The Design and Evaluation of the Persuasiveness of e-Learning Interfaces

Eric Brangier, Psychologie Ergonomique et Sociale pour l'Expérience Utilisateurs (PErSEUs EA 7312), Université de Lorraine – Metz, Metz, France

Michel C. Desmarais, Département de Génie Informatique et Génie Logiciel, Polytechnique Montréal, Montréal, Canada

ABSTRACT

This study addresses the general goal of designing more engaging e-learning applications through persuasive technology. The authors present and discuss two potential approaches to the design persuasive e-learning applications that differ in terms of comprehensiveness and ease of application. The more straightforward approach based on Fogg is considered for designers who may not have the time or background to invest large efforts to analyze and understand how the principles of persuasive technology can be deployed. The Oinas-Kukkonen and Harjumaa (2009) approach is presented as a different approach that does require such investment. The design approaches are complemented with a persuasive assessment grid that can be used as an inspection instrument, akin to usability inspections as found in the field of human-computer interaction. The intent is that this instrument can complement the design process by giving early feedback on issues to address. The authors report an experiment where the inspection instrument is applied to an existing e-learning application. The actual data on how students used it provides feedback on how effective the persuasive grid is for detecting issues. The results show that the application scores low on most criteria, and the usage patterns generally confirm this assessment. However, the authors also find that some students were persuaded to engage more thoroughly to use the system and conclude that large individual differences affects the factors of influence and should lead the designers of e-learning application to consider different means in the design of persuasive technology.

Keywords: Applications, E-Learning, Heuristic Inspection, Persuasive Criteria, Persuasive Technology

INTRODUCTION

Persuasive technology (PT) nowadays spans across all domains of Human-Computer Interaction where some form of social influence is involved (Consolvo, Everitt, Smith, & Landay, 2006 ; Adams et al., 2009). For example, we can mention electronic commerce (influence the user to purchase), e-learning (entice the user to engage in effective means to enhance skills and knowledge), security (bring users to adopt safe behaviours); health (reduce and stop

DOI: 10.4018/ijcssa.2013070105

Copyright © 2013, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

cigarette smoking), ecology (raise awareness of pollution and sustainable practices), management (influence people to optimise their family budget management), social life (foster community involvement).

Whilst the stakes are important in all these domains, we focus on the learning domain and note that on-line learners are particularly prone to dropping out of a learning process, and suffer from lack of support when faced with failures and obstacles. Means to design more engaging learning environments appear therefore of great importance.

The objective of this paper is threefold:

- Provide a theoretical framework for the design of persuasive e-learning technology.
- Motivate and provide a criteria grid to assess the persuasiveness of an e-learning interface; we demonstrate how the proposed criteria grid can be used as an interface inspection tool to assess the capacity of the application to effectively convince a user to engage in using it to learn ; we will focus on one specific application to learn mathematics;
- Show the usefulness of the inspection approach to assess and improve the persuasiveness of an e-learning interface.

We first propose a design perspective by which the developers of e-learning technologies can build persuasiveness into their applications. It follows the standard guidelines to persuasive systems design. Complementary to this design perspective, we define a set of evaluation criteria grid to assess the persuasiveness of an e-learning interface. These criteria aim to help developers focus their efforts to improve the persuasiveness features of the application's interface and interaction patterns. We demonstrate the application of the persuasiveness criteria over a study guide that is intended for bringing freshmen engineers' level of mastery of college mathematics up to the expectations for the first year mathematics courses.

THEORETICAL FRAMEWORK FOR THE DESIGN OF PERSUASIVE E-LEARNING TECHNOLOGY

We adopt the perspective that the design of persuasive e-learning applications follows the same generic principles of designing persuasive technology and describe two frameworks towards this goal: the work by Fogg (2009a) who proposes a step by step approach to the design of PT, and the work of Oinas-Kukkonen and Harjumaa (2009) who introduce seven underlying postulates behind persuasive systems and 28 design principles. Based on the procedural nature of Fogg's approach, we consider that it represents a simpler method than the principled-based approach of Kukkonen and Harjumaa, and therefore that the later approach is better suited for the persuasion aware designers willing to invest more time and effort to the design of PT. As such, they can be considered complementary.

In line with his own research on PT, Fogg introduced a guide to the design of PT (2009a). His design process proposal is tainted by his observation that « *The landscape of persuasive technology is riddled with the carcasses of failed projects* » (p.2) and that the emphasis should lie on providing accessible means to learn the principles and practice of designing PT. The process is broken down into eight steps and is targeted towards newcomers to PT. It aims to introduce early and small steps towards bringing desired behavioural changes:

1. Start by aiming to induce a simple behaviour by the user. Although apparently modest and benign, the underlying assumption is that it will bring an attitudinal change and open the way to more profound changes. For e.g., changing for low consumption light bulbs can raise the awareness of users towards ecologically friendly practices and raise their curiosity and willingness to learn more about them.
2. Designers must target the subset of users who are most receptive to behaviour change

Copyright © 2013, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

and select an appropriate channel familiar to this audience.
3. Once these two steps are completed, the designer should determine what could hinder the desired change of behavior and find means to counter these obstacles.
4. Based on the first three steps, an appropriate channel is chosen for the targeted means (Internet, smart phone, etc.).
5. Then, once these parameters are determined (desired behaviour, target audience, and channel) a review of similar means should be conducted, either in the scientific literature or other dissemination channels, to better understand and assess how similar experiences have been successful.
6. Fogg recommends to simply emulate the critical mechanism of persuasion found in other similar experiences.
7. A series of short test-retests over prototypes of the approach designed should be performed in order to iron out any glitches and ensure maximum effectiveness.
8. Finally, once the approach is tested and successful, the designers should aim to deploy it and consider its extension over larger audiences and new behaviours.

In contrast to Fogg's procedural approach, a principled-based approach to the design process was attempted through the Persuasive System Design initiative (Oinas-Kukkonen & Harjumaa, 2009). The authors describe three steps to the development of efficient persuasive systems.

Initially, *an analysis of the key elements involved in the PT context* is necessary: the design team should aim to obtain the most comprehensive knowledge of the persuasion framework it subscribes to. The authors focus on seven fundamental assumptions that characterize persuasive systems. First, they assert that technology is never neutral. It necessarily represents a source of influence ("Always on"). Persuasion is thereby to be considered as a process instead of a specific event in time. It also implies that the process adapts to the user over time. Second, the authors revisit the notions of engagement and consistency. Engagement should lead to persistent behaviour towards a target objective (Joule & Beauvois, 2000). And cognitive dissonance, a form of inconsistency between the individual's own behaviours or thoughts free of outside pressures and constraints, creates a feeling of discomfort that will induce a will to restore consistency. One common mean to restore consistency is to adopt the view that the contradictory behaviours or thoughts are in fact, our own through an attitude change (Fointiat, Girandola & Gosling, 2013). The third assumption points to direct and indirect means to achieve persuasion (Petty & Cacioppo, 1986). The direct means refer to content-based actions and is deemed more efficient over the long term, but very often the abundant flow of information that characterize technological environments prevents the effective application of this means. The fourth assumption states that persuasion is incremental: the desired changes occur over long periods of repeated solicitation. Then the fifth assumption underlines that persuasion must necessarily be transparent. This follows the fact that the user is willingly engaging in behaviour change. The authors also assume that the persuasion means should be undisruptive and unobtrusive to the user's task. Finally, a persuasive apparatus should always be useful and easy to use. Usability is considered as a necessary condition to PT.

Once the design team has a good grasp of the PT principles, it should focus over the *description of the desired persuasion's context of deployment* to ensure the greatest efficiency. The persuasion agent and its goal must be well defined and three conditions can occur: the agent of persuasion are (1) the designers (endogenous persuasion), the technology suppliers (exogenous), or the user himself (autogenous). In endogenous persuasion, the context should clearly and openly let the user know the goal of the system's design. For exogenous persuasion, the user should have some flexibility to customize the persuasive goals. Finally, for autogenous persuasion, the apparatus should be sufficiently attractive and engaging for the user to persist in using it.

Copyright © 2013, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

Once the analyses are completed, *persuasive design principles come into play.* They are broken down into four categories:

- **Primary Task Support:** It consists of a set of techniques that supports and simplifies the completion of the user's task. This includes *reduction* (streamline the process), *tunneling* (funnel the user activities in a series of steps), *tailoring* (adapt the information to the user's characteristics), *self-monitoring* (provide feedback on the user's activity), *simulation* (find causal relations between events) and finally *rehearsal* (foster the repetition of a behaviour).
- **Dialog Support:** This includes techniques such as *praise* (positive feedback on user performance), *rewards* (after an objective is met), *reminders* (remind user of the final objective), *suggestion* (present meaningful information for user), *similarity* (blend persuasive features into environment), *liking* (create an attractive environment), and *social role* (embed a social role in the apparatus, e.g. virtual nurse for a medical site).
- **Social Support:** They are effective means to motivate based on social influence. Such means include *social learning* (learn from observing peer behaviour), *social comparison* (compare behaviour), *normative influence* (social pressure from the majority), *social facilitation* (observation or replication of a behaviour from a peer), *cooperation/competition* (the apparatus facilitates cooperation/competition), and *recognition* (public recognition of one's new attitude or behaviour).
- **System Credibility Support:** It aims to enhance the social acceptability and legitimacy of the system to increase the persuasive effectiveness. It breaks down into: *trustworthiness* (perception of well-intended, morally founded, and non-biased interaction), *expertise* (knowledge and experience), *third-party endorsement* (a form of reputation acknowledgement), *surface credibility* (subjective impression stemming from the design), *real-world feel* (impression of a real organisation and people behind system), *authority* (recognition from other instances in the domain), and *verifiability* (possibility to verify accuracy of content through independent means).

Oinas-Kukkonen and Harjumaa (2009) emphasize the necessity to get a good understanding of PT in general, and to choose and adapt the means to each specific situation. However, given that persuasive design methodologies remain opaque to individuals unfamiliar with the domain, the proposed approach is at risk of remaining accessible only to a select group of designers who are more familiar with these theories.

AN INSPECTION METHOD TO ASSESS PERSUASIVENESS OF E-LEARNING SYSTEMS

Inspections are a complement to the design perspective. Through iterative prototyping, they allow the development of more effective PT, especially in the early stages of development, when prototypes are too rudimentary for user testing. We rely on the Némery, Brangier and Kopp (2011) inspection grid to assess the persuasiveness of e-learning systems and apply it over an existing e-learning environment to gather concrete experience on how appropriate it is in the specific context of e-learning. In addition to the inspection, we can get further insights into the persuasive effectiveness of the e-learning application with usage data that was gathered over four months.

The Némery, Brangier and Kopp (2011) grid rests on the general technique of inspection. To inspect the usability of a product, whether a user interface or any artefact designed to be used by some user, is to make a judgement about its ability to be effective, efficient, error-tolerant, easy to learn and satisfying. This judgement is made by experts in ergonomics or HCI. Inspections are often the method of choice to quickly target usability issues and find the proper corrections to bring to the design of an application.

Copyright © 2013, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

The Némery et al. grid (Table 1) follows from the review of 164 papers in the field of captology and PT. Eight criteria were deemed sufficient to encompass the persuasiveness factors: credibility, privacy, personalization, attractiveness, solicitation, initiation, commitment and ascendency (Némery & Brangier, 2011). These criteria are grouped under static and dynamic categories (see Némery, Brangier, & Kopp, 2011):

- **Static criteria** are prerequisite elements to establish a fertile context within which a dynamic process of persuasion can be launched. These elements promote the acceptance of a persuading process.
- **Dynamic criteria** are involved in a process designed to engage the user in a series of planned and ordered persuasive steps in which the temporal factor is critical. At each step of the behavioral changes, elements of the interface bring the user to commit to greater levels of engagement.

A CASE STUDY FOR THE CRITERIA GRID

In an effort to assess the PT criteria grid, we analyze an e-learning application using this grid. We refer the reader to Brangier and Desmarais (2013) for a comparison of this grid with motivational factors from de Vicente and Pain (2002).

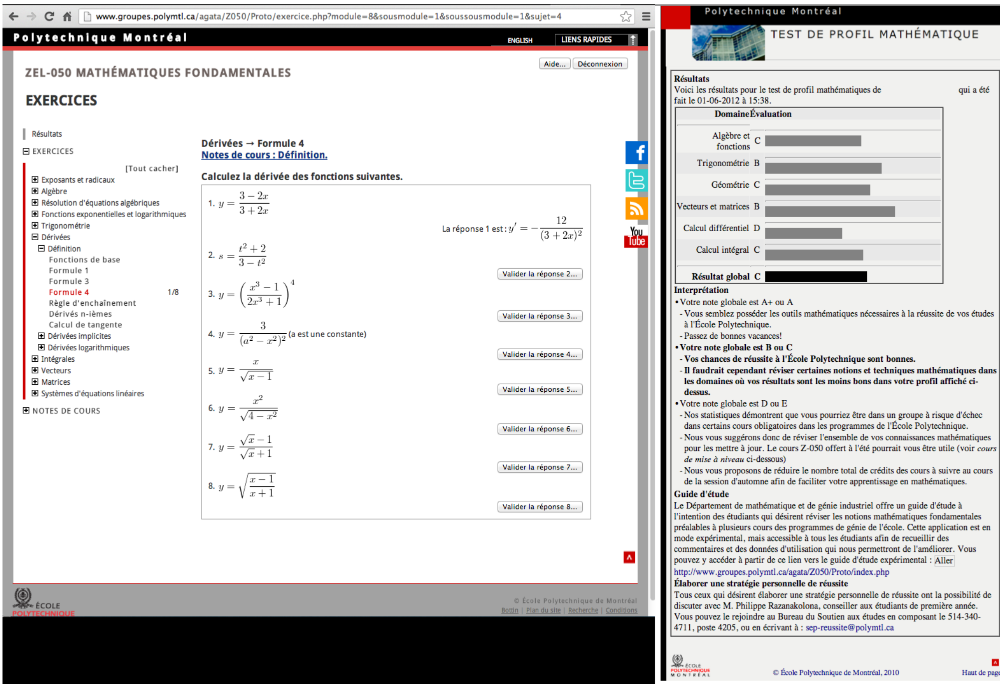
The software over which the grid is applied is designed as a drill and practice learning environment on the topic of college mathematics. We will refer to it as the Exerciser. It aims to help newly enrolled engineers to assess their level of mastery of college math with respect to the level expected in their first year. If their mastery is lacking on any of topic, or if they want to enhance their skills, the Exerciser contains over 1000 problems and the equivalent of approximately 150 pages of notes that cover the theory. The notes were contextually accessed within the exercise section, and vice-versa. Figure 1 contains two screen dumps of the Exerciser.

Table 1. The eight persuasive interactions criteria of Némery et al. (2011)

Criteria		Definitions
Static criteria	**Credibility**	is the ability of the interface to inspire confidence and to make the user confident in the veracity of its information. Credibility is based on reputation and notoriety.
	Privacy	refers to the protection of personal data and the preservation of personal integrity and security of the interaction. It also refers to protection against loss, destruction or inadvertent disclosure of this data.
	Personalization	refers to the concept of customization of the interface to the needs of the user. The customization can be a greeting, a promotion, or any means to achieve a more personal interaction with the user. It may also rely on group membership.
	Attractiveness	is the use of aesthetics (graphic, art, design) to capture the attention of the user, to support the interaction and create a positive emotion. The animation, colors, menus, drawings, video films are designed to catch and maintain the interest of the user.
Dynamic criteria	**Solicitation**	is the first of the four dynamic criteria. It refers to the initial stage which aims to swiftly attract and challenge the user to initiate the relationship. The interface attempts by words, graphics, or any form of dialogue, to suggest a behavior and induce action through minimal influence.
	Initiation	refers to elements of the media that entice the first user-initiated actions. The user's attention is captured and, through his own initiative, encouraged to realize the first engaging action. The user is caught in a gradual engagement process.
	Commitment	means that system further involves the user in a process. Several queries and incentives regularly and gradually engage the user. The electronic media will induce more intensive and regular behavior.
	Ascendency	is an expression of the completion of the engaging scenario. The user has unequivocally accepted the logic and goals of the media. The interaction is characterized by induced pleasure and possibly by the relief of internal discomfort. Ascendency is closely related to the concept of immersion in the video game field and it implies a high level of repetition and regularity of interaction, and sometimes emotional involvement in the story that results in dependence and game character identification. Users develop emotional attachment and cannot envision themselves without these product, or would feel a substantive negative effect in case of loss.

Copyright © 2013, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

Figure 1. Two screen dumps of the Exerciser. The top screen shows the exercise section where the user can test his skills over the different topics. The bottom screen is in fact the result of a test given to students prior to inviting them to access the Exerciser.



The assessment is conducted with the aim to address the following questions:

- How heuristic inspection could be done on persuasive elements situated in HCI?
- To which extent does the grid provide explanatory insights into the Exerciser persuasiveness?
- Which ergonomic recommendations can be derived from the inspection to improve the interfaces?

The Exerciser was analyzed by the two authors who are HCI and e-learning experts. Their analysis was done separately and consensually combined in a second step.

Highlighted Deficiencies with Persuasive Criteria

Figure 2 highlights some examples of the inspection results. The darker boxes with an 'x' sign indicates failed criteria, whereas the white background checked boxes indicate good scores on a criteria.

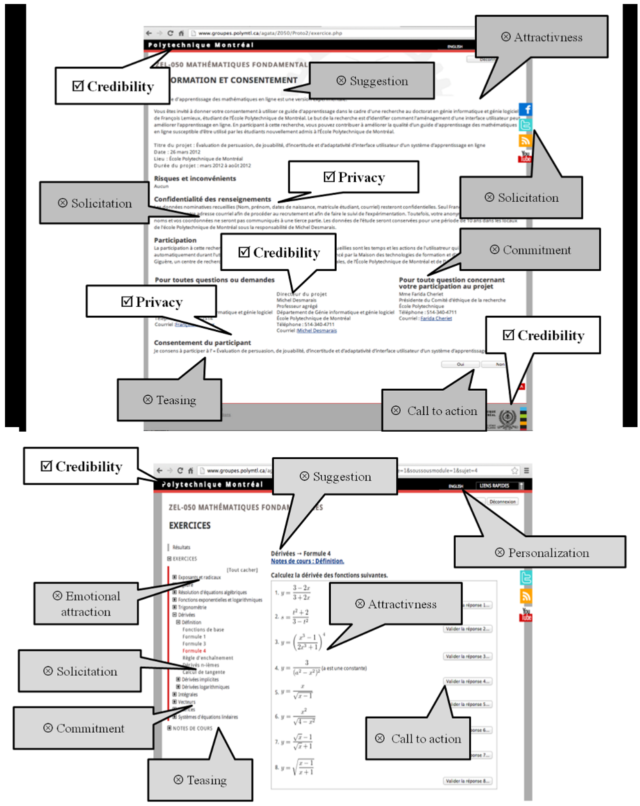
The Exerciser scores well on the static criteria of privacy and credibility. The presence of the institution's name and logo is a guarantee for the student that personal data will be protected and the content is credible. Figure 2 shows the consent letter (top screen) which is surely the most convincing argument in that respect.

On all other criteria, there are either few, or no elements that allows the inspection to give a good score to the Exerciser. The aesthetic of the interface is professionally sober, but it does not display attractiveness in the sense of sensory stimulation and eye pleasing. Personalization is limited to the display of the user name in the top right of the screen.

The Exerciser scores particularly low on the dynamic criteria. In general, there are no means deployed to engage the user in a gradual process of using the application. The Exerciser does not

Copyright © 2013, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

Figure 2. Examples of screens inspected with the criteria grid of persuasiveness



solicit, hunt for, or encourage learners (except for the test explained in the next paragraph). Suggestions and teasing that could awaken the curiosity are absent. The same is true for the sub-criterion of the initiation of the users who use the system once; they are not guided to undertake a first engaging action.

A notable exception to the weaknesses mentioned above is the right screen of Figure 1 which reports the results of a pre-test. The user will be encouraged to use the Exerciser if his score is low. But beyond this initial solicitation, the engagement process is not sustained.

Furthermore, we note that there is no reference to group membership, nor to peer activities and performances that the user can consult, and finally no tutor monitoring or other incentives that could induce some form of social pressure to engage in the task.

Finally, we note that the call to action is non-existent: the user is left to himself without a clear plan to follow or task sequencing incentives.

As commitment is not supported by the interface, we cannot find elements that would lead to any form of control or addiction of the user.

More details can be found in Brangier and Desmarais (2013).

Additional Observations from Usage Data

In addition to the inspections from experts, we also had data from the deployment of the Exerciser during the four months the summer 2013 (Lemieux and Desmarais, 2013). Usage log provides the time spent by each student and the number of exercises completed. Close

Copyright © 2013, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

to 300 students were invited to use the system, of which about 123 actually logged into it. This data yields valuable feedback on the actual effectiveness of the system to engage users to raise their skills in mathematics.

In that respect, the data shows that the array of levels of usage varies extensively, from a few minutes to over 100 hours. But the more intensive use of the Exerciser is the exception: only two students spent over 100 hours, whereas about half of the users spent less than an hour in total, sometimes only a few minutes. Obviously, some factors that affect long term engagement are highly variable across individuals.

We can reasonably attribute the general lack of usage of the system to the Exerciser's low score on the dynamic criteria of the grid that would foster a progressive engagement. It represents a sound explanation for the large proportion of users who spend a few minutes exploring the Exerciser without committing to its long term use.

However, these weak factors that were revealed in the inspection did not hinder some users to engage in a much more intensive use of the exerciser. We could attribute this to the fact that the initial test resulted in different incentives for users to use the system. One could believe that the first incentive would come from the pre-test scores, but Lemieux and Desmarais (2013) did not find a substantial correlation between the scores of the users at the pre-test and the usage of the Exerciser, and the two most intensive users of the Exerciser actually got average scores. Obviously, other factors are at play here.

A potential factor to explain the high engagement in some students is the perceived value, which represents the importance that the learning goal represents to the user, or the intrinsic motivation and even pleasure that some students can have in learning mathematics. Or, it can simply be that some students are easier to persuade and motivate to learn than other based on factors like test scores. Nevertheless, the strong individual differences are a difficult factor to integrate in an inspection grid and suggest that the design and assessment of PT may have to take better account of individual differences.

CONCLUSION

This study addresses the general goal of designing more engaging e-learning applications through PT. We put forward a design process based on two potential approaches that differ in terms of comprehensiveness and ease of application. They are inspired from the general principles of designing PT systems. The design approaches are complemented with a persuasive assessment grid that can be used as an inspection instrument, as we find in the field of usability assessment. The intent is that this instrument can complement the design process by giving early feedback on issues to address.

We conducted a persuasiveness assessment with the grid of an existing e-learning application intended for self-regulated learning of college mathematics. It provides evidence that the inspection can reveal factors that explain the low engagement observed as the Exerciser application was deployed and usage data was recorded. However, the high variability in usage levels of the Exerciser is an indicator that a small number of students reacted differently to the factors that can lead the student to engage in learning. This suggests large individual differences in the factors that can persuade people to engage in e-learning and that such individual differences should lead the designers of e-learning application to consider different means in the design of PT.

REFERENCES

Adams, M. A., Marshall, S. J., Dillon, L., Caparosa, S., Ramirez, E., Phillips, J., & Norman, G. J. (2009). A theory-based framework for evaluating exergames as persuasive technology. In *Proceedings of the Persuasive'2009, Conference on Persuasive Technology*. Association for Computing Machinery Press.

Copyright © 2013, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

Brangier, E., & Desmarais, M. (2013). A set of criteria to assess motivation and/or persuasion of elearning applications. In R. Behringer & G. Sinclair (Eds.), *Proceedings of International Workshop on EuroPLOT Persuasive Technology for Learning, Education and Teaching (IWEPLET)* (pp. 117-124).

Consolvo, S., Everitt, K., Smith, I., & Landay, J. A. (2006). Design requirements for technologies that encourage physical activity. In *Proceedings of the ACM Conference on Human Factors in Computing Systems (CHI 2006)* (pp. 457-466).

de Vicente, A., & Pain, H. (2002). Informing the detection of the students' motivational state: an empirical study. In Intelligent tutoring systems (pp. 933–943).

Fogg, B. J. (2009a). Creating persuasive technologies: An eight-step design process. In *Proceedings of the 4th International Conference on Persuasive Technology, Persuasive '09* (pp. 1-7). New York, NY: ACM Press.

Fogg, B. J. (2009b). A behavior model for persuasive design. In *Proceedings of the 4th International Conference on Persuasive Technology, Persuasive '09* (pp. 1-7). New York, NY: ACM Press.

Fointiat, V., Girandola, F., & Gosling, P. (2013). *La dissonance cognitive, quand les actes changent les idées*. Armand Colin. Collection U.

Joule, R.-V., & Beauvois, J.-L. (2000). *Petit traité de manipulation à le usage des honnêtes gens*. Grenoble: Presses Universitaires de Grenoble.

Lemieux, F., Desmarais, M. C., & Robillard, P.-N. (2013). Motivation et analyse chronologique des traces d'un exerciseur pour l'auto-apprentissage. *Sciences et Technologies de l'Information et de la Communication pour L'Education et la Formation*. STICEF (submitted).

Némery, A., & Brangier, E. (2011). *Criteria grid for persuasive interfaces*. Retrieved October 2013, from http://www.univ-metz.fr/ufr/sha/2lp-etic/Criteres_Persuasion_Interactive-2.pdf

Némery, A., Brangier, E., & Kopp, S. (2011). First validation of persuasive criteria for designing and evaluating the social influence of user interfaces: justification of a guideline. In A. Marcus (Ed.), Design, user experience, and usability (LNCS 6770, pp. 616-624).

Oinas-Kukkonen, H., & Harjumaa, M. (2009). Persuasive systems design: Key issues, process model, and system features. *Communications of the Association for Information Systems*, *24*(1), 485–500.

Petty, R. E., & Cacioppo, J. T. (1986). In L. Berkowitz (Ed.), Advances in experimental social psychology: Vol. 19. *The elaboration likelihood model of persuasion* (pp. 123–205). San Diego, CA: Academic Press.

Eric Brangier is Full Professor at the University of Lorraine. He passed his Ph. D. in 1991 in work psychology. After spending four years as a research engineer in a computer company, he founded a laboratory on User Experience. His research deals with the topics of ergonomics of products, prospective ergonomics, psychology of new technologies, cognitive ergonomics, usability and user experience. His international scientific responsibilities were to be chairman of three scientific conferences. Pr. Eric Brangier has also been working as an expert for different committees (France, Canada and Belgium). He has participated in 52 committees of international conferences. He was invited in, Belgium, Canada, Norway, Poland, Portugal and Swiss. In 2004, Prof. Brangier received the Second prize for research by the "Conseil Régional de Lorraine". He is the author of 2 books and more than 300 scientific papers, communications and conferences.

Copyright © 2013, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.

Michel C. Desmarais is professor at the Computer and Software Engineering Department at Ecole Polytechnique de Montreal since 2002. His field of expertise is in the domains of Human-Computer Interactions, e-learning, and Artificial Intelligence. He has 15 years of experience in software project management. He was principal researcher of the Human-Computer Interaction and Computerized Learning Environments groups at the Computer Research Institute of Montreal between 1990 and 1998, where he directed a research program in HCI and computer assisted learning, and was involved in a number of research projects in close collaboration with private corporations. From 1998 to 2002, he was director of the Web services department in a private company and leader of a number of R&D Web-based software projects. He is the author of about 100 scientific publications.

Copyright © 2013, IGI Global. Copying or distributing in print or electronic forms without written permission of IGI Global is prohibited.