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Paul Bourgine
Pierre Collet
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First Complex Systems Digital Campus World E-Conference 2015

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Paul Bourgine • Pierre Collet • Pierre Parrend
Editors

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Editors
Paul Bourgine
Paris, France

Pierre Collet
Univ de Strasbourg
Strasbourg, France

Pierre Parrend
ECAM Strasbourg-Europe
Schiltigheim, France

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Contents

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From Individual to Social Cognition: Piaget, Jung, and Commons

Francisco Antonio Pereira Fialho

1 Introduction

> Butterflies won't exist if life didn't go through a silent and lonely metamorphosis processes (Rubem Alves)

Education is a metamorphosis process. Assimilation, accommodation, as defined by Piaget, and transcendence, the way toward the "self," as stated by Jung, are stages of this growing up process. The final goal is the realization of the promise present in all young birds: the possibility of flying.

Individuation must be the education goal. We are fragmented beings, thousands subpersonalities that must be united. We live inside conversation networks that are both external and internal. We are never alone. Personas are the masks we use to establish relations with the world outside. Animas are the subpersonalities existing inside us. Education in the past was concerned in strengthening the "ego" in order to avoid "schizophrenia." As pointed out by Deleuze and Guattari[1] we need to empower the thousands of voices that share a living inside us. A flexible "ego" is a goal to be achieved. We believe like Fernando Pessoa (poem "After All," using the Anima of Álvaro de Campos) that:

> The more I feel, the more I feel like many people,
> The more personality I have,
> The more intensely, stridently I have them,
> The more simultaneously to feel with all of them,

[1] *Anti-Oedipus: Capitalism and Schizophrenia* is a 1972 book by philosopher Gilles Deleuze and psychoanalyst Félix Guattari. *A Thousand Plateaus* is a book of 1989.

F.A.P. Fialho (✉)
Santa Catarina Federal University, Florianópolis, Santa Catarina, Brazil
e-mail: fapfialho@gmail.com

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The more unified diverse, sparsely attentive,
Are, feel, live, be,
Longer I'll get the total existence of the universe,
More complete I'll be by the entire space outside.
More analogous to God I will be, whoever could he be,
Because, whoever could he be, surely is Everything,
And outside Him there's only Him, and All for him is little (less).

As pointed out by Professor Roeris Gonzáles Sivilla in revising this paper, the first statement "There is no individual Cognition" is too "strong." The social historic cultural theory of Lev Vygotsky adopted by the scientific community's majority states that learning has two moments: An interpsychological and an intrapsychological moment. Even in this theory he defends that learning processes are social, he acknowledges that a stage of the learning of the individual develops internally and not only in his interactions with others.

Besides human beings are not only social beings. We learn in our interaction with the nature around us. How can social connections influence the sensation to please that we experiment when we took a bath in a river, seeing the dawn from a hill or the sunset in front of the sea? Can we deny that these experiences bring us an important ethical learning?

I agreed both with Dr. Roeris and Vygotsky. I see no contradiction in this. In accordance with Jung there is no "individual." We are a social community dominated by what is called "Ego." Descartes is wrong, says Freud: "We are where we do not think." We also understand "social" as including people, animals, and things, as actants (agents) in accordance with Algirdas Julien Greimas semiotics. Things and animal live also inside us as subpersonalities.

2 Designing Education as a Flow Process

There are schools that are cages and there are schools that are wings. Schools like cages are for the birds to unlearn the art of flight. Birds are caged birds under control. Caged, its owner can take them wherever he wants. Caged birds always have an owner. Because the essence of birds is flying, schools like wings do not deal with caged birds. What they love are birds in flight. They exist to give courage to birds to fly. Teaching flight is impossible, because the flight is born within the birds. The flight cannot be taught. It can only be encouraged. (Rubem Alves)

Csikszentmihalyi [1] stated that: "Flow is characterized by one or more of the following, but it is not yet clear which of these elements must be present so that there is flow."

(a) Challenge-Skill Balance

Children are naturally curious. Teaching is like giving the feather to Dumbo, the magical elephant of Disney, encouraging him to do what he was born to: fly.

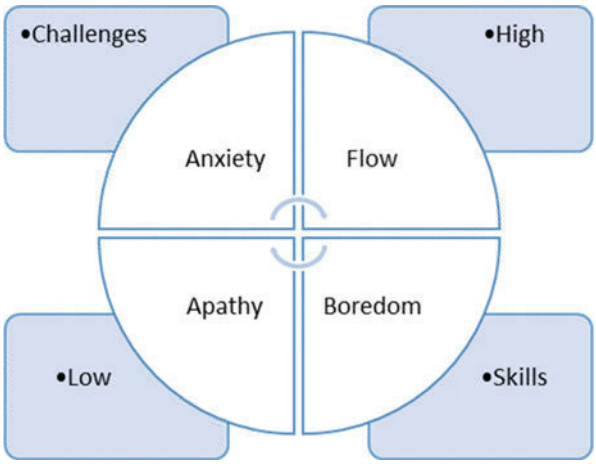

Fig. 1 Flow characteristics (Source: Adapted from Csikszentmihalyi [2, 3])

Plato believes that learning is remembering. The path of curiosity guides the student in the process of remembering. Challenges are invitations to adventure. While playing a wonderful game we record old forgotten skills.

Professors are gardeners. They prepare the soil, enriching it with the best chemicals and natural fertilizer existing. Watch the small seeds grow and flourish. Figure 1 suggests that we must adequate the level of challenge to student's skills.

(b) Merging Action and Attention

> Life cannot be saved for tomorrow. Life happens always in the present. (Rubem Alves)

The path toward illumination demands reflection and action. Making mistakes is necessary. Piaget thinks that we learn more from our own errors then when we are right. But the action that guides us to an error must be followed by the act of reflection.

The professor must be a "Magister Ludi" like Joseph Knecht, the Castalia Rector in Hermann Hess "The Glass Bead Game." The pleasure of playing games awakes in the student the passion for learning.

(c) Clear Objectives

The objectives must not be "curriculum." It is not clear for us what we really want. This is the work to be done, to help the student to make clear what he really wants. The rest is magic, is the encounter of something you are looking for, something you are in love with.

The professor here must be a "Dreams Interpreter." If a dream can be interpreted you will be able to learn (construct) what to expect in the future. Ergonomics is the art of transforming a "*ponein*" (painful) life in "*ergon*" (something wonderful).

> You must not give way to desires which you don't believe in.
>
> I know what you desire. You should, however, either be capable of renouncing these desires or feel wholly justified in having them. Once you are able to make your request

> in such a way that you will be quite certain of its fulfillment, then the fulfillment will come. But at present you alternate between desire and renunciation and are afraid all the time.
>
> All that must be overcome.[2]

(d) Immediate Feedback

> If I were to teach a child the beauty of music I would not start with scores, notes and guidelines. Together we would hear the hottest tunes and learn about the instruments that make the music. Then, enchanted by the beauty of music, he asks me who taught him the mystery of those written black polka dots on five lines. Because black polka dots and the five lines are just tools for the production of musical beauty, the experience of beauty has to come first. (Rubem Alves)

Paulo Freire states that "dialogic is more than dialectics.. Dialogic is the possibility of several interpretations. Piaget said that there is no mistake, only the use of a different logic. A class is not a lot of non-meaningful knowledge that the teacher deposit inside their students heads. Rubem Alves states that inside the classroom there are three movements. Teacher teaches students; students teach teachers; and students teach students. The last one in accordance with Rubem Alver is the most powerful.

From a successful feedback, it becomes possible to develop an optimal experience, one able to provide a flow state. There are many challenges to achieve this, since individuals are different and may perceive the experience in their own way.

Seminar comes from "semen." A good seminar must eroticize the participants. The indicator here is the intensity of the orgasm. In a seminar all actors must expose themselves sharing their knowledge.

We have here the Professor as a "Love Master," teaching their students to make love with words and ideas. The feedback is measured by the intensity of the orgasm reached.

(e) Intense Concentration on the Task

> All the words literally taken are false. The truth lives in the silence that exists around the words. Pay attention to what has not been said, read between the lines. Attention floats: play the words without being haunted by them. Beware the lure of clarity! Beware of the deception of the obvious! (Rubem Alves)

Design Thinking suggests that the first "insight" is not (usually) the best. One must say that Fernando Pessoa "Sheep Keeper" contradicts this assertive.[3] Creative Thinking demands a wandering thought. Diverge and then converge, is the trick.

Neuroscience talks about the importance of meditation. Focused Meditation prevents age. More than this, it helps students to concentrate. Mindfulness is the key to innovation, creative thought.

[2]Hermann Hesse. Demian (1919).

[3]Pessoa wakes up in a morning and wrote the entire poem at once. After a year he was not able to change one line. It came complete.

The professor here acts like a "Meditation Master," teaching their students the art of meditation. Several schools around the world discovered the importance of meditation for education.

(f) Absolute Actions Control

> I was given the freedom to discover my own inclination and talents, to fashion my inmost pleasures and sorrows myself and to regard the future not as an alien higher power but as the hope and product of my own strength.[4]

The locus of control must remain in the student's hands. The professor is a follower, a fellow traveler, nourishing the student adventure desires.

Professors as "Fellow Travelers" must encourage their student's adventures.

(g) Loss of Self-Consciousness

> The sacred sense of beyond, of timelessness, of a world which had an eternal value and the substance of which was divine had been given back to me today by this friend of mine who taught me dancing.[5]

To be in flow is like dancing a waltz, playing jazz, wave surfing, gliding through strange spaces, and a total immersion in the pleasure of learning.

The professor here is the "Game Animator," the one who provides the wave and the air, the surfboard and the parachutes. He is also the partner you are dancing with, and also the Master of Ceremony who brings to your attention other partners. Lose yourself in the experience of dancing.

The loss of self-consciousness refers to the loss of representation that the person has of herself and the lack of concern you have with your own personality when engaged in activities that you like. The individual begins to forget who he is being involved by the pleasure provided by the experience.

As pointed out by Professor Roeris Gonzáles Sivilla "lost of self-consciousness" could make the individual vulnerable to manipulation by others. It conflicts with (f) "absolute actions control." In psychology we talk about "transference" and its risks. The professor here must be a therapist. In other to perform his job he demands "power." This power must be freely given by the student (f). It allows the professor to "manipulate" him. He sacrifices his free will because he has confidence in the ability of his teacher to show him the way.

(h) Loss of Sense of Time

> No wonder that Adelia Prado said "erotic is the soul". They are wrong who think that erotic is the body. The body is only erotic through the worlds walking inside it. Erotic do not walk according to the directions of the flesh. She lives in the interstices of words. There is no love that resists face a body empty of fantasies. A body empty of fantasies is a silent instrument, which does not leave any melody. Therefore, Nietzsche said that there is only one question to be asked when you want to marry, "I will continue to take pleasure in talking to this person 30 years from now?" (Rubem Alves)

[4]Hermann Hesse. Gertrude (1910, p. 4).

[5]Hermann Hesse. The Steppenwolf (1927, p. 154).

The loss of sense of time is another important aspect to be analyzed in an experiment in culinary (education) flow (and complements the previous since the loss of self-consciousness leads to the notion of time loss), since it clearly demonstrates satisfaction of a customer (student), or at least the desire to remain in a certain experience. It is clear that a customer (student) of a restaurant (classroom) is enjoying the experience when it stays there for a long time.

(i) Autotelic Experience

> What is essential is that which, if we were robbed, we would die. What cannot be forgotten. Substance of our body and our soul ... Poets are those who, in the midst of ten thousand things that distract us are able to see the essential and call it by name. When this happens, the heart smiles and feels at peace ...
>
> (The chronicle entitled: The Essential Things—Rubem Alves, from the book: The Return and Suit)

"When experience is intrinsically rewarding, life is justified in the present, instead of being held hostage by a hypothetical future gain."

The autotelic experience occurs when "being there" is enough to make you feel great. That is, the moment that stands on its own, without the need to seek a goal beyond, or without creating expectations the next time.

According to Flusser [4, p. 182], the very word design "takes place in a context of trickery and fraud. The designer is therefore a malicious conspiratorial dedicated to engender traps." A good instructional designer concentrates not in "solving" but in "creating" problems, students must solve. Like a "gymkhana" full of hurdles to be transposed or a "game" to be played. Something fun that turns knowledge gathering in a wonderful adventure. Each obstacle results in a "learning by discovering" experience.

In accordance with Brown [5] we live in an "economy of experience." Consumers participate actively, and no longer can be considered as passive elements. This type of economy seeks a change going from basically functional for emotional basically. Thus, an experiment must meet the primary need that motivated his quest (kill hunger) and also go beyond satisfying emotional.

Teachers are storytellers. The rule is not to be true, but to charm, impress, calls the attention. Through enchantment we learn. A good instructional designer must think of himself at least as a demigod capable to create enchantment worlds, full of glamor, imaginary, and ephemeral dimensions, where alumni goes in search for light (the word alumni in Latin means without light). In this sense "Alumni" is not an adequate word. Our students hide inside then the fires of heaven. Teachers must perform like Michelangelo Buonarroti not "designing" but revealing what is hidden.

Professors are (Fig. 2):

Fig. 2 Professor Metaphors (Source: The author)

3 Education as a Common

> Siddhartha ... had begun to suspect that his worthy father and his other teachers, the wise Brahmins, had already passed on to him the bulk and best of their wisdom, that they had already poured the sum total of their knowledge into his waiting vessel; and the vessel was not full, his intellect was not satisfied.[6]

In accordance with Hess and Ostrom [6], Commons are resources shared by a group of individuals subject to social conflicts. Knowledge Commons consists of shared knowledge and can be organized around intellectual and cultural practices [7].

The tragedy of the commons is a type of social trap, usually economic, that involves a conflict between public and individual interests in the use of finite resources. It states that free access and unrestricted demand for a finite resource ends up structurally condemning this recourse because of their over-exploitation.

This notion is not merely an abstraction, but its consequences manifest themselves literally on practical issues, such as the Pau-Brazil, where exploration has made the Common no longer used due to the risk of extinction.

Associative Commons are those controlled by a group that involves rules, regulations, and restrictions and can publicly articulate a comprehensive set of values. Religious congregations, universities, scientific organizations, and professional groups are examples of Associative Commons and vary in its rules and structures, but they often have the function to protect or improve something.

Free Commons are those that anyone has the right to use and contribute. By being open, it is difficult to regulate, even though the vast majority of participants feel that specific rules should be imposed. Squares and sites linked to nature as beaches, lagoons, and also the culture of a place are examples of this type of Commons [8].

The concept of "community of practice" was coined by Etienne Wenger and, in short, can be explained as a group of individuals who meet periodically, because they have a common interest in learning and applying what has been learned.

Education is a "common." Usually there are two models for exploring this human need for completeness called education: private enterprises or treating it as a public politics issue. Nevertheless, most of the examples of success, mainly in fundamental and middle schools, come from a third possibility: "auto governance."

[6]Hermann Hesse. Siddhartha (1971, p. 5).

A "community of practice" understanding knowledge as a "Free Commons," through an auto organization process, which includes open innovation and design thinking find a "new and wonderful approach of how to provide the best possible education." All actors here must cooperate: citizens, authorities, and private organizations.

4 Design Thinking, Cuisine, and Education

> I suspect that our schools teach very accurately science to buy the tickets and packing. But I have serious doubts that they teach students the art of seeing while traveling. (Rubem Alves)

Analyzing the use of the Design Thinking approach to education, we can see the possibility of applying some of the concepts proposed by Brown [5]. These include empathy, prototyping, and experiences design.

Empathy means becoming the other. Tim Brown says that we can build bridges insights through empathy, trying to see the world through the eyes of others, of other people's experiences and emotions [5].

Savarin [9] has said that the discovery of a new recipe brings more happiness than the discovery of a new star. This quote is relevant and refers to one of education goals: pleasure. The pleasure of learning captures stars, recipes, dreams, and expectations in a magical place called memory. "We do not see what we see, we see what we are. Only see the beauties of the world, those who have beauty within" (Rubem Alves).

In 1923 Célestin Freinet reinvented education. In 1915 he was recruited into the French army and was wounded in the lung. Since his lung injury made it difficult for him to talk for long periods he purchased a printing press, originally to assist with his teaching. It was with this press that he printed free texts and class newspapers for his students. Anticipating co-working and design thinking ideas, the children would compose their own works on the press and would discuss and edit them as a group before presenting them as a team effort. Designers must leave their comfort zones in order to innovate. Freinet's students would regularly leave the classroom to conduct field trips.

Brown [5] states that an experiment should be designed in the same way as any other product, and that the components of a product must fit to create an excellent experience. The newspapers were exchanged with those from other schools. Gradually the group texts replaced conventional school books.

In education, new opportunities need to be created so that people have access to knowledge. In Manaus, a city placed within Amazon Forest, we found a school floating above the Rio Negro (Black River). In Florianopolis (Santa Catarina—Brazil) children living in "Costa da Lagoa" go and return to school in a boat. A good example of design alternatives is the Boat School in Amapá (Brazil, near French Guyana) (Fig. 3).

Fig. 3 Boat School

Anísio Teixeira was the inventor of public school in Brazil. A school for all that must be a full-time school for teachers and students, as the Park School he founded in 1950 in Salvador, who later would inspire the Integrated Centers for Public Education (CIEPS) of Rio de Janeiro. It is a shame that the idea of the CIEPS, created by Darcy Ribeiro[7] and designed by Oscar Niemeyer[8] was abandoned.

We think education as a COMMON. We don't believe in the state or in the private economy for providing good education. The example of the CIEPS is clear. Implemented initially in the state of Rio de Janeiro, Brazil, during 1983–1987 and 1991–1994, aimed to provide quality public education, the idea was abandoned and not copied in other Brazilian states.

The class schedule stretched from 8 to 17 h, offering in addition to the regular curriculum, cultural activities, directed studies, and physical education. The CIEPs provided full meals to their students, as well as medical and dental care. The average capacity of each unit was about a 1000 students.

A concept of design thinking that is present in gastronomy (not in education, unfortunately) is prototyping. We can say that gastronomy, when practical, is purely prototyping. Brown [5] states that prototyping is the culmination of a design thinking project. In most post-graduation programs we have "special topics" disciplines. Some of them stand for one period; others become permanent, living a little longer. No new discipline is created without going through this prototyping phase.

All schools should be "Experimental Schools," learning by doing. Innovation must become cultural. The world is changing and we need not just follow these

[7]Darcy Ribeiro was a Brazilian anthropologist, author, and politician. His ideas of Latin American identity have influenced several later scholars of Latin American studies. As Minister of Education of Brazil he carried out profound reforms which led him to be invited to participate in university reforms in Chile, Mexico, and others after leaving Brazil due to the 1964 coup d'état.

[8]Oscar Niemeyer was a Brazilian architect who is considered to be one of the key figures in the development of modern architecture.

changes but be the cause of these changes. As pointed by Peter Drucker the best way to foreseen the future is to construct it.

We need an "International Education Design Society," a network of people, in passion with education, contributing with better ideas for transforming this world into a better one through education. There are good examples of this, like Riane Eisler's[9] partnership education and others.

5 The Schools of the Future

> It is a mistake to try to look too far ahead. The chain of destiny can only be grasped one link at a time. (Winston S. Churchill)

It is perfectly plausible to suppose that the first places that most attracted populations for a permanent settlement necessarily had to have water. Most of the medieval cities have a mile of diameter with a water pool in the center. A mile was the distance allowing transportation of water in a comfortable way.

Imagine the world mapped as a cooperative of medieval cities with a mile of diameter. In the center of each of these we place a school: Water for the body and knowledge for the soul.

Paulo Freire says that "worst then no school at all is this school we have." We are not talking about "just another school," but a Walt Disney designed school similar to the Tivoli Gardens in the center of Copenhagen (Fig. 4). Amusement Park School where children within the mile perimeter goes each day by bike (no cars at all, we need to educate for a sustainable environment) to have fun. Imagine children walking toward these Gardens—Amusement Park—Restaurant like schools in order to play, to have fun, to socialize, and to learn. Each day lived as an adventure to be remembered. Emotions driving student's minds toward a significant knowledge inside a space designed for creation, for innovation, and for auto knowledge. We need to reinvent the school and their users each morning.

Learning with "cooperatives" and "communities of practice" we will never build something "big" (like the CIEPs for 1000 students), so big that forgets its builders and acquires a new and ferocious identity just trying to get bigger and bigger even with the prejudice of their founders.

Learning with inter-cooperatives we imagine middle school as attending at most eight of fundamental schools living and breathing around then. Universities will be created in the same scale. Amusement Parks.

All schools must be virtually connected. One school in a Florianópolis (Brazil) neighborhood will be linked with other similar schools situated in "sister cities" like

[9] http://www.mediaed.org/cgi-bin/commerce.cgi?display=home.

Fig. 4 Tivoli Gardens in Copenhagen. A school designed for a wonderful learning experience

Wonju (Korea); Kisumu (Kenya); Pskov (Russia); Opole (Poland); Lijiang (China); Saint-Lô (France), and Roanoke Valley (USA). Virtual activities will be performed in order to create a family spirit between children from all these places.

6 Final Considerations

> I want to unlearn to learn again. Scrape the paint that painted me. Emotions must be unpacked, sensations must be retrieved. (Rubem Alves)

Good education requires teachers that acted like cookers and cookers that performed like teachers. Prepare a good class demand a design thinking approach. We propose a "co-design" process enrolling all stakeholders. The instructional designer creates problems that the students must solve. A balance between challenge and skills must be reached.

We must remember that: "Anyone who tries to help a butterfly emerging from cocoons will kill it. Who tries to help a sprout out of the seed destroys it. There are certain things that cannot be adjusted. It has to happen from the inside out" (Rubem Alves).

Anísio Teixeira said: "You want democracy. Teach democracy." Although what we are proposing here seems an expensive utopia it is much cheaper than war, violence, and corruption: "While happy society does not come, there is at least future fragments where laughter is served as a sacrament, so that children learn that the world can be different. The school, itself, is a fragment of the future . . . " (Rubem Alves).

In accordance with Jung there will be no peace outside us if we do not conquer the peace inside us: “What people want most is someone to listen in a calm and quiet manner. In silence. Without giving advice. Unknown to say: If I were you . . . ” (Rubem Alves).

This article does not have a conclusion. The author only asks for some time to inhale, breath, and continue to attack their windmills. For this, the author has the words. May the reader receive them fondly. Because:

(Weaving the Morning)
A rooster alone did not weave a morning:
he will always need other roosters.
One that take his cry
and bid it to another; another rooster
to pick up the cry of a rooster before him
and bid to another; and other roosters
than with many other roosters crossing
the sun rays of all rooster’s cries,
so that a new morning, from a fine web,
goes weaving itself between all the roosters.
(João Cabral de Melo Neto)

7 Scientific Validation

This paper has been unanimously validated in a collaborative review mode with the following reviewers:

- Reviewer 1 Roeris Gonzalez Sivilla, Universidad de Camagüey “Ignacio Agramonte Loynaz.” Educación de la Ciencias Naturales, Cuba
- Reviewer 2 Angel Ric, Instituto Nacional de Educación Física de Cataluña, Grupo de Investigación Sistemas Complejos y Deporte, Universitat de Barcelona, Spain.

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POEM-COPA Collaborative Open Peer Assessment

Pierre Collet, Raaj Seereekissoon, Isaac Abotsi, Marie Michaud-Maret, Anna Scius-Bertrand, Emma Tillich, and Pierre Parrend

1 Introduction

A long time ago, education was provided by personal tutors who were paid by rich families to take care of 3 or 4 children. This type of education was of very high quality, as the tutor could adapt his tuition to the capabilities and inclinations of each student, therefore providing personalized education. Unfortunately, this was also very expensive, meaning that very few people were educated. The advent of schools allowed for many more people to learn how to read, write and count but this was only possible through mass education, with classrooms of 30 pupils and national education programmes that are identical for all. This means that slow students are often left behind whilst bright students have to wait for the others. This is even more so with the advent of Massive Open Online Courses (MOOC) [7], that are currently invading the world of e-education. With MOOCs, a single course can be followed by thousands of students.

The aim of the Personalised Open Education for the Masses (POEM) platform is to use complex systems to create an intelligent Learning Management System that

P. Collet (✉) • R. Seereekissoon • I. Abotsi • E. Tillich • P. Parrend
CSTB Team, ICUBE Laboratory, Strasbourg University, Strasbourg, France

e-laboratory on Education, CS-DC UNESCO UniTwin, Paris, France
e-mail: pierre.collet@unistra.fr

M. Michaud-Maret
Institut de Formation des Métiers de Santé du Nord Franche-Comté, Belfort, France

A. Scius-Bertrand
e-laboratory on Education, CS-DC UNESCO UniTwin, Paris, France
École Pratique des Hautes Études, Paris, France

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is able to educate hundreds of thousands of students along personalized trajectories, depending on their previous knowledge, skills and experience, as with the personal tutor of ancient times.

One could think that massive education and personalized education are antagonistic objectives but on the contrary, they are in synergy.

A long time ago, personal tutors would use their teaching experience to find the best series of exercises on topics adapted to each child they were in charge of. Then, if they detected a particular skill or interest in literature, science or the arts in their pupil, the tutors (who were often multifaceted) would adapt their teaching to nurture and develop this inclination for a more personalized education.

Their pedagogic experience increased with the number of children they taught, as trial and error improved their tuition skills. Having the opportunity to statistically study large numbers of educational trajectories, modern Intelligent Tutoring Systems can draw conclusions on previous successes and failures to improve their interactions with students online, and are in the position of predicting the best future for a student.

More accurate predictions require assimilating data of a massive number of such trajectories (which once more is what good professors do as their experience increases). For this reason, the participation of everyone to such an educational ecosystem is extremely desirable. Not only will it improve the system, but anyone wanting to resume their education will be quickly learning things they do not already know. Such synergy between massive and personalized education is only possible within a social intelligent ICT platform. The aim of POEM is therefore to implement an educational ecosystem responding to the objectives of 4P-education, i.e.:

- **P**articipative (to collect data and reinforce the "experience" of the system),
- **P**redictive (to guide the student using the elaborated experience),
- **P**reventive (to avoid failure) and
- **P**ersonalized, thanks to multi-level Quality Measurements allowing for an experience tailored to each student.

Many functionalities must be developed in order to develop such a comprehensive platform, typically:

- **Constructing and visualizing dynamic Knowledge Maps** of domains, to help students determine their objectives.
- **Developing individual MOOC and curricula trajectories.** POEM conjectures that, given an individual profile, the best next incremental step is determined in probability by the distribution of the choices of previous learners with similar profiles. This conjecture is developed in the Personalized Educational Man-Hill Problem, because of the similarity with ants' collective behaviour, which is known to quickly find optimal paths towards food sources [2–4, 6].
- **Providing inter-tutoring** between students, which is needed if direct Student-Teacher interaction is impossible due to the very large number of students. In such cases, POEM provides each student with a tutor, who is also a student but

more advanced in the same curriculum. The student can ask questions to his tutor. If the tutor cannot provide an answer to a difficult question, he himself can forward the question to his own tutor and so on, until there is no tutor anymore and the question reaches a professor.
- **Offering an automatic skill-level assessment system** depending on success/failure along the personalized trajectories of students. This is implemented through Elo-points as in chess or Tennis ranking.
- **Offering a high-quality assessment of open answers to open questions**. This is proposed through peer assessment, which is recognized to be of mutual benefit.
- **Provide crowdsourcing** by letting students bring new questions and new content as part of their evaluations. Good questions and content will find their way into participatively evolved trajectories, while poor content will eventually get discarded.

This paper will focus on the two last points, implemented in the COPA (Collaborative Open Peer Assessment) module of the POEM[1] educational ecosystem of the CS-DC (*Complex Systems Digital Campus*) UNESCO UniTwin.[2]

2 Peer Evaluation of Open Answers to Open Questions

Peer evaluation has been studied for a long time [16] but was only recently experimented extensively, in distance learning with platforms such as Spark (Self and Peer Assessment Resource Kit) or more recently in different MOOCs [9, 15]. It is quite frequently used for operational teaching, such as management or software development [10] but remains a top down approach, from the teacher to the learner, as topics are not dynamic and imposed to students. In the evaluation of these technical teachings, peer assessment shows a limited deviation that can be lower than 3 % [11], which means that it is quite accurate (at least in computer science, in which this experiment was published). It is also efficient for the assessment of complex tasks such as composition, typically when associated with appropriate coaching [12], which is more difficult to put into practice within MOOCs.

Peer assessment is often better accepted by students than an evaluation performed by the teachers. It enables them to improve the content of the course as well as their ability to evaluate others.

One of the current limitations of available solutions is the static character of the set of questions, which increases the risk of cheating. By including in the assessment the requirement to ask a question (that will be posed to other students), COPA provides a solution to this problem by turning learners into producers of new knowledge and analyses, that will feed the system to create a virtuous circle.

[1] http://poem.unistra.fr.

[2] http://cs-dc.org.

COPA therefore inserts into xMOOCs the transmission of specific knowledge [13], some dynamic elements of connectivist cMOOCs [14] based on individual experience and interaction between learners.

3 Principles and Implementation of COPA

Implementation of a COPA evaluation needs several databases:

- A database containing the courses (videos, Powerpoint or PREZI presentations, PDF or Word documents, etc.),
- A database containing questions,
- A database containing answers,
- A database containing students and professors.

Then, COPA evaluation uses three stages: a participative stage where students must ask a question on the course, a more passive stage where they should answer three questions and then, a third stage where they should evaluate the answers given by other students.

Before the COPA evaluation takes place, students should have followed a course (face-to-face or video) on which they are to be evaluated. If digital contents are associated with the course, they can be stored in the courses database, so that students can access them for reference during all stages of the COPA evaluation.

Interestingly enough, because COPA allows open questions and answers, topics are not limited to hard sciences where one can expect exact answers to precise questions. COPA can also be used to evaluate knowledge in social sciences, skills, literature, arts, a.s.o.

3.1 COPA Phase 1

Write a question on the course and
Provide a model answer.

When opening phase one, students have access to the course but rather than being asked to answer some questions, they are asked to pose a question on the corresponding course. This activity is much more demanding than answering a question because the students must be creative in order to ask relevant and interesting questions. Indeed, the quality of their questions will be rated (by other students) against questions from the pedagogic team, so if the question they imagine is less interesting than the teacher's questions, they will not get a good grade on the exercise.

Then, after they have been asked to pose a question, an even more challenging task is asked from them: they must provide a model answer for the question they have imagined.

Here again, the quality of the provided model answer will be evaluated by other students.

4 COPA Phase 2

Answer (and evaluate the quality of) three questions.

This phase has several purposes:

1. assessing if the students have understood the content of the course,
2. evaluating the quality of the questions posed by students in Phase 1 and
3. improving the quality of the database of student questions.

The contents of this phase are inspired by CAPTCHAs [1] and Re-CAPTCHAs [7]. CAPTCHA is an acronym for "Completely Automated Public Turing test to tell Computers and Humans Apart". Indeed, during 1950 Turing came out with a very famous test [5] to allow humans to determine if an unseen interlocutor is a human or a machine, a CAPTCHA can be seen as a reverse Turing test, created to allow computers to determine whether their interlocutor is another computer or a human.

Re-CAPTCHAs make use of the time and energy given by humans to pass the CAPTCHA test in a constructive way, i.e. to solve a problem for the computer (cf. Fig. 1.) Because POEM-COPA is run by a computer, the algorithms used in POEM-COPA are computer-oriented, not human-oriented, and therefore CAPTCHA-like. As in re-CAPTCHAs, COPA is not only asking the students to answer the questions, but also asking them to rate the relevance, originality and quality of the formulation of the questions they are asked.

Fig. 1 Re-CAPTCHA: the computer not only tests whether its interlocutor is human or not (by asking him to decipher the twisted text on the right) but also asks him what is the word on the left (that it could not recognize *via* Optical Character Recognition because it was badly printed)

However, because the aim of this phase is to evaluate how much of the course has been understood by the student, it is important that most of the questions come from the pedagogic team.

4.1 Answering 3 Questions

Re-CAPTCHAs are typically divided into two parts: a part to tell if the user is human or not, and another "crowdsourcing" part where the collaboration of users is sought.

In COPA, 2 questions come from a database of questions validated by the pedagogical team (providing for an approved evaluation), and one question comes from another student (crowd-sourcing part, where the participation of the user is sought) but of course, the user does not know which question among the 3 is by the student.

This 2/3–1/3 proportion means that students are mostly evaluated on validated questions (with model answers provided by the pedagogical team).

Each provided answer will be anonymously evaluated by 3 other students (peers), following the current practice in scientific journals/conferences where the quality of submitted research is also evaluated by peers.

4.2 Constrained Evaluation of Questions

In this collaborative part, students are asked to evaluate the relevance, originality and formulation of the 3 questions they are asked, with the aim of evaluating the quality of the student question that is posed along with 2 questions from the pedagogical team.

The risk of self-assessment between students is to observe some bias induced by the type of training undergone by the students: in competitive training (ending with a competitive exam), it is in the interest of the students to give bad marks to the others, in the hope of obtaining better relative marks. On the contrary, in courses where all students above a certain grade pass the exam, there is no competitive pressure so students may decide mark other students more generously than they otherwise would.

In order to reduce such bias, students are not asked to give grades to the questions but to rank them *via* a constrained rating, meaning that in effect, the question asked by a student will be compared to the questions asked by the pedagogical team.

Students must give 0–5 points to each of the 3 questions but they only have exactly 10 points that they must distribute entirely.

This method imposes that only the cases of Table 1 can be encountered. One can see in this table that:

Table 1 Rating combinations and marking

Teacher Q1	Teacher Q2	Student Q	Teacher average	Difference	Grade	Mark/5
0	5	5	2.5	2.5	7.5	5
1	4	5	2.5	2.5	7.5	5
2	3	5	2.5	2.5	7.5	5
3	2	5	2.5	2.5	7.5	5
4	1	5	2.5	2.5	7.5	5
5	0	5	2.5	2.5	7.5	5
1	5	4	3.0	1.0	6	4
2	4	4	3.0	1.0	6	4
3	3	4	3.0	1.0	6	4
4	2	4	3.0	1.0	6	4
5	1	4	3.0	1.0	6	4
2	5	3	3.5	−0.5	4.5	3
3	4	3	3.5	−0.5	4.5	3
4	3	3	3.5	−0.5	4.5	3
5	2	3	3.5	−0.5	4.5	3
3	5	2	4.0	−2.0	3	2
4	4	2	4.0	−2.0	3	2
5	3	2	4.0	−2.0	3	2
4	5	1	4.5	−3.5	1.5	1
5	4	1	4.5	−3.5	1.5	1
5	5	0	5.0	−5.0	0	0

Col 3 and 4: The quality of the student question can never be equal to the average quality of the 2 questions of the pedagogical team.

Col 5: In 11 cases, the student question gets better grades than the average of the teacher questions, *vs* 10 cases when it is deemed worse.

Col 6: If one adds 5 points so that the student gets grades between 0 and 7.5 and if

Col 7: one multiplies by 5/7.5 in order to get the grades back into a [1,5] interval,

the student question gets a mark (Col 7) that is identical to the grade given to him by the student undergoing the COPA evaluation.

Students whose question have been estimated as being of slightly lower quality than the average of the teacher's questions will get 3/5, which is fine as it can be considered difficult for students to only obtain points if their question is better than the questions of the teacher.

If the question of the student is used several times, it will get marked several times. COPA will use the average mark, weighed by the number of evaluations.

4.3 Improving the Quality of the Questions in the Database

Because there are obvious questions for all courses, there is a great risk that many students will ask the same questions. Then, some of the obvious questions may also be asked by the pedagogic team.

This could cause a problem as it allows for the possibility that the selected student question be semantically identical to the question provided by the pedagogic team, in which case the student undergoing the COPA evaluation will be faced with two identical questions (one from a student and another one from the pedagogic team).

If this is the case, the student has the possibility to indicate that 2 questions are identical. If the student clicks on the "similar questions" button, the student question will be replaced by a question from the pedagogical team, therefore guaranteeing that all 3 questions are different.

Then, the student question that was noted as being similar to one of the teacher's questions will be flagged and not be selected along with the incriminated teacher question in the future.

Another button is available for students to signal if the contents of a question are inappropriate. Inappropriate questions are removed from the students question database and an email is sent to the pedagogic team containing the question and the email of the student who submitted it.

5 COPA Phase 3

Evaluate 9 answers from other students and
Evaluate the quality of model answers.

The current practice in science is that new research submitted to a conference or journal is evaluated by 3 experts on the domain. Because no "super-scientist" exists, the "experts" cannot be anyone else other than scientists (i.e. peers) working in the same field as the scientist who submitted the work, so basically, research is driven by anonymous peer reviewing.

We pose that (even if double blind peer reviewing has its pros and cons) what is currently good enough for research evaluation could also be used for student evaluation.

Each of the three answers given in phase 2 will be evaluated by 3 peers, to determine if the answer is correct or not. Such student peer review is very desirable because:

1. The online evaluation scheme is not limited to Multiple Choice Questions: students have brains that can be used to analyse the provided answers. Using students as evaluators allows COPA to use human brains to evaluate the quality of *open responses to open questions*.