New Didactic Models for MOOCs

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Abstract: In recent years we observed an enormous rise of Massive Open Online Courses (MOOCs). A problem of MOOCs is the high dropout rate. This caused by the lack of an appropriate didactic model, low interaction students teacher, poor feedback mechanism. In this paper we propose some improvements. Our proposed didactic model is a description of the learning interaction process in the course of the time. Emotions play an important role in this model. It proves that emotions have a great impact on the study behaviour of students. Some emotions as happiness, can stimulate students to go on with the study, other emotions as fear for exams, anger, disappointment about results of exams can block the study behaviour of students. Next we present some educational actions grounded on our model and proposed to decrease the dropout rates. One of the actions is based on verbal and nonverbal feedback of students about their emotional state. Our proposed actions are tested on a small scale using a MOOC implemented under Moodle.

1 INTRODUCTION

Massive Open Online Courses (MOOCs) are a recent phenomenon in distant learning. Consortia as edX, Coursera and Udacity offer hundreds of courses. Students have free access to courses taught by excellent teachers from renowned Institutes. MOOCs are attractive for unprivileged students because usually no entrance exams and tuition fees are required. One big disadvantage of MOOCs is the low success rate. On average only 7% of the students finish a MOOC successfully. One of the reasons is that an appropriate didactic model for MOOCs is still lacking, interaction students teacher is difficult to realise and poor feedback mechanism.

Nowadays the focus is on training 21st century skills, as cooperation, problem solving, creativity and critical thinking. MOOCs are well suited for training such abilities. But a great problem is that students easily drop-off as soon as the learning material starts to be boring, difficult to understand or too much cognitive processes are required. These learning problems are not new. Many students have the experience that they lose their attention regularly during oral lectures or presentations. But a good lecturer is able by giving summaries, examples to get students again on-board. And a big advantage is that students are not allowed to leave the lecture room and can give the teacher the impression that they are still listening. But as soon students starts consulting their smartphones or laptop, the attention for the oral lectures is dropping. In case of MOOCs students can also lose their attention, motivation and interest and can easily drop-out. The challenge is how to keep students on board during the MOOCs learning process.

In this paper we introduce a new didactic model for MOOCs. Important components in this model are emotions, attractiveness, social support and of course the learning material. In the student-teaching interaction model the components can be positively or negatively stimulated. A sequence of negative stimuli will result in drop-off from the MOOC course. We will present some didactic educational actions focussed on positive stimuli to increase the interest, motivation and learning activities of students. The new didactic approach has been implemented in a prototype of a MOOC on crisis management during flooding disaster developed at Czech Technical University in Prague. We performed some small scale experiments to test our approach. The preliminary results will be reported in this paper.

The outline of the paper is as follows. In chapter two we present some related work. And in chapter three we present our new didactic model. In the rest of the paper we present some methods how to assess

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the emotional state of students and how the information can be used to improve the learning process.

2 RELATED WORK

One online survey lists down the top 10 reasons for the low completion rates, and lecture fatigue and poor course design figure at numbers 4 and 5 respectively in this list (Colman, 2013). Many researchers emphasizes on the lack of professional instructional design for MOOCs. Especially disturbing is that none of the major MOOC providers have hired anyone trained in instructional design, the learning sciences, educational technology, course design, or other educational specialties to help with the design of their courses.

Armellini et al (Armellini, Padilla Rodriguez, 2016) researched the question if MOOCs are pedagogically innovative. They surveyed different stakeholders. Their conclusion was that claims linking pedagogic innovation to MOOCs are largely unfounded. xMOOCs in particular seem to rely on strategies that have been used in online and distance learning for decades. The authors state that MOOCs provide good examples of technological innovation but also of highly debatable approaches to pedagogy. They may be deemed valuable as resources (MOORs), but far less so in terms of being pedagogically innovative courses.

Tak-ming Wong, (Tak-ming Wong, 2016) summarises the factors leading to effective teaching of MOOCs at the various stages of course delivery, as reported in relevant studies. The preparation stage involves understanding the various aspects of the development of a MOOC. For attraction, how to draw and arouse the interest of "target learners" in the course is discussed. The emphasis in participation is on the ways to make learners engage in learning activities and interact with the course contents. Interaction centres on encouraging learners to interact with each other to foster learning. In consolidation, the assessment issues are addressed. Finally, post-course support examines monitoring and analysis of student data for the continuous improvement of teaching.

Dillon et al (Dillon, 2016) measured a range of self-reported student emotions in a MOOC context. They found that hope and enjoyment were the most frequently reported emotions, followed by contentment, anxiety and pride, while shame, disappointment, isolation, anger and sadness were rarely reported. Maybe students don't like to report that they experienced negative emotions. It proved that the results depend of the context. Self-reported emotions related to specific segments of content, or study activities may elicit different emotional responses. The emotions anxiety, confusion, frustration and hope were reported to dropout

Leony et al (Leony, 2015) discovered correlations between emotions such as frustration, confusion, boredom and happiness and evaluation metrics as percentage of exercises solved well, time spent in exercises, video abandon and video avoidance. Their hypothesis is that learner's emotions can be inferred by analysing their actions.
We present similar ideas in this paper. The authors used the affective information to personalise the MOOC experience to the learner's skills, objectives and profile. The goal is to create an adaptive educational system with personalised action plan. The learner profile can include information like current learning skills. Learning style, learning goals and accessibility needs. The inclusion of affective information in MOOCs can be used to customise the learning experience.

"Emotions, technology and learning" is a volume of research papers on emotions in education edited by Tettegah et al (Tettegah, 2016). According to the editor research suggests two important roles of emotion related to learning and technology. First, emotion can be the key factor that is being learned or taught through technological means. Second, emotional responses with and through technology can alter what is being learned or how the content is learned. Both perspectives are discussed in the volume by focusing on the relationship between emotion and learning as facilitated by technology. The book is divided into four sections to represent the specific interest related to emotion and learning, with an interesting section on theory and emotions and Learning Online.

3 DIDACTIC MODEL FOR MOOCs

In (Rothkrantz, 2016b) we presented new didactic models for regular courses and distant learning. The first model was focussed on finding the impact of different components on the academic performance measured as the number of exams passed successfully. Because we used a longitudinal model the impact of the components is time dependent. To understand the dropout process of students we have to study the interaction process of students with the

learning material. What is the causality of the abrupt stop of the interaction process? We stress the dynamic aspect of the interaction process over time. It is impossible to measure the interaction process continuously over time by surveys. Another assessment methodology is requested. Next we developed a model describing the individually based interaction process of a student with the learning material. We like to measure the activity level of students, his emotional state and to understand the impact of these components on the interaction process of student-learning material.

To visualise the dynamic interaction process we take a metaphor from fluid dynamics. We assume a system of connected liquid reservoirs. In the basic reservoir the interaction process is fuelled by a stream of study liquid. Several components of the model as presented in Figure 1, are represented as sub processes of the interaction process and can generate additional liquid or consume available liquid. Such a model is needed to assess at some moment which resources consume too much energy and which resources don't produce any energy anymore. Based on that assessment we are able to compute if the level of study liquid is approaching a critical level. If a student passes a minimal threshold he will be at risk dropping-out. In that case some educational actions are needed to fuel the interaction process again. In our experiments we will discuss some examples.

The different components of the model interact via the basic reservoir. A lack of cognitive capabilities can be compensated by strong motivation, hardworking and control of study behaviour. The basic fuel of the process is a melting pot of study liquid. Several components provide new fuel to this process, other components consume fuel. It is important to research which components are main resources for new study liquid. In this section we describe some didactic measurements stimulating several components to trigger more study liquid. Important to note that the amount of liquid depends of the time, student characteristics and context characteristics.

Before a student starts a MOOC his basin should be filled by sufficient study liquid. His perception of his capabilities, abilities, motivation, goal and evaluation of a preview of the study generate some fuel. Once a student enrolled in the course the learning interaction process provides additional liquid but also costs some liquid. Viewing interesting movies or mastering assignments generates additional liquid via the component motivation. Asking questions, special alerts or

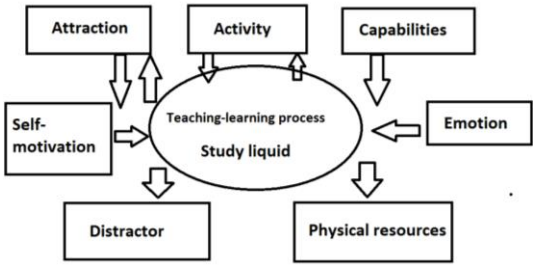

Figure 1: Didactic model.

switching to more interesting topics stimulate the component attention. But over time attention is decreasing, student can lost his interest and liquid is leaking away via the component physics.

We stress the fact that the impacts of components are not static but can change over time. We also consider interaction of components and summation of liquid contribution and liquid leakage of different components.

Attraction: An important component in the interaction student learning material is interest of students. As long as the learning material is interesting a student keeps on board. But as soon the learning material gets boring, student lose their interest and the dropout process has been started. In case of regular courses there is a lot of pressure of peers, Institute, teaching schemas to follow lectures the other day. New topics provide opportunities for a new start. Usually this is missing in case of MOOCs. By the huge amount of students individual tutoring is difficult to realize. A special didactic approach is needed. The span of attention or control is very short, only some minutes. A varied way of presentation of learning material is needed by showing movies, video lectures, simulations and interesting applied assignments for students. After positive experiences of the students with the learning material the attraction will be increased. For example after solving assignments, understanding the learning material, or after positive feedback of peers or tutor.

Capabilities: A student assumes at start he has sufficient capabilities to complete the course successfully. But when he interacts with the learning material and it proves that it is far beyond his capabilities, the dropout process has been started. In regular face to face courses a student is not allowed to leave the teaching hall. In case many students lose their interest an experienced teacher starts a summary, a clarifying example to get students back in the teaching-learning process. In regular courses there is support of peers during the breaks or after the lectures. In MOOCs social support of peers is

wanted but usual less developed. There is a trend to develop MOOCs as self-paced courses for individual students. That makes these students vulnerable for negative interactions.

Activity: Attractive learning material and required capabilities are prerequisite of a positive interaction process of a student with his learning material. Next a student is assumed to play an active role in this process. Many students read the description of the offered courses, they even enrol in the courses but the next step is to start the study activity. Students have to set themselves into action. Wandering about, missing adequate study abilities can take a lot of energy but without the expected result. Most MOOCs are not designed for passive students, a lot of activity is required varying from posing and answering questions, making assignments and involvement in project activities. After positive feedback from the interaction process of students with the learning material the activity can be increased

Distraction: Interest and sufficient capabilities are the positive drives of the interaction students with the learning material. But there are also two negative drives. Distraction is the first negative drive. In case of MOOCs students usually study in a stimulus rich environment. The computer used for taking the course offers a lot of alternatives for distraction especially in case the MOOC material gets boring or is beyond the capabilities of students. Surfing on the web is a favourite activity, takes a lot of energy but doesn't contribute to successful completion of the course.

Physiology: A second negative drive is the physiological state of the students. If a student gets tired, continuation of the learning activities take a lot of additional energy. If a student gets hungry, sleepy he can start a break. A lot of discipline is needed for a restart and to keep the length of the break under control. In case of regular courses there are social rules, institutional rules regulating breaks.

Self-motivation: In a classroom setting is able to motivate his students and to push him to activities. In distant learning this is more complicated and can only be realised by the learning material. A student in distant learning courses is assumed to motivate himself. In some cases fellow students can take the role of tutor. A low degree of self-motivation in self-paced courses is a main factor to explain the dropout rates of students in MOOCs (Rothkrantz, 2016a). A strong stimulating role should be played by the learning material. This material should contain a lot of variation in learning activities and variation in energy needed to process the offered material.

Emotions: We stressed already that affective components as feelings and emotions have a huge impact on successful study behaviour of students. Students should like their study, being proud of their study and have progressive learning results. Successive negative emotions can result in a negative mood of students and in that state they are very sensitive to dropout. In the next section we focus on the assessment of the emotional state of the students and how to transform negative mood to a positive mood. An important role is played by variation in learning material and learning activities and affective support by peers.

3.1 Validation of Learning Model

A fluid dynamic approach of psycho-somatic processes has its roots in ancient time. The model enables us to relate different processes involved in learning. The idea that physic somatic processes share simultaneous resources has been researched recently by the brain scientist Scherder (Niet, van der). He claims that exercises and making music have healthy effect on the brains.

In (Rothkrantz, 216b) we presented a didactic model describing students as open systems. This implies an ecological attitude with respect to causality. Context and evolution have to be considered. Success of study is not only dependent of student's characteristics as capabilities, knowledge, used study methods, but is the result of a complex interaction process. To validate the model we performed a survey study. All students Informatics (n=160) were requested to fill in a questionnaire of 190 items on a 3 point Likert scale. In these items students were questioned about their opinions, motivations, and assessments, experiences with respect to the study, study environment and study conditions with a focus on the interactive aspect. It proves that 80% of the variables show a significant difference between the groups of students passing, 0, 1, 2, 3 or 4 exams successfully at the first exam session of the academic year. Students with bad academic results had low scores on motivation, capabilities, learning activities. Students who decided to stop the study had an exit interview with the student's counsellor and again it proves that during the first weeks/months of study the motivation, activity, appreciation and pleasure decreased and finally resulted in the drop-off process.

We assumed that factors underlying the drop-off process during regular courses and e-learning play a role in learning via MOOCs. Based on the survey

research we were able to detect factors having an impact on study-success or failure of the whole cohort of students. Analysis of the data of individual students obtained by questionnaires on succeeding moment we were able to confirm our results. To evaluate MOOCs studies more advance learning analytics methods are needed. The response rate via questionnaires is usual low in MOOCs studies. In our first preliminary assessments we researched the feedback and interaction of students via special interfaces presented in the next chapters of this paper. The impact of these special educational can be understood and explained using our didactic model.

4 EDUCATIONAL ACTIONS

In regular classroom teaching a teacher is able to perceive the level of attention, participation and other learning activities of his students by observation of their body language. If students start reading their e-mail, interacting with their smartphone, closing their eyes, looking at their watch, yawning or starting a discussion with peers, the teacher may assume he is losing contact with his students and start special actions as giving a summary, giving an example, making a joke or starting a discussion with the students.

Observing students during our MOOC course is much more complicated. Many students are supposed to study the course, remote in place and time. Individual tutoring, personalised interaction is difficult to realise because of the massive character of the course. As a consequence all kind of interaction has to be automated. Observation should be unobtrusive and not disturb but support the learning process. Sending e-mail at regular times to check if students are still alert was not an option for us because expected response rate will be low. We preferred observation and interaction integrated in the learning process. We implemented the following different kind of interactions. Some of these interactions will be discussed in more detail in the next section.

Keyboard Interaction, Mouse Klicks, and Button Interaction. If there is no user response for a longer time, probably the user is not active anymore. Requests of a new learning material nugget of a user have been logged and the time between requests is computed. If the time lap between requests surpasses a threshold, a special alert will be generated, calling attention for the next attractive part of the course such as a movie, or simulation. If the student doesn't show any reaction, the assumption is that he left for a longer or shorter time and an automated break will be generated. We realise that a tailor made reaction could be possible but then additional information is needed.

To go from one learning nugget to the other students have to click buttons. But we implemented much more interactions in our module such as replay a simulation or a movie or requesting an example or additional information or help. One of the reasons is to keep the student active without boring him. These are ad-on actions to the mainstream of the course.

A special type of buttons are emotion related buttons to enable nonverbal emotional communication to be discussed in the next section. Students can express their emotional state by pressing buttons with emotional words or visualizing their emotional state by an icon or facial expression, as displayed in Figure 2. Nonverbal expressions reduce the ambiguity of words. The verbal label to emotional representation can be used to compute the valence and arousal score using DAL The possible emotions can also be represented by their valence and arousal coordinates on a two dimensional plane as displayed in Figure 3. In case a student selects a strong negative or passive emotional state, an attractive intermezzo by movie or simulation will be offered. In our experiments we found that students have no problems to select icons showing negative facial expressions. In face to face communication students usually are not willing to show such negative emotions. In case the student is studying on an advanced level with assignments or further readings the option to return to the basic level will be offered to the student.

Text based Interaction. Natural language processing is usually rather complicated. We found that text input in chat session or tweets is usually not grammatically correct, includes a lot of out-of-vocabulary words, restarts and corrections. In our case we process only one-liners and keywords. We searched for emotional keywords, negations and adjectives of tweets. In (Fitrianie, 2007) we created lists of emotional words with valence and arousal scores using the Dictionary of Affect in Language (DAL) and Affective Norms for English Words (ANEW). We preferred ANEW because the list of emotional words is limited. To maximize the matching between our words and the words from the ANEW list, we have applied stemming for all words. The score of each utterance is initialized to neutral valence and arousal values All the words from the utterance are looked up in the ANEW list. If matches are found, a new score is computed by

averaging over the valence and arousal scores of the matching words. We find that only 34% of the utterances contained words from the ANEW list, therefore the majority of the scores still indicated neutral, valence and arousal.

Peers Discussion. Students are stimulated to use social media for their discussion. At this moment there is a focus on individual based, self-paced learning systems. To stimulate cooperative learning some modules of our MOOC is based on group work. In one of the assignments of the module of the management of the flooding disaster in Prague students have to play different roles in the crisis team. In (Rothkrantz, 2015) we designed a special procedure to assign individual students to a team. Different tasks are assigned to the group members and the group assignments end with a common written report.

One student is supposed to play the role of the mayor of the city and head of the crisis team. In our experiments it proves that the head of the crisis team feels responsible for the performance of the crisis team. Communication between team members was stimulated; some team members were pushed to activities. From a didactical point of view it proves that peers played the role of tutor and mentor in face to face learning reserved to the teacher.

Questioning-answering Systems. In the past we developed an Elisa-like Q-A system (Fitrianie, 2003). The system enables a dialogue between student-tutor. The focus of the system was to simulate a human dialogue about users with mental problems (student counsellor). To help students with study problems (tutor) requires much more knowledge of problematic interaction with the learning content of the course. At this moment a first prototype has been developed of a study information system to help students to choose the right study. A digital tutor is postponed to future work.

5 EMOTION BUTTON

At start the learning material was grouped together in in interactive e-learning nuggets ordered in a linear way. Usually a module starts with an introductory movie, or video or a combination, followed by a short video lecture, assignments followed by a new learning cycle. Many MOOCs using Moodle, edX or similar learning management tools or designed in this way. The characteristic feature of these MOOCs is that the designer has full control over the learning model. The students have to follow the nuggets, learning modules according to his design. He has the freedom to start or dropout of the MOOCs

In recent e-learning design students have more control of the order of the learning nuggets. We also ordered the nuggets in a layered design. At the bottom we have the basic nuggets (labelled by green buttons). Every student should be able to follow these nuggets composed of light way learning material as movies, simulations and short pitch talks. In the second layer we have the more complicated learning topics and the assignments (labelled by blue buttons). At the third level (orange buttons) we have advanced readings, mathematical models and finally we have the red buttons composed of group assignments.

In the navigation interface of the lessons the coloured buttons are displayed and students have the freedom to select the next buttons. In some test experiments it proves that students not only want a freedom of choice but also wants to express their valuation and emotional state. We implemented several other buttons, as facial expression and with a text label as displayed in Figure 2 (Desmet, 2012), (Fitrianie, 2007).

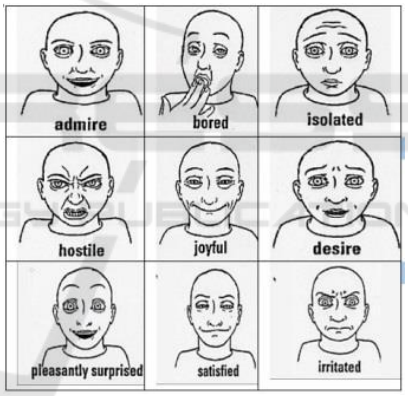

Figure 2: Personalized button interface.

The valence and arousal value of every button and corresponding verbal label, can be computed using the Whissel or DAL dictionary. In that dictionary every emotional word has two coordinates corresponding with valence and arousal. In Figure 3 we plot all the buttons by their valence and arousal coordinates.

In case the student is in the advanced levels and presses a sad expression, the system concludes that the level is too advanced or the learning material is boring, so a nugget on the basis level with interesting visual material is offered.

In case a student on the basic level choses a sad smiley, the system assumes the learning material is boring a new topic or more challenging nuggets are

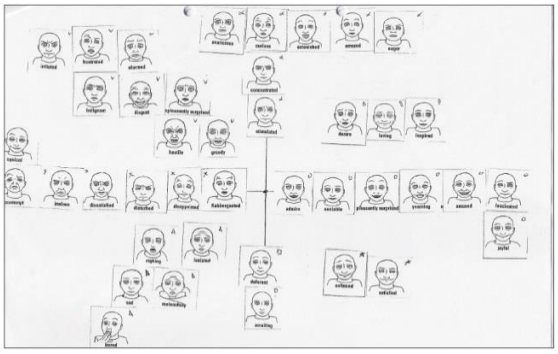

Figure 3: Buttons plotted on a valence-arousal map, valence corresponds with the horizontal axis and arousal with the vertical axis.

offered, depending of the recent learning history. As default a new topic will be offered because the student didn't select a nugget on a higher level. The system tries to keep the student on-board.

6 FEEDBACK BY EMOTIONAL WORDS, EMOTICONS OR ONELINERS

FeedBackFruits a start-up company at the campus of TUDelft developed educational tools. One of those tools allows students to give feedback during lectures via their smartphone. Later the company generated a plugin for edX one of the MOOCs consortia (Rothkrantz, 2015). We developed a similar tool for our special MOOC. The tool allows students to add comments via one-liners or emotional words to the teaching material. The idea was that students can provide in this way information about their current emotional state and if they like or dislike the study. Users of Facebook are familiar with this (dis-)like comment.

In one of our small scale test experiments with the current MOOC, 25 students Mathematics from Delft University of Technology were requested to provide at least one emotional word for every learning nugget. This resulted in a total of 750 emotional words. Using the Whissel database, it was possible to compute the coordinates on the valence and arousal dimension. A plot of the used emotional words can be seen in Figure 4. The similarity measure of words corresponds with the Euclidean distance measure. If users use words from the 2, 3th quadrant, the system starts a stimulating action as stated before.

In (Fitrianie, 2007), we developed an icon-based communication interface to represent concepts and

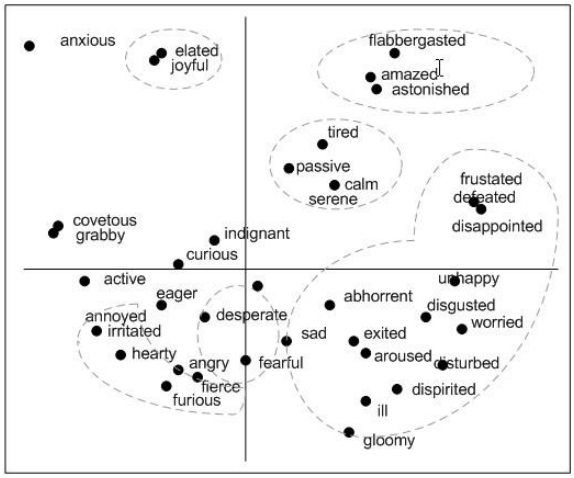

Figure 4: Plot of used emotional words during e-learning on a valence-arousal scale.

ideas. Users can create messages to communicate with others using a spatial arrangement of visual symbols. We even developed a context free grammar for our icon language based on an adapted version of the Backus-Naur Form. If we restrict the set of icons to the set of emoticons we can communicate our motional state by using emoticons, as displayed in Figure 5. The use of emoticons is rather popular under users of social media. Emoticons can be expressed by a picture or by one or more characters. In (Rothkrantz, 2000, 2009, 2010) we researched the relationship between facial expressions and emoticons in e-learning sessions.

Punctuation		Emblems		Emotions		Onomatopoeia	
?	:-Q	wink	;-)	happy	:-)	Oops	;-*
!	:-o	woman	>-	laughing	:-D	Ha ha	;-D
, ;	':-|	unclear	:-$	excited	8-)	Hmmm	:-I
.	:-|	Lincoln	=|:-)=	sad	:-(	Hi hi	:->>

Figure 5: Examples of emoticons.

7 CONCLUSIONS

In this paper we presented a new didactic model for MOOCs. Most current didactic models are modified copies of didactic models for face to face teaching-learning. But the dropout rate of MOOCs is very high and to our opinion an inappropriate didactic model is one of the causalities.

The learning material is supposed to attract the attention of students and is supposed to stimulate students to learning activities. In face to face learning a teacher has an important role to keep students focussed and can use many didactic tricks

to reactive students in case they lose their attention to the lessons. The impact of teachers in the interactive learning process in MOOCs is reduced to a minimum. Everything should be included in the learning material.

We discussed our layered ordering of the learning material to enable students to select their individual learning paths of different difficulty degree. But the learning material should include much more stimuli to attract and keep the attention of students and stimulate them to learning activities. We presented a new didactic approach modelling the learning activities and study interaction students with the MOOC. The basic idea is that the learning process of students is fuelled by a study liquid. Several resources consume this energy liquid and other resources provide new liquid. When the liquid drops below some threshold, the learning process will stop and probably a student drop-out. In face to face learning it can happen that students lost their attention and are not able to process the presented material anymore. But students are not able to leave the classroom and a didactically gifted teacher is able to get students back in the learning process. During MOOCs learning the situation is different. We stressed that peers are important because they are able to support students and because of social interaction in peer groups they take part in the lessons.

Emotions play an important role in our model. We realised that students should be attracted by the learning material, they should like the interaction and their motivation to follow the MOOCs should not decrease. Based on our new didactic model we designed some didactic stimuli to re-activate students during the learning activities. The communication of students with the Learning Management System is modelled by using emotional buttons, keywords, one-liners and by facial expression. The recognition of a positive or negative emotional state of the student will result in special adaptation in the flow of the learning material. Students can go back to lower level or more attractive study activities as movies, simulations etc.

Next future we envision a digital tutor at the end who is able to supervise and improve the learning process of students. Such a tutor requires improvement of the needed technology for e-learning. We discussed already the option of multipath, streaming and circular ways of learning. But unfortunately many public domain tools of e-learning are still based on a linear approach. But recent developments around e-learning and MOOCs are promising.

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