Universiteit Utrecht

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18 September, 2017

Dear Professor Trlifaj,

It is a pleasure and honor for me to review the habilitation thesis *Learning with Digital Technologies: the Role of Positive Affect and Motivation* by Cyril Brom.
First, I will make some general remarks about the work of Cyril Brom, next I will list some more detailed reflections or discussion points that were raised to me after reading the thesis, and I will conclude, as requested, with some recommendation concerning appointment as Associate professor.

I. General remarks

The thesis concerns many studies on the topic of digital learning technology, more specifically how these technologies can stimulate learners, and increase their active participation, and in this way, improve learning. The work can be characterized as highly profound and very detailed, making life of a reviewer not easy. Furthermore, the work comprises many, many studies. One could say, it contains not one dissertation, it includes at least *two* dissertations! (Also this makes life of a reviewer not easy). All together I am very positive about the scientific quality of the work that is done, and the extensiveness of reporting. One point of criticism, I did not like the referring to studies that are not (yet) officially published and for this reason are not included in the manuscript (e.g. a study on gamification, page 23 of the thesis), while the thesis did draw conclusions about these studies. It did make it hard for me to check the underlying data and to evaluate the conclusions.
The theoretical framework, mainly the Cognitive-Affective Theory of Learning from Media (CATLM) seems to me very appropriate as well as the methodology including the statistical analyses that are used.
Studies on simulations, games and gamification get nowadays a lot of attention, so the results of these studies will be very useful in the debate on best ways to improve games, and on what might be expected from results of playing a game. Lastly, Cyril did focus on a topic that does not get that much attention in all these studies, though all researchers refer to it: the role of affect and motivation. One reason could be that the topic of affect and motivation is not easy to study. So, also in this respect is the work of Cyril very useful and meets clear needs.

Concluding, in general this thesis seems to me very profound work, with important research questions and important results. Of course I have also points of discussion and reflections, and will list some of them in the next section. However, I do see these comments merely as triggers for an interesting discussion.

II. Reflections

Theoretical Basis. The Cognitive-Affective Theory of Learning from Media (CATLM) of Mayer, (2009) and Moreno (2005) (see e.g. page 11 of the dissertation) is used as theoretical basis to describe the processes and to predict what kind of effects should be found. Important parts of the model are the selection, organization and integration processes that influence, and sometimes facilitate learning. These processes in that model are, in turn, influenced by affective-motivational factors, the topic of the project of Cyril Brom. My point is that maybe it would have been more useful to look at the cognitive processes like selection/ organization/integration *directly*, and to design game-interventions that are aligned with these processes. Information on this point is lacking in the dissertation, and maybe in this way bigger effects could have been found.

Game characteristics. A very important issue in game design and the evaluation of the effectiveness of games concerning learning involves the integration of game features or game mechanics *with* the learning content itself. To put it simply: "what you do during the game, should also be what you have to learn". This problem also known as the "chocolate-covered broccoli" problem was convincingly demonstrated by Habgood and Ainsworth (2011). What a learner is doing during playing should be clearly relevant to the needed cognitive operations or learning content, and it should not be an isolated sugar-coated layer. I miss a discussion of this issue, particularly in the context of gamification. Gamification can easily result in the chocolate layer on top of the broccoli. I don't know whether the lack of positive effects in Cyril's games can be explained in this way.

Adequacy of the games. I cannot find information on the constructed games itself: how adequate in technical sense or attractive were they? And that is of course an essential condition with intervention studies: it could be that the games used in the studies were not adequate or attractive enough to players, and the assumed processes can still be correct, though the results in general did not indicate that.

Mental model construction. An important issue of learning and teaching is to stimulate the construction of mental models in learners because that promotes transfer and retention after longer delays, and that involves deeper learning as opposed to surface or superficial learning or rote retention. Some searchers claim that games are particularly suited for facilitating mental model construction (e.g. Graesser et al., 2009; Mayer, 2011). It is not clear to me, in all the experiments that are conducted, whether the games as constructed were focused on this, and also not, whether the dependent variables (the measurements) could have detected this. But maybe I have missed it.

Questionnaires as dependent variables of affect and motivation. In general, small or no effects were found on the affective-motivational variables. Flow is, I believe, a frequent exception (page 41 and 226). I wonder whether *online, non-obtrusive* measurements would have been more sensitive to detect affective-motivational changes in learners. See e.g. Georgiadis et al., 2016 who studied successfully EEG patterns to demonstrate these effects, while questionnaires showed no differences

Context chosen. Cyril Brom did chose educational context to study the effects of gamification (Chapter 5.4), which is understandable because he is interested in learning with digital technologies.

However, I wonder here whether the context chosen to demonstrate effects of gamification probably is not lucky; maybe routine-like work processes are more appropriate for this.

Individual differences. Many games in general show that their effects depend on individual differences. Prior knowledge is in this context is a very relevant one. I noticed that in many experiments of Cyril prior knowledge as operationalized as Perceived Prior Knowledge, was handled as a *covariate* in the studies (e.g. Table F2, page 140). In my opinion that is a bit a pity because one wants really to know the influence of prior knowledge and it should not be partialled out, as in a covariance analysis, but included as a *factor* in the analyses of variance. There is one study –The Cultural Background studies on Personalization- that demonstrates this point clearly (page 99, Chapter 6): there is an interesting interaction effect of study level and personalization (or not); weaker students were helped by personalization while better students were not helped or even hindered (F=5.31, p=.02). These kinds of interactions are very important and remain invisible when variables as study level or prior knowledge only function as covariates.

III. Recommendation

Based on my evaluation of the habilitation thesis of Cyril Brom as given above, and knowing many of his publications, and based on the information available to me I would like to provide you with my recommendation.

Cyril has initiated, carried out and coordinated scientific research within the domain of Digital Technology. In doing this, he has also been responsible for planning and developing a long-term research project.

He has developed and applied recognized scientific knowledge within the field of Digital Technology and valorized this for the befit of science and society by means of improved, modern educational programs.

From his publications it is clear that he supervised many collaborators over longer period, also often in interdisciplinary relationship. From his publication list I understand that he also supervised many Master and (possibly) PhD students.

Many of his publications and conference contributions are published in high quality journals and presented on high impact conferences. Next to that, several manuscripts are right now in the pipeline so his productivity will still increase.

Concluding: I am recommending to appoint dr. Brom as Associate professor.

I hope my review contributes to the decision process, and I am looking forward to a face-to-face discussion with Cyril Brom on his work.

Yours sincerely,

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