HAL
open science

Use of Project-Based Learning and Living Personas to Train Future Designers of Interactive Applications

Christophe Kolski, Walid Merrad, Claudine Piau-Toffolon, Bruno Warin

To cite this version:

Christophe Kolski, Walid Merrad, Claudine Piau-Toffolon, Bruno Warin. Use of Project-Based Learning and Living Personas to Train Future Designers of Interactive Applications. 28th International Conference on Systems Engineering, Wroclaw University of science and technology, Dec 2021, Wroclaw, Poland. pp.79-88, 10.1007/978-3-030-92604-5_8 . hal-03706838

HAL Id: hal-03706838

https://uphf.hal.science/hal-03706838v1

Submitted on 8 Mar 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Use of Project-Based Learning and Living Personas to train future designers of interactive applications

Christophe Kolski[1[0000-0002-7881-6435]] and Walid Merrad[1] and Claudine Toffolon[2[0000-0002-8911-6995]] and Bruno Warin[3[0000-0003-4550-4918]]

[1] LAMIH-UMR CNRS 8201, Univ. Polytechnique Hauts-de-France, Valenciennes, France
christophe.kolski@uphf.fr
[2] LIUM - EA 4023, Le Mans Université, France
claudine.piau-toffolon@univ-lemans.fr
[3] LISIC - EA 4491, Université du Littoral Côte d'Opale, Calais, France
bruno.warin@univ-littoral.fr

Abstract. In a course to train future designers of interactive applications, an original pedagogical approach is implemented and proposed for the students' practical work. It is organized in project mode, complementing the more traditional lectures and tutorials (exercises) in the classroom. The subject is provided in the form of a call for tender, encouraging each group of students to innovate by simulating companies responding to this call. The practical work consists of an articulation between two pedagogical approaches and a methodological one. The two pedagogical approaches concerned are project-based pedagogy and living persona. Through the living persona technique, the teacher plays a double role, including that of the customer, spokesperson for future users; the descriptive persona is made available to the students, at the same time as the call for tender. The methodological approach is the agile one. In this paper, we aim at describing the complete process, including needs analysis, mock-up and prototyping, with oral and written defense of the proposed solution in front of the customer, as well as a first experience feedback. This approach should be generic enough to be used for most of the application areas covered by the ICSEng conferences.

Keywords: Project-Based Learning, Living Persona, Persona, Software Engineering, Human-Computer Interaction, Practical Work, Active pedagogy, IT.

1 Introduction

In the IT industry, communication in the broadest sense (whether written, oral, or via different types of representations) very often plays an essential role. This is particularly the case when it comes to understanding the needs of the customer, of current and/or future users of interactive systems: information systems, medical systems, websites, interactive terminals, intelligent systems, IoT Systems, etc., as interactive systems are increasingly present in all fields. In particular, this communication requires a common modeling language that can be understood by all development ac-

tors (customers, users, analysts, designers, developers, testers, etc.). For this purpose, the *Unified Modeling Language* (UML) supported by the Object Management Group is the most widely used in companies [19]. Knowing UML makes it much easier to learn other industry standards such as *Systems Modeling Language* (SysML) and *Business Process Model and Notation* (BPMN) [19]. It is therefore essential that every student enrolled in a computer science program in higher education masters UML.

In projects, it is a matter of understanding, observing, listening and questioning, imagining, modeling, designing, showing and demonstrating, convincing, presenting, evaluating, and questioning, regardless of the software development models followed [4]. However, if "external" communication plays an essential role, "internal" communication within development teams composed of different talents with sometimes contradictory objectives, methods, techniques and practices, must also be mastered, regardless of the approach used. This one can be structured and defined by a series of distinct phases whose organization is sequential, such as the waterfall model or the V model; it can be iterative and guided by risk management when moving from one phase to the next, such as the spiral model [11]. It can be incremental, based on a progressive construction of the software system, increment by increment. An increment can represent one or several functional elements of the system to be produced. In this case, it is also iterative in the way it organizes the work of the development team, usually organized in sprints and commonly called the agile method [2] (see for example the principles of the Scrum method [23]).

Note also that an approach may or may not be developed to be user-centric [14].

In all cases, the aim is quality (in the sense of the ISO/CEI 25000:2014 standard), [13]), customer satisfaction and user satisfaction. It is therefore important that, within the framework of the methodological courses taught, both technical and transversal skills, in particular those necessary for the stages of IT projects, are targeted. Their articulation can be part of a project-based pedagogy, as described in [24] and [25]. The approach described in the practical work of a course called *Software Engineering and Human-Machine Interaction* goes in this direction. This one is integrated in the *Information Systems* teaching track at the National Institute of Applied Sciences (INSA) Hauts-de-France.

2 Pedagogical and methodological bases of the approach followed in the practical work

2.1 Project-based learning

The first pedagogical basis of the approach followed is the project-based pedagogy. This is an active pedagogical practice. This pedagogy is very old, since it was advocated by various philosophers. The first pedagogue of mankind, the Chinese philosopher Confucius (551-479 B.C.), advised a pedagogy of Learning by Doing when he said "I hear and I forget, I see and I remember, I do and I understand". Aristotle (384-322 B.C.) did the same when he said "What we have to learn, we learn by doing". Active pedagogy is linked to the concept of Learning by Doing. This practice aims at

generating learning through the realization of a concrete production. Project-based teaching is a particular category of active teaching, carried out individually or collectively, while following an approach made up of stages, associated with one or more objectives [9]. An example of a project-based pedagogy method is *Multi-Role Project* (MRP) [27].

This pedagogy seems to be well-suited for teaching systems analysis and design, and it promotes pedagogical situations adapted to future work situations where students may interact with customers. Rob in [22] proposed a project-based methodology to keep students engaged in these activities of the development life cycle and to help develop competencies of a systems analyst required by the IT industry. This kind of pedagogy has been experimented for the teaching of analysis, design and implementation with object-oriented analysis and design methods [10]. They found out that the project must be robust enough to require multiple students to work on it; it should be a real-life project with customers that may change their minds and deliverables. Students may work in a collaborative way, so teachers may have to manage heterogeneous groups. Project-based learning agile projects as been proposed to assist individual learning processes and help teachers to design and organize projects [15]. It has been analyzed that agile projects increase the quantity and quality of interactions and have positive effects on the acquisition of sustainable skills.

See [3], [6], [17] and [20] for a history and detailed description of foundations on active and project-based pedagogy.

2.2 From Persona to Living Persona

A persona is a fictitious person who represents/synthesizes a group of individuals representing a future user of a system and illustrating various characteristics. The persona is considered a UX (User Experience) technique [1] [21], and is now commonly used for interactive system design [7] [12] [18]. By directly or indirectly suggesting needs, expectations, but also characteristics to be considered, personas can be particularly inspiring, both for designers of interactive systems [5], and for learners in the design domain [26].

The second pedagogical basis is the exploitation in the practical work of the living persona technique [17] [26]. The teacher embodies a dual role, including that of the customer, spokesperson for future users; his or her descriptive persona is made available to the students, along with the subject describing the work to be done, falling within the framework of a call for tender. The teacher can then wear a distinctive sign: a cap, a vest around the neck of the company to which he or she is supposed to belong.

2.3 SCRUM

The SCRUM agile method serves as a methodological basis. SCRUM is one of the agile methods [2] developed in the early 1990s by Schawber and defined as "a framework for responding to complex and changing problems, while productively and creatively delivering products of the highest possible value" [23].

From an organizational point of view, Scrum defines three actors (the Product Owner, the Scrum Master and a developer team without sub-teams or hierarchies), three types of artifacts (the Product Backlog, the Sprint Backlog and the Increment) and four types of meetings (Sprint Planning, Daily Scrum, Sprint Review and Sprint Retrospective). These basic elements of the organization of a Scrum project must be integrated into the timeboxing of a project. Each element of the breakdown is called a Sprint. The objective is to ensure incremental development in the sense that the product is built little by little by successive increments. Each increment increases the added value of the software. The development is iterative in the sense that the team may have to perform several sprints to deliver or improve an added value. Development is guided by the customer's needs in the sense that the Product Owner is not required to specify all of the customer's needs from the start. A set of initial requirements, more or less detailed, are recorded in the Product BackLog and then negotiated at the beginning of each Sprint and recorded in the Product Backlog and in the various Sprint Backlogs at the beginning of each Sprint.

3 Context and description of the subject provided to students

3.1 *Software Engineering and Human-Computer Interaction* Course

The *Software Engineering and Human-Computer Interaction* course of the *Information Systems* teaching track at INSA Hauts-de-France takes place in Semester 5. It is one of the three courses of the *Basis of software Development* Teaching Unit which also includes the following courses: *O.O. Programming / Java Programming* and *Database*. It consists of 7.5 hours of lectures, 9 hours of tutorials (exercises), 18 hours of practical work and an examination lasting 1.5 hours. This course is mainly centered on Software Engineering but aims at making the link with approaches coming from Human-Computer Interaction.

The course focuses on basic software engineering principles, describes and illustrates the main UML diagrams, explains the foundations of agile approaches and illustrates them with Scrum. It also describes a set of Human-Computer Interaction models. Several resources (written works) are also provided to students. In tutorials, a case study on all the sessions allows to approach different facets of the UML modeling, while insisting throughout the study on the analysis of the customer's needs. A challenge in tutorials also focuses on the mock-up of functionalities to be proposed to the customer. The approach followed in practical work is detailed below.

3.2 Information concerning the organization of the practical work

It is first specified to the students that the practical work is in the form of a project, spread over 6 sessions of 3 hours each, that they must be organized in pairs (simulating companies), and that groups of 3 are also possible. The aim is to simulate and put into practice the Scrum agile method. The deliverables will be considered as increments (in the framework of sprints) and the final product will be presented and

demonstrated during the last session. The students (in groups) will play the role of the development teams, the teacher playing also the role of the customer (product owner) as a living persona according to the description given to the students (Fig. 1) and the Scrum Master if needed. The persona is based on the structure proposed in [8]. It shows the characteristics of the person playing the role of customer/product owner, this role being in addition to that of the teacher. Meetings will take place at the beginning of the sessions (sprint planning, daily scrum, sprint retrospective & sprint review) throughout the project. In 2020-21, eight groups have been formed: seven groups of two students, and one group of three students.

Dr. Adams Brown in front of his poster at a conference in 2019 in Shanghai, China.

Dr. Adams Brown, of the international Good Health Medical Group, is available to companies responding to a all for tenders for the design of an easy-to-use, interactive management system for physicians. He is 37 years old, married with two children (one boy and one girl).

Dr. Adams Brown is representative of both the users of the future system (as he is originally a physician). In his various positions within the group, his goal has always been to help the company better manage its patient records and keep up to date with ICT for the healthcare field. His motto is: "*Nothing beats a good user experience*".

Dr. Adams Brown is a graduate of Harvard Medical School, Harvard University, and has completed an MBA (Information Technology Specialty) at London Business School, making him ideally suited to work in the management of a healthcare group.

He has worked his way up through the ranks at Good Health Medical Group. Hired as a general practitioner in 2010, he then had many experiences as a manager and project leader, always being at the heart of innovation and ICT. He has worked in different subsidiaries of the group, both in France and abroad (Algeria, Germany, USA, Holland and Tunisia).

As a project manager, he likes to surround himself with creative people from different disciplines to facilitate the cross-fertilization of ideas. It is no coincidence that his teams have filed more than 20 international patents, and that he received an Innovation Golden Globe at the INNOV'2012 trade show in New York, in connection with a playful and personalized information system in the health field. He proposed among other things the design of new educational simulators in the field of surgery, a card game for the visually impaired and has intervened as a freelance consultant in several international projects.

Even if he is appreciated for his conviviality, his colleagues know that they will always have to surpass themselves because he does not like mediocrity, banality: each system must stand out from the crowd, must bring something more than the competition; he is very demanding, but does not hesitate to spend a lot of time advising and guiding junior analysts and designers, so that they always go further in the concepts, in the service of the projects and objectives of the team.

Dr. Adams Brown loves his job and spends his time looking for new ideas for new systems, whether in nature, in movies (especially science fiction), by observing people's behaviors on the street, at work, in transportation, in stores, etc.

He would like the new interactive systems to be everywhere, to contribute to an ambient intelligence, in all rooms and environments, in all circumstances.

He also notes that his hearing tends to decline over the years, while noting that the population is aging in some countries. "This is a parameter to be taken into account during innovation processes," he often tells his teams.

Fig. 1. Persona made available to groups of students simulating companies responding to the call for tender (persona adapted from that published in [16] and [26]).

3.3 Information concerning the context and the theme to be addressed by the students

The information provided to students regarding the context is as follows:

"*You are responding to a call for tender from the international Good Health Medical Group, which is established in fifty-nine countries (head office in Valenciennes, France). This group is used to working with patients of different ages, different nationalities and with different health problems.*

This call for tender is for an interactive information system specification. You are competing with other companies. Each company is represented by a team. It is clear that the work to be done requires each team to be well organized. The aim of the call for tender is to select the best of the companies involved, for a big budget project. The information provided for this selection only partially reflects the complexity of the problem.

Good Health Medical Group is represented during the 6 sessions by Mr. Adams Brown. He has 11 years of experience as a doctor, group manager and project manager in connection with interactive systems in the field of health in the broadest sense of the term, in various subsidiaries of the group in Algeria, Germany, the USA, France, Holland and Tunisia. He is responsible for answering questions that are not of a confidential nature." (see Fig. 1 for the persona provided to the students).

The theme of the call for tender in 2020 was: "*Interactive and easy-to-use management system for physicians, integrated into their practices, aimed at providing better management of patient records and practices*".[1]

The project is sufficiently broad and rooted in reality to allow students to work in groups (two or three in this case) and to facilitate exchanges with the living persona to help them define and analyze the needs and propose an innovative solution. This is also a condition for such an agile project-based learning method to be effective, i.e. by allowing students to work on the business skills required for the development of IT projects (see Section 4).

3.4 Deliverables to be provided by each company responding to the simulated call for tender

The deliverables to be provided by each group were the followings: (1) Preliminary information: name of the company (to be defined), names of the collaborators and functions of these employees, description of the distribution of the tasks between them (by naming them); (2) Description of the proposed solution (technical proposal): using a model-based approach (between 12 and 15 pages approximately), the specification file will include at least the following models: use case diagram (at least one), class diagram (at least one), state-transition diagram (at least one), activity diagram (at least one), sequence diagram (at least one). The description of the solution must also contain mock-ups of user interfaces; (3) A financial proposal, associated with the

[1] It is important to note that the approach is generic. So the theme chosen each year could cover any of the ICSEng conference topics (see the themes of the 2021 edition).

technical one and detailing the expenses, charges and resources allocated and/or used (purchase of equipment, hosting servers,...); (4) A prototype of the system (the application) developed in the language and tools desired by the company. It is also required to manage several versions of this application, using a version management tool (such as Github).

4 Evaluation of the students

The evaluation of the students takes into account both the students' productions and their oral performance during the last session of the practical work. The grading is linked to the skills to be acquired by the students, which are essential in the computer science profession. The grading is done in relation to different skills (Fig. 2). As specified in the table, a bonus may be added to the final grade if the student has contributed to the best mock-ups proposed and discussed in one of the tutorial sessions, as part of a challenge.

The role-playing continues during the oral presentation session. Each group goes before an evaluation committee made up of (1) the teacher of the practical work who plays the role described by his or her persona (see Fig. 1) and (2) the course and tutorial teacher who is presented by the teacher of the practical work under another name, and as an expert in the field.

Student	Introduce yourself to the customer	Present a solution orally to the customer	Convince the customer with mock-ups	Deepen a solution proposal by prototyping	Write down the customer's needs and the proposed solution	Carry out and propose a financial proposal	Grade	Tutorial bonus (challenge by mock-up of solution)	**Final grade**
	/2	/2	/2	/3	/8	/3	/20		/20

Fig. 2. Grading of students on various skills (Maximal grade: 20).

5 Experience feedback

This study followed two preliminary studies that focused on the definition and introduction of the Living Persona technique in a classical pedagogy [16] [26]. As in these preliminary studies, early feedback from students indicates that they appreciate the pedagogical situation experienced as they have the feeling it is close to the professional reality and that the living persona technique provides a statement close to business reality.

The main challenge of this study was to integrate an agile approach as a methodological support. This challenge has been partially met because we had to move away from the original model on two important points. The first one is that the students had to propose themselves the system and its functionalities (many soutions being possible), before starting to detail it. The second point is that, in the SCRUM method, the members of the development team must be complementary and the team must have all the necessary skills for the development (graphic designer, designer, developer,

testers, etc.). Talents must be shared and complementary to be efficient. Using SCRUM as a methodological basis in a pedagogical framework does not allow to implement this recommendation, as students should have acquired the same technical and transversal skills at the end of the course. Consequently, either the members of a team do not specialize in any role and in this case, the project risks not meeting the deadlines. Alternatively, they do a specialization and in this case, the teacher must encourage the transfer of knowledge between the team members. This is a necessary adaptation of SCRUM to our use of project-based pedagogy as we have designed it.

Improvements should be made in the form of focused meetings with each group, rather than collectively (to better approximate the principles of the agile approach). In addition, the pandemic situation did not allow for oral presentations to all the other groups in the last session, as originally planned. However, the results obtained in the two years that this course has existed are promising. Indeed, the students' performances are of good quality, both from the point of view of responding to the request (technical aspects, content of the deliverables, proposed solutions), and from the point of view of oral and written communication, within the framework of these interactions with the simulated customer, on an open and topical theme, encouraging creativity.

Student	Introduce yourself to the customer	Present a solution orally to the customer	Convince the customer with mock-ups	Deepen a solution proposal by prototyping	Write down the customer's needs and the proposed solution	Carry out and propose a financial proposal
	/2	/2	/2	/3	/8	/3
#01	A	B	A	B	A	B
#02	A	A	A	A	A	A
#03	B	B	A	B	A	C
#04	A	A	A	A	A	C
#05	B	A	A	A	A	B
#06	A	C	B	A	A	A
#07	B	A	A	A	A	A
#08	C	A	A	C	B	C
#09	B	B	A	B	A	C
#10	A	A	A	A	A	C
#11	C	C	B	D	B	C
#12	C	C	B	D	B	C
#13	C	A	A	C	B	C
#14	A	A	A	A	A	A
#15	A	B	A	B	A	B
#16	A	A	A	A	A	A
#17	A	C	B	A	A	A

Fig. 3. Results obtained for the different skills for the 17 students of this academic year (A: very well acquired skill, B: well acquired, C: insufficiently acquired, D: skill not acquired).

Fig. 3 provides an overview of the results obtained for the different skills emphasized. This figure shows that the best results were obtained this year in the areas of mock-ups and written presentation. On the other hand, about half the students had problems with the financial study. Additional explanations in the courses and/or tutorials should be provided. In addition, students #11 and #12 (who were in the same group) produced a disappointing prototype. One way to improve would be to improve interactions with students to give feedback on the prototype before its "official" presentation in the last session.

6 Conclusion

With the aim to train future designers of interactive applications , this paper presented an innovative pedagogy based on two pedagogical methods: the project-based pedagogy and the Living Persona technique; these being supported by an agile methodological framework widely used in companies: the SCRUM method. This implementation has required a significant work, over several years in several universities. The present teaching is the result that shows the feasibility of this rich pedagogy. It has been applied here to the teaching of analysis and design of interactive software applications. These learning methods are separately promoted in the literature for teaching these key activities of the Systems Development Life Cycle. The technique of the Living Persona is an evolution of the classical technique of the Persona initiated by Cooper [7] in the field of HCI. We integrated this technique as a central element of a scenario where teams of students, put in competition, had to produce a specification of an interactive system, associated mock-ups, a prototype and a financial proposal. The teacher had to play two main roles: (1) that of the customer who had to adopt a precise state of mind, described through a *Persona* (provided to the students); (2) that of the traditional teacher who had to accompany the teams from an academic point of view.

The results obtained by the students are promising. Moreover, since our first preliminary studies [16] [26], the behaviors observed during the sessions with the students confirm their interest in such pedagogies. We think that this pedagogy could be reused and tested by the academic members of the ICSEng community to train future designers. Further studies are planned to continue to evaluate the pedagogy described in this paper, including a control group. Pedagogical resources for teachers are being developed to disseminate the method or parts of it more widely. Other studies are being considered to evaluate its effectiveness in a pedagogical context that does not deal with software development usually taught in software engineering courses: the field of artificial intelligence for example, would also be a potentially interesting and rich field. Other application areas in line with topics of the ICSEng conference could also be explored.

References

1. Adlin, T., Pruitt, J.: The Essential Persona Lifecycle: Your Guide to Building and Using Personas 1st Edition. Morgan Kaufmann Publishers (2010)
2. Beck, K., Beedle, M. et al.: Manifesto for agile software development (2001), retrieved the 22th may 2021 at https://agilemanifesto.org/
3. Boss, S.: Project-based learning: a short history, Edutopia (2011). retrieved the 22 may 2021 at https://www.edutopia.org/project-based-learning-history
4. Bourque, P., Fairley, R.E.: SWEBOK V3.0, Guide to the Software Engineering Body of Knowledge, IEEE (2014)
5. Brangier, E., Bornet, C.: Persona: A Method to produce representations focused on consumers' needs. In: W. Karwowski, M. Soares and N. Stanton (Eds.), Human Factors and ergonomics in Consumer Product Design, Taylor and Francis, pp. 38–61 (2011).

6. Burlbaw, L.M., Ortwein, M., Willams, J.K.: The project-based method in historical context, in book: STEM Project-Based Learning, Springer, pp. 7-14 (2013)
7. Cooper, A.: The inmates are running the asylum. Indianapolis, SAMS Publishing (1999)
8. Courage, C., Baxter, K.: Understanding your users: a practical guide to user requirements methods, tools, and techniques. Elsevier, San Francisco, CA (2005)
9. Dewey, J.: The School and Society. The University of Chicago Press (1899)
10. Fernandez, E., Williamson, D.M.: Using PBL to Teach Object Oriented Application Development. CITC4'03, Proc. of the 4th conf. on Information technology curriculum, Oct. 16–18, Lafayette, Indiana, USA, pp. 37-40 (2003)
11. Forsberg, K., Mooz, H.: The Relationship of System Engineering to the Project Cycle. INCOSE International Symposium, pp. 57-65 (1991)
12. Idoughi, D., Seffah, A., Kolski, C.: Adding user experience into the interactive service design loop: a persona-based approach, Behaviour & Inf. Technology 31 (3), 287-303 (2012)
13. ISO/CEI 25000:2014: Systems and software engineering — Systems and software Quality Requirements and Evaluation (SQuaRE) — Guide to SQuaRE. ISO, Geneva (2014)
14. ISO 9241-210:2019: Ergonomics of human-system interaction - Part 210: Human-centred design for interactive systems. ISO, Geneva (2019)
15. Kastl, P., Romeike, R.: Agile Projects to Foster Cooperative Learning in Heterogeneous Classes. IEEE EDUCON, Global Engineering Education Conf., pp. 1188-1197 (2018)
16. Kolski, C., Warin, B.: From Persona to Living Persona, Preliminary Data from a Pilot Study in HCI Education. In: Learning and Collaboration Tech., HCI Int. 2018, Las Vegas, NV, USA, July 15-20, 2018, Proc., Part I, LNCS 10924, Springer, pp. 136-146 (2018)
17. Krajcik, J.S., Blumenfeld, P.C.: Project-based learning. In: R. K. Sawyer (ed.), The Cambridge Handbook of the Learning Sciences, Cambridge University Press (2006)
18. Nielsen, L.: Personas - User Focused Design, 2nd Ed.. Springer (2019)
19. OMG, Object Management Group. Retrieved the 22th may 2021 at https://www.omg.org/
20. Page, M.: Active Learning: Historical and Contemporary Perspectives. Doctoral paper, University of Massachusetts, May (1990), pp 112.
21. Pruitt, J., Grudin, J.J.: Personas: practice and theory. In: Proceedings of the Designing for User Experiences, DUX 2003, ACM Press, pp. 1–15 (2003)
22. Rob, M.A.: Practical Methods of Preparing a Systems Analyst. International Journal of Research in Educational Research, 3 (3), 359-371 (2013)
23. Schwaber, K., Sutherland, J.: The Scrum guide, the Definitive Guide to Scrum: The Rules of the Game. (2010-2020),
24. Talon, B., Sagar, M., Kolski, C.: Developing Competence in Interactive Systems: The GRASP tool for the design or redesign of pedagogical ICT devices. ACM Transactions on Computing Education 12 (3), 1-43 (2012)
25. Warin, B., Kolski, C., Sagar, M.: Framework for the evolution of acquiring knowledge modules to integrate the acquisition of high-level cognitive skills and professional competencies: principles and case studies. Computers & Education, 57 (2), 1595-1614 (2011)
26. Warin, B., Kolski, C., Toffolon, C.: Living Persona Technique applied to HCI Education. IEEE Global Engineering Education Conference, EDUCON 2018 (17-20 April), IEEE, Santa Cruz De Tenerife, Spain, pp. 57-65 (2018)
27. Warin, B., Talbi, O., Kolski, C., Hoogstoel, F.: Multi-Role Project (MRP): a new Project-based Learning Method for STEM. IEEE Trans. on Education, 59 (2), 137-146 (2016)