by a focus on testing and accountability, by Ill-equipped teachers, by time pressure, and by a view of creative practices as something "extra", leads to the exclusion of creative teaching and learning (Nicholl, and McLellan, 2008).

There is a circular and reciprocal relationship between creativity and technology. Technology can enhance creativity, technology can require creativity, and creativity is often necessary to take advantage of the various affordances of technology for teaching and learning (DeSchryver, Leahy, Koehler, and Leigh, 2013). Research has consistently shown that technology alone cannot significantly impact teaching and learning unless it is combined with effective and efficient instructional design. However, technology could provide efficient ways of exploring information and designing solutions (Chandra, and Lloyd, 2008; Mishra, Koehler., and Henriksen,,2011; Van Merriënboer, and Stoyanov, 2008; Yang, Tzuo, and Komara, 2011 . Integrating technology in teaching and learning have demonstrated positive effects on students' motivation, attitudes, achievement, and peer interactions in the classrooms (Yang, Tzuo, and Komara, 2011). Re-examining the effect of teaching and learning with technology on student cognitive and affective outcomes using a meta-analytic technique indicates that, overall, effect sizes were small to moderate. Project-based learning (PBL) yielded the highest effect. Each of the PBL steps were anchored upon basic skills/factual learning and instructional elements that are challenging, sense-making, collaborative and contextualized (Lee, Waxman., Wu, Michko, and Lin, 2013).. One effective approach to study technology is to involve students in projects in which they use technology to explore technology and then share their experience as how this particular technology can be used for education purposes (Shaltry., Henriksen, Lun Wu and Dickson, 2013).

Eight learning approaches using ICT have proved effective (Stokes, 2012): learning from experts; learning with others (peers) as three particularly promising areas for development were identified: representational tools, scaffolding tools and communications tools; learning through making - it involves students in constructing and sharing artefacts (e.g. Learning by design); learning through exploring - strategies and skills are required to find and filter information usefully; learning through inquiry - learners can ask questions, formulate hypotheses, and conduct experiments using mobile devices, simulations and augmented reality; learning through practicing; learning from assessment - adaptive technologies and learning analytics can be used to support formative assessment, self-assessment and peer-assessment; learning in and across settings - technology (PDAs, cameras to GPS-enabled phones, mobile technologies) can help teachers and learners collect, store, compare and integrate information from and across different settings and contexts.

A popular approach for teaching creativity is the Cognitive Research Trust – CoRT programme (De Bono, 1992). The author describes a number of techniques, called tools (e.g 'Six Thinking Hats'), that need to be mastered like any tool.

In addition to the literature review an attempt was made to identify some good practices of teaching creativity with ICT. Using a pre-specified template, each project's partner described at least four good practices in regard to the current-state-of-the-art of fostering creativity with ICT, associated with projects or surveys conducted in the period 2010-2013. Some suggestions based on the findings are: Consider learning-by-doing, project-based learning, self-directed learning, problem-based learning, and inquiry-based learning. They were the most referred learning strategies and pedagogical approaches; Recon MOOC format; Provide tools to promote online mentoring through forums, social networks and video conferencing tools, webinars, collaboration tools, eportfolio tools used for assessment/self-reflection purposes; Development/deployment of Open Educational resources (OER) repositories with educational resources/content, best practices, pedagogical scenarios about the creative use of ICT in different educational contexts; Utilize a cascade approach, that is teachers are considered as learning agents that will transfer their experience to their colleagues and students.

PEDAGOGICAL APPROACHES RELEVANT FOR HANDSONICT MOOC

The literature review and the scanning of good practices provide a rather fragmented picture of teaching strategies for creative problem solving using ICT, not suggesting any concrete instructional design guidelines. One approach could be De Bono's thinking exercises with creativity tools included in the CoRT programme. It is very much creativity-bounded approach but the tools have been exercised on artificial problems not related to any subject-matter. The CoRT programme had mixed success across schools around the world.

A second approach would be to combine some of the eight instructional approaches as described above (e.g. learning from expert, learning through exploring, and learning through practicing) but a further operationalization of the learning activities is needed and a clear indication how creativity is supported.

A third approach would be to use the template of the instructional design framework of inquiry-based learning (Manlove, Lazonder, and Jong de, Ton, 2009). Inquiry-based learning was one of the approaches suggested by the findings from exploring good practices for teaching ICT and creativity. The idea seems appealing as inquiry-based learning is evidenced-based, has the potential to be applied to all educational levels (from primary school to higher education) and each subject-matter could be designed according to this approach. Creativity could be supported implicitly through the whole process of inquiry-based learning asking and testing different 'what if' questions. In addition, studying a particular subject-matter is a natural way for initiating discussions on how some domain-specific discoveries have been made and showing a range of creative problem solving styles (e.g. from more methodical, small steps incremental improvements within a paradigm to more radical changes across different paradigms[ii]). Inquiry-based learning has often been criticised for not providing enough instructional guidance, which may be problematic, especially for lower educational levels (Kirschner, Sweller and Clark, 2006). In addition there is not an explicit support for creativity. Recently, inquiry-based approach has broaden its definition to increase intellectual engagement and foster deep understanding through the development of a hands-on, minds-on and 'research-based disposition' towards teaching and learning. Inquiry honours the complex, interconnected nature of knowledge construction, striving to provide opportunities for both teachers and students to collaboratively build, test and reflect on their learning" (Stephenson, 2013). It is also claimed that while IBL is based on the pre-existing knowledge structure and skills of learners, it stimulate them to discover new things, something that is 'not yet there'. How people arrive at new things and something that is 'not yet there' is not completely clear and need further elaboration. A very similar approach but specific for teachers as adult learners is Design Inquiry of Learning. Apart from inquiry-based learning, it integrates also the ideas of design science (Laurillard, 2012; Laurillard, Charlton, Craft, Dimakopoulos, Ljubojevic, Magoulas, Masterman, Pujadas, Whitley, and Whittlestone, 2013), design-based research (Collins, Diana, and Bielaczyc, 2004; McKenney, and Reeves, 2013) and studio Instruction in arts and design. Learning Design Studio is the course format that implements the Design Inquiry of Learning (Cox, Harrison and Hoadley, 2008; Mor and Mogilevsky, 2013). Teachers are put in the position of learning designers. They need to identify an educational challenge, to analyse the context of it, to generate ideas for possible solutions, to prototype a solution, to test the solution and to reflect on the design process and outcomes produced.

Other instructional design approaches that could be worth to consider here are problem-based learning (Hmelo-Silver, 2004), cognitive apprenticeship approach (Brown and Duguid, 2000), cognitive flexibility theory (Spiro, and Jehng, 1990) and Four Component Instructional Design Model (4C/ID) (Van Merriënboer and Kirschner, 2007). Problem-based learning was one of the most referred instructional approaches according to good practices findings. Problem-based learning require students to collect information, reflect and discuss it to formulate possible solutions. One substantial criticism to problem-based learning is that it does not provide explicit support in terms of concrete techniques (including creative ones).

[ii] Eg Nuclear chain reaction: Enrico Fermi vs Leo Szilard; Structural Model of DNA: Maurice Wilkins & Rosalind Franklin vs James Watson & Francis Crick

While cognitive apprenticeship is based on the hands-ons of traditional apprenticeship, it also emphasizes on minds-ons of experts' performance. Experts need to externalise and make visible how they use concepts, facts, and procedures when solving problems and accomplish tasks (e.g. T. Buzan showing how he applies mind mapping). The approach utilises six teaching methods, namely: modelling, coaching, scaffolding, articulation, and exploration. 4C/ID is a highly structured approach that confront learners with a problem, which is then divided into a sequence of tasks/sub-problems. For each task a guided support is provided consisting of supportive information (theories, expert's modelling or work out examples). An important component of this instructional design approach is just-in-time training for recurrent skills, that is skills that can be repeated unchangeably in many situations. Examples are searching and filtering information from internet, using concept mapping or mind mapping software tools for visual brainstorming, or scoop.it for organising and sharing information. Cognitive flexibility theory emphasizes on challenging the learners with ill-structured problems and approaching it from different 'criss-crossing' perspectives with multiple representations.

Although the instructional design approaches discussed above represent different instructional design paradigms (e.g. 4C/ID is based on instructivism; problem-based learning, cognitive apprenticeship, and cognitive flexibility promotes constructivism), they share some common components as the theory of First Principles of Instruction (Merrill, 2002) suggests: confronting learners with a problem, issue, challenge, preferably, real-life one; considering the problem from different perspectives; dividing the problem into sub-problems/tasks; for each task an explicit support in terms of background information, examples, procedures, methods, techniques, and tools is provided; and deliberate practicing

As teachers are adult learners, principles of adult learning should be taken into account as well. Adults are internally motivated and self-directed; Adults draw upon their experiences to aid their learning; Adults are goal and relevancy oriented. Adults are problem-centred rather than content-oriented. Some of the instructional guidelines to support adult learning include: there is a need to explain the reasons specific things are being taught; instruction should be task-oriented instead based on memorization; instruction should take into account the wide range of different backgrounds of learners; learning materials and activities should allow for different levels/types of previous experience; since adults are self-directed, instruction should allow learners to discover things and knowledge for themselves but guidance and help should be provided when mistakes are made Knowles, 1984).

Massive Open Online Courses (MOOCs)

With the hype around Massive Open Online Courses (MOOCs) one issue that has not received yet sufficient attention is pedagogies within MOOCs. Very often the discourse on MOOCs learning designs has been replaced by a discussion on the affordances of technological platforms. When it comes to classifications of pedagogies they typically include three categories: cognitive-behaviorist, socio-constructist and connectivist (Dron and Anderson, 2011). Cognitive-Behaviorist approach has been associated with xMOOCs, while social constructivism and connectivism have been linked to cMOOCs. While the debate xMOOC vs cMOOC is useful on a general level, it is not particularly helpful on micro-level, that is how learning activities should be structured to foster effective, efficient and enjoyable learning. Research also indicates that such a dichotomous, 'either-or', categorization obscures variation and richness of the pedagogic approaches applied (Conole, de Laat, Dillon and Darby, 2008). Conole et al., suggest a more elaborated classification, called 7S, aimed at helping teachers to design better learning experiences. The 7S are as follows: Conceptualize (what is the vision for the course?), Capture (a resource audit), Communicate (mechanisms to foster communication), Collaborate (mechanisms to foster collaboration), Consider (assessment strategies), Combine (overarching views of the design), and Consolidate (implementing and evaluating the design in a real learning context). For each 'C' a range of resources and tools to guide the teacher through the design process have been proposed. This design framework is based upon the author's understanding of what characterizes a good learning, namely: encourages reflection, enables dialogue, fosters collaboration, applies theory learnt to practice, creates a community of peers, enables creativity and motivates the learners.

Our approach is similar but we draw upon a particular theory of learning, that is experiential learning Kolb, 1984), and further operationalize its principles with some instructional design guidelines based on the idea of First Principles of Instruction Merrill, 2002), which demands a combination of components of different instructional design approaches. Experiential learning includes different modes of grasping and transforming learning experience, including learning-by-doing, which was requested by the original project's assignment, but not limited to it. The theory of experiential learning promotes also the idea of learning styles. One challenge with designing MOOC(s) is how to accommodate the needs of the participants whose number is expected to be high. The four learning styles associated with the experiential learning theory (Kolb, 1984; Honey, and Mumford, 1992) could help in structuring the content. For each task the participants can be asked to explore information in terms of (a) theoretical background, accommodating different perspectives – theorist learning style); (b) work out examples or modeling examples (expert performance) – reflector learning style'; (c) procedures (heuristics, or rules of thumb) – pragmatist learning style; and (d) practicing the task creating an artefact – activist learning style. Prompted by their dominant learning style, the participants could choose to start with any of the content types described (preferential adaptation) but need to complete all of them (compensational adaptation). In addition, the experience needs to be reflected upon, shared and discuss with others. Although adult learners are assumed to be self-directed learners, the literature suggests (Kirton, 2003) that people differ in how much structure they would prefer to see in the content and learning activities. People can be positioned on a continuum with one extreme external learning locus of control (looking for very structured course and guidance) and the other – internal learning locus of control (as minimal structure and guidance as possible). This difference in preferences to structure and guidance is not related to level of knowledge and skills people have. A group of skilled learners, for example, can include a range of learning locus of controls. The paradox of knowledge structure ([Kirton, 2003; Stoyanov and Kirscher, 2007) states that structure is both enabling and restricting. People with more external learning of control would see the enabling part of the structure, internal learning of controls would notice the restricting part of it. Apparently we can not without any structure, the questions is to find a balance – neither too much, nor too little structure, which is a challenge. Different options for students should be made available. We could provide the students with some sequences of learning activities and recommended recourses, but also ask them to explore a topic and share their findings with others. The participants should be given the opportunity to go outside the course environment to construct their knowledge connecting with people who are not part of the course. Finally the design of the course should take into account the behavioral patterns (personas) that have been identified in MOOCs. We should expect that less than 10% of attendee will complete the course. Some people would only be active in one or two activities. A third group would only download some of the resources. A fourth group would passively be observing what is happening. The evaluation of OLDS MOOC indicates that although less than 10% of the participants finished the course, 80% reported a gain, they learned something from the course (Cross, 2013).

Technological tools could be offered to facilitate learning activities (e.g. scoop.it for curating and sharing information; mind mapping for idea generation; forums for discussions).

HANDSON ICT ITERATIVE COURSE DESIGN

The first version of the HandsonICT was very simple and addressed the original assignment of presenting a number of creativity techniques supported by some ICT tools. The content included three creativity techniques: Mind Mapping and Concept Mapping, Six Thinking Hats, and Triggering Questions (SCAMPER). The design blueprints of the units were a subject of critical discussions within the project. The design blueprint of mind mapping, concept mapping and creativity included the following elements (to save space only suggested actions for mind mapping are presented): Introduction to Mind Mapping (An introduction to mind mapping given by the originator of the technique Tony Buzan); Information and examples how fellow teachers use mind mapping; Review mind mapping software; Create mind maps with software; Create a mind map on a topic related to participants' professional practice with mind mapping software.

Each of the three units run on one week in the period of 13th – 20th January 2014. Eighteen participants from countries representing the project (Greece, Slovenia, Spain, United Kingdom and The Netherlands) took part in this pilot. Although, in general positive, the results from a survey and interviews identified some drawbacks that needed to be addressed for the second pilot. They are as follows: lack of context for creativity techniques, too much instruction, lack of clear link to the real teaching practice, the need of designing educational artifacts, and more interaction with the tutor and peers.

To improve the course in all these aspects, we adopted but also adapted the Learning Design Studio (LDS) format and followed the principles of experiential learning and the guidelines of the First Principles of Instructional Design. The basic idea is that the teacher is put in the position of a learning designer, that is s/he identifies an issue with the educational practice to which a solution is needed (a tool supporting the design of a lesson plan or a learning game), looks upon different theories and good practices to devise solutions, develops design blueprints, mock ups or prototypes, test to improve them, and implement them into the professional practice. 'Prototype' means a storyboard, or a paper prototype, not a digital prototype, which certainly is not meant to restrict the participants if they want to go for a software application. Creativity is covered by the overall idea of design studio, and a special unit on Ideation and Conceptualization with creativity techniques integrated in a creativity set up. Writing Persona, Visioning and Storyboarding can also be considered creativity techniques.

The first unit of the course is Advanced Organiser. It informs the participants on how the course is organized and what they could expect from it. A publication on LDS is attached as well. The participants are advised to start writing an individual Learning Journal, which is sort of an assessment portfolio. Learning Journal could be a sequence of blogs.

The second unit is needs assessment for defining the educational challenges to which the participants are going to provide a solution. It should be a real educational problem, something in their practice that needs to be improved. The basic technique proposed is contextual inquiry interview (CII). Although recommendations for some sources of information are given, the students need to search for and explore information about CII, curate and shared it using scoop.it or peartrees software, and finally conduct themselves a contextual inquiry interview. With typically many people involved in MOOCS, it is more natural, realistic and practical for the participants to conduct needs analysis with their colleagues in school rather than make MOOC groups with people who are reluctant to do so and have completely different issues to discuss. The tools used (scoop.it and/or peartrees) allow for a more connectivist way of building knowledge with people outside the course environment. Pearltrees for example, is a cloud service where one can create a digital concept map on an topic, can borrow nodes, called 'pearls' from others, will be informed about similar pearltrees, and can team up with others with similar interests. This learning activity gives also the participants an opportunity to discuss in a forum ('A faster horse vs a car') a common issue when conducting a needs analysis – what people want vs what they need. The discussion is prompted by famous saying of H. Ford: "If I had asked people what they wanted they would have said faster horses". Eventually he constructed a car.

The third unit is based entirely on Writing Persona, a technique that consolidates the information collected in the previous activity of needs assessment . Some readings about persona are recommended but the participants are encouraged to make their own search and to share information with others (in a Moodle forum, a blog, twitter, scoop.it, pearltrees). The final task of this learning activity requires each student to write a persona.

The fourth unit is Ideation and Conceptualisation, that is searching for, generating and selecting solutions to the challenge. A combination of creativity techniques in a ideation set up (SCAMPER, The Dreamer-the-Critic-the Realist, Six Thinking Hats, Forced relationship, Inside View) is proposed to support these actions. Affinity diagram technique is suggested to facilitate conceptualisation. Mind mapping tools such as Mind Meister and Coogle.it are proposed for idea generation and concept mapping tools such as cMap and Visual Understanding Environment (VUE) are recommended for

supporting conceptualisation. Additional information is given for two more advanced tools: Concept Systems Global Max and Optimal Sorting.

The fifth unit is developing a prototype, which consists of visioning and a storyboarding but the participants are not restricted to develop a digital prototype if they wish to do so. One of the critics during the internal project evaluation was that most of the students would feel intimidated if asked to develop a software application. The unit includes also a forum where the participants could discussed three educational software prototypes, winners of a competition for educational software applications.

In the last unit the participants need to perform some actions to evaluate their products. The students are provided with an evaluation script template and asked to adapt it to their situation. In addition the participants are asked to try out a walkthrough-with-think-loud interview method provided with some guidelines, and eventually apply a usability questionnaire. System Usability Scale (SUS) toolkit is attached as a resource.

The final assessment consists of a presentation of the final product with a reference to all artefacts that have been created along the way (needs analysis, persona, visioning, storyboard). Individual learning Journal is also part of the final assessment.

This course design was also a subject of expert evaluation. The main critic was that the course is complex and requires students to invest too much time. The solution was to keep the course as simple as possible with minimum information about the learning activities, and make the remaining parts optional (see Figure 1 as an illustration). For example, the contextual inquiry interview, usability questionnaires, tools such as Optimal Sorting, Concept System Global and pearltrees are voluntary now. Participation in the forums 'a fast horse vs a car' and 'evaluating winners prototypes' is optional as well. The course will also include a Google Hangouts for introduction of the course and convergent discussions after each unit. Before the second pilot nearly 1000 people have subscribed to the course.

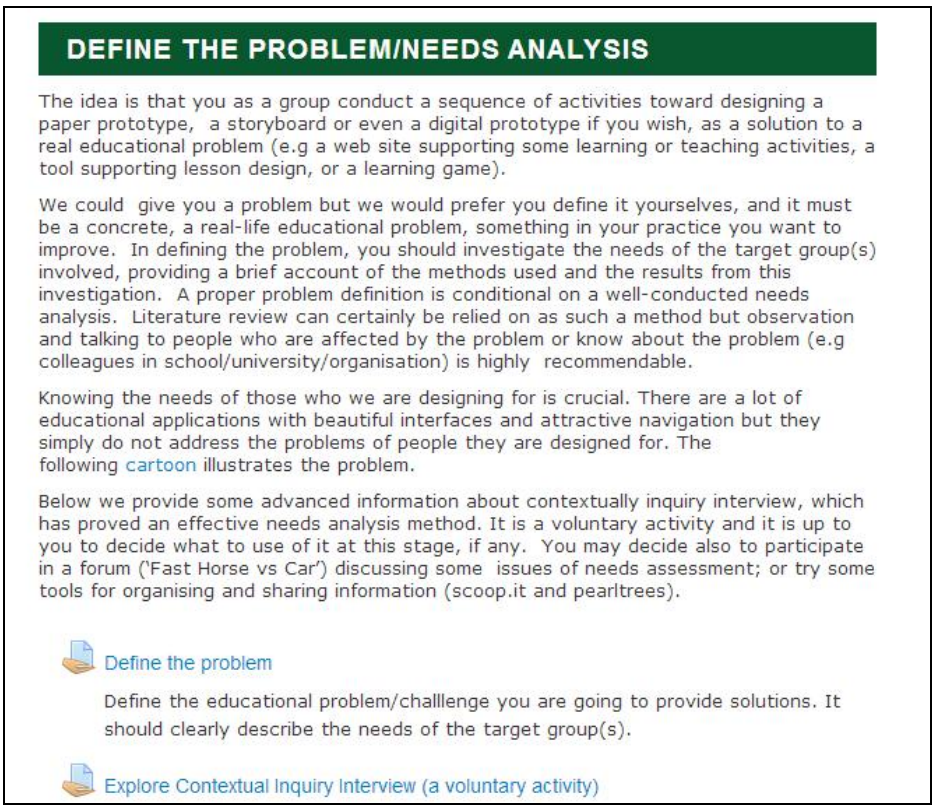

Figure 1. Part of the unit Needs Analysis with compulsory and optional activities

CONCLUSIONS OR LESSON LEARNED

1. The best way to understand what is it to design and teach a MOOC is to design and teach a MOOC. Teaching teaches teaching.
2. Although MOOC is new phenomenon "old guns" such as classical learning theories and instructional design approaches can help the MOOC design. They have accumulated extensive experience and are evidence-based.
3. Combining cMOOC and xMOOC, instructivism, constructivism and connectivism is really a challenging task but it is worth keep trying as it would lead to true effective, efficient and enjoyable learning experience.
4. 'M' is the trickiest in the configuration 'MOOC'. Massive participation may require dramatic changes in the initial course design, even in the meaning of 'C' (course). Course completion is maybe not the most important result but rather the acknowledgment that people learn what they like or find interesting and they are going to use it. 'M' also means accommodating as much as possible the needs of the participants. It may seem a 'mission impossible' but research-based expectations on behavioural patterns of people taking part in MOOCs and their preferences for structuring content and learning activities could be a good starting point for the design .
5. When designing a MOOC, the first assumption should be that we are going to make mistakes. The question is to identify what and why are these mistakes and gradually improve the design (Successive Approximation Model – SAM; Design-Based Research).

REFERENCES

Brown J.S., Duguid P.(2000). *The social life of information*. Harvard Business School: Boston, MA.

Cachia, R., Ferrari, A., Ala-Mutka, K. & Punie, Y. (2010). Creative learning and innovative teaching. *JRC Scientific and Technical Reports*. European Commission, Join Research Centre, Institute for Prospective Technological Studies.

Chandra, V., & Lloyd, M. (2008). The methodological nettle: ICT and student achievement. *British Journal of Educational Technology*, 39(6), 1087–1098.

Collins, A., Diana, J., & Bielaczyc, K. (2004). Design research: theoretical and methodological issues. *The Journal of The Learning Sciences*, 13(1), 15-42.

Conole, G., de Laat, M., Dillon, T., & Darby, J. (2008). Disruptive technologies, pedagogical innovation: What's new? Findings from an in-depth study of students' use and perception of technology. *Computers & Education*, 50, 511– 524.

Cox, C., Harrison, S., & Hoadley, C. (2008). Applying the ''studio model'' to learning technology design. In C. DiGiano, S. Goldman and M. Chorost (Eds). *Educating learning technology designers: guiding and inspiring creators of innovative educational tools,* pp. 145-164. Routledge, NY.

Cross, S. (2013). Evaluation of the OLDS MOOC curriculum design course: participant perspectives, expectations and experiences. *OLDS MOOC Project*, Milton Keynes .

De Bono (1992).*Teach your child how to think*. London: Viking.

DeSchryver, M.D., Leahy, S.M., Koehler M.J.,& Leigh G. W. (2013). Technology, learning, creativity, and design: The habits of mind necessary to generate new ways of teaching in a career of constant change. *TechTrends* , May/June 2013 57 (3).

Dron, J. & Anderson, T.(2011). Three generation of distance education pedagogies. *International Review of Research in Open and Distance Learning*, 12(3).

Hmelo-Silver, C.E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review*, 3, 235–66.

Honey, P., &. Mumford, A. (1992) *The Manual of learning styles*. Maidenhead, Berkshire: Published and Distributed by Peter Honey .

Kirschner,P.A., Sweller, S., Clark, R.E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, 41(2), 75–86.

Kirton, M. (2003). Adaption—Innovation in the context of diversity and change. London: Routledge.

Knowles, M. (1984). *Andragogy in Action*. San Francisco: Jossey-Bass .

Kolb, D. A. (1984). Experiential learning: Experience as the source of learning and development. New Jersey: Prentice-Hall .

Laurillard, D. (2012). Teaching as a Design Science: Building Pedagogical Patterns for Learning and Technology. Routledge, Florence, NY.

Laurillard, D., Charlton, P., Craft, B., Dimakopoulos, D., Ljubojevic, D., Magoulas, G., Masterman, E., Pujadas, R., Whitley, E.A. and Whittlestone, K. (2013). A constructionist learning environment for teachers to model learning designs. *Journal of Computer Assisted Learning*, 29,15–30.

Lee, Y.-H., Waxman. H., Wu, J.-Y., Michko, G., & Lin, G. (2013). Revisit the effect of teaching and learning with technology. *Educational Technology & Society*, *16* (1), 133–146.

Manlove, S., Lazonder, A.W. & Jong de, Ton (2009). Trends and issues of regulative support use during inquiry learning: patterns from three studies. *Computers in Human Behavior*, 25 (4), 795-803.

McKenney, S. & Reeves, T.C. (2013). Systematic review of design-based research progress: Is a little knowledge a dangerous thing? *Educational Researcher*, 42(2), 97-100.

Merrill, D. (2002). First principles of instruction. *Educational Technology, Research and Development*, Vol. 50, pp.43–59.

Mishra, P., Koehler, M.J., & Henriksen, D. (2011). The seven trans-disciplinary habits of mind: Extending the pack framework towards 21st century learning. *Educational Technology, 11*(2), 22-28.

Mor, Y., Mogilevsky, O. (2013). The learning design studio: collaborative design inquiry as teachers' professional development. *Research in Learning Technology* 2013, 21.

Nicholl, B., McLellan, R. (2008). We're all in this game whether we like it or not to get a number of As to Cs. Design and technology teachers' struggles to implement creativity and performativity policies. *British Educational Research Journal*, 34 (5), 585–600.

O'Brieti, C., Aguinaga, N.J., Hines, R., & Hartshorne, R. (2011). Using contemporary technology tools to Improve the effectiveness of teacher educators in special education. *Rural Special Education Quarterly*, 30(3), 33-40.

Redecker, Ch., Ala-Mutka,K., Bacigalupo, M., Ferrari, A., & Punie, Y., (2009). Learning 2.0: The impact of Web 2.0 innovations on education and training in Europe. *JRC Scientific and Technical Reports*. European Commission, Join Research Centre, Institute for Prospective Technological Studies.

Shaltry, C., Henriksen, D., Lun Wu M., & Dickson, P.W. (2013).Teaching pre-service teachers to integrate technology: Situated learning with online portfolios, classroom websites and facebook. *TechTrends*, May/June 2013, 57 (3).

Spiro, R.J, Jehng J. (1990). Cognitive flexibility and hypertext: theory and technology for the non-linear and multidimensional traversal of complex subject matter. In: D. Nix and R. Spiro (Eds). *Cognition, education and multimedia*, pp. 163–205. Hillsdale, NJ: Erlbaum.

Stephenson, N. (2013). Introduction to inquiry-based learning. Retrieved from http://teachinquiry.com/index/Introduction.html.

Stokes, K. (2012). Decoding learning: the proof, promise and potential of digital education. *Educational Journal*, 7, (149).

Stoyanov, S., & Kirschner, P. (2007). Effect of problem solving support and cognitive style on idea generation: Implications for Technology-Enhanced-Learning. *Journal of Research on Technology of Education*, 40 (1), 49-63.

Van Merriënboer, J. J. G., & Stoyanov, S. (2008). Learners in a changing learning landscape: Reflections from an instructional design perspective. In J. Visser & M. Visser-Valfrey (Eds.), *Learners in a changing learning landscape: Reflections from a dialogue on new roles and expectations*. Dordrecht: Springer.

Van Merriënboer, J.J.G.,Kirschner, P.A. (2007). *Ten steps to complex learning*. Mahwah, NJ: Erlbaum/Taylor and Francis .

Yang, Ch-H., Tzuo, P-W., Komara, S. (2011). WebQuest and collaborative learning in teacher preparation. Singapore study. *Educational Media International*, 48(3), 209-220.

This project has been funded with support from the European Commission. This publication reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein