Colour Codes Method Digitalization in edX E-learning Platform

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Keywords: Colour Codes, edX E-learning Platform, Learning Analytics, Learning Evaluation, E-learning Software, Open Code, IBM SPSS Modeler.

Abstract: Evaluation and improvement of the e-learning process are getting more and more attention. There are tools and methods available, but none of them is a solution to everything. A new Colour code method for understanding students' learning process has been introduced in the previous papers. The method uses three colour codes: red for "problem", yellow for "work in progress" and green for "job done", and previous research in classroom showed that this system works. The next step was taken to implement the method in the computer-based learning management system (LMS). For this purpose, edX learning platform was chosen. In this paper, an overview of edX learning platform and e-learning course evaluation methods and strategies is given, as well as a description of method and implementation. The main conclusions are that edX platform is suitable for the new tool and code block generation, as well as for sharing this code with others; the colour buttons worked as predicted, the data are gathering and gives an insight of which learning items get the most attention by learners, rating by the usage of colour buttons. 45% of students that attended e-learning course at least once, used colour buttons as well. The most used button was the green button "done" (67.2% of all pushes), the second largest was orange "process" (25.4%), but the least used was red "problem" button (7.4%). Mostly the codes were used in online tests (75%), but some part went to peer assessment (9%), informative learning materials (8%) and homeworks (5%).

1 INTRODUCTION

Organizations nowadays focus very much on the production and distribution of information and knowledge, in what has been termed the Knowledge Age (Soares, 2013). Especially important it gets in the education field which is all about knowledge.

E-learning is also one of the areas that attracts the most research and development funding. If this investment is to be maximised, it is imperative that we generate robust models for the evaluation of e-learning and tools which are flexible in use but consistent in results. Student examination is a powerful indicator of the effectiveness of e-learning, it is not the only one (Attwell, 2006).

Possibility to evaluate and improve the learning process is getting more and more topical. It is spoken a lot about the educational system and change of paradigms. New and digital age based educational paradigms are emerging (e.g., connectivism (Siemens, 2005)). But the question about how to find out, what improvements are needed in the learning process and content, is still actual.

It is always hard to make changes in the existing system, especially in such an inert system as education. And change is difficult, complex, and risky because it has unintended side effects. Effects of change ricochet through systems via interactions between its parts (Mitra, 2008). That is why people are intuitively rather cautious with any kind of change in the educational field because the consequences are often not observed right away and too many other systems depend on the educational system to experiment with it blindly since knowledge is the chief resource in our economy (Drucker, 2000).

In order to improve educators possibilities to make improve the quality of a learning course, a new Colour code system was introduced in previous research in a face-to-face learning environment. The system is meant for understanding students' learning process dynamics and find the black spots more quickly.

Dzelzkaleja, L. and Timsans, Z.
Colour Codes Method Digitalization in edX E-learning Platform.
DOI: 10.5220/0006806601650172
In *Proceedings of the 10th International Conference on Computer Supported Education (CSEDU 2018)*, pages 165-172
ISBN: 978-989-758-291-2

2 COLOUR CODE TOOL IMPLEMENTATION IN A LEARNING PLATFORM

The method could be referred as a Benchmarking model by Attwell (2006). “There have been several attempts to generate sets of criteria for quality assuring e-learning. However, these tend to be skewed towards proposing quality standards for e-learning systems and software which often disregard key variables in the wider learning environment or are based on criteria associated with evaluating traditional learning processes (and which disregard the technology) or criteria associated with measuring learner achievement through traditional pedagogies. An additional problem is that the designers of these benchmarking systems are often locked into a particular model of e-learning which limits their transferability” (Attwell, 2006).

2.1 Colour Code Method

A new approach, presented in the authors’ previous papers (Dzelzkaleja (2016), Dzelzkaleja (2017)) for continuously evaluating learning process in real time was presented. In this paper, the method is further analysed with the data gained from the first experimental observations.

The main principle of the method is as follows: there are three colour codes which are used by a learner to show the teacher the progress in every moment of the learning process.

- “Red” is used to show that the task is not clear or difficulties have appeared during the process, some assistance is needed (in the form of tutour or some extra learning materials);
- “Orange” is used whenever the task is being done and everything is clear – no need for assistance;
- “Green” is used when the learner has finished the task or isn’t doing anything.

The colours have been chosen based on the traffic-lights colour coding, since these colours are recognizable for almost every person andgives and opportunity to intuitivelly guess the meaning of the buttons – red as a something that slows down or stops, green s something that allows you to go the next place and is connected to pleasurable associations, and orange (yellow in some cases) being something in the middle of both previous.

In case of distant learning, the codes need to be installed so that the learner could click on the appropriate colour on the screen conveniently in every moment of the learning process.

There are other widely used methods for getting a feedback. A nice example of giving a feedback are voting systems expressing sentiment such as “like” and “dislike” which is already a popular way of showing your opinion of a picture, video, text etc. in social media platforms. Coursera learning platform offers possiblity to rate each learning object with “like” (thumbs up symbol) and “dislike” (thumbs down symbol), as well as report a problem (flag symbol), visually they are represented with a dark contour with no filling. In the case of such voting systems, students have to make a decision whether they like or dislike the material, and it can be connected to extra cognitive pressure, since there are only too possibilities to chose from and nothing in the middle. In Moodle there is a block available, that provides a possibility for a teacher and the student to follow the progress of the student with the help of a colourful Progress Bar, that shows how much of the course materials are already viewed or completed and identifies students at risk of completing the course. The proposed Colour code method in this paper differs from already available methods because it doesn’t ask from the user to make a decision whether they like every single learning item, but just ask to record, when and how their learning situation changes. So basically, it is meant to provide continuous data rather than discrete data. For example, it can show that from time x till time y the student has been in the learning process, from time y till time w the student struggles with a problem, in time y the student presses “Done” button and from time y till time z the student has a break, in the moment z the student presses “In process” button and starts another learning session until time a etc.

2.2 edX Learning Platform

The Internet and related web technologies do offer great solutions for presenting, publishing and sharing learning content and information, as is the case in many other areas. Special software called Learning Management System (LMS) is generally used in most institutions providing web-based learning. Nowadays, various LMS are used as a supporting tool in electronic education. A great number of LMSs, both commercial and open source, are widely used for educational and training purposes. Most universities combine the forms of learning, using one of the commercial or open-source LMSs. They tend to use

products such as Claroline, Fle3, ILIAS, MS Class Server, WebCT, Eden, Enterprise Knowledge Platform, LearningSpace, eAmos, eDoceo, Uniforms, uLern, Aspen, Oracle iLearnin, NETOPIL School and Moodle (Balogh, 2013).

edX learning platform is not among the most popular learning platforms in the world Toren (2015), Mauri (2017), Burns (2014), Laurinavicius (2017), Getting Smart (2017), nevertheless, its influence is growing and is mentioned in research articles like de Lera, (2012) and Banday (2014). edX was launched only in the spring of 2012 by Massachusetts Institute of Technology (MIT) and Harvard University and is supported by Google. Despite the short time of existence, in the end of 2016, it had already ~ 10 million users (Goulart, 2016). In comparison Moodle, which is the biggest LMS, have about 122 million users (Moodle, 2016) and Coursera learning platform, that has the biggest course catalogue amongst MOOC providers, has 23 million registered users. So edX is coming in as a powerful player.

EdX provides university-level courses and the topics are mostly associated with science (Fenton, 2015). In 2015 Riga Technical University launched their own open source edX learning platform in which the Colour code method was initially deployed.

The strengths of edX according to Fenton (2015) is a large catalog of online higher education courses; enroll in either self-paced or timed classes, ranging between four and twelve weeks; open source platform (Open edX) enables developers to build and share assessment modules, so it is possible to make changes to the appearance of the learning platform, and to add an additional functionality in form of “xBlocks” which are components of edX architecture and connects different sources (Open edX , 2017) students may audit or pursue Honor Certificates both for a fee or for free; video transcripts available.

Weaknesses of this platform are that students have little contact with their professors; outside the sciences, edX catalogue has gaps; discussion forums are comparably less convenient (Fenton, 2015).

As a not-for-profit open source platform, edX encourages developers to contribute to their Open edX initiative, and, thanks to that access, developers have made edX course assessment, while still imperfect, the most versatile currently available. Its courses are supplied by some of the world's most prestigious institutions, including UC Berkeley, Boston University, as well as both founding institutions. But edX is not meant as a replacement of a traditional university. While participants can audit classes and earn proof of enrollment for free, edX does not offer the credentialing of a traditional university. Typically, learners are adults interested in sciences, but that is expanding, thanks to a high school initiative and professional education program (Fenton, 2015).

To call edX courses "online courses" is somewhat misleading. EdX courses possess features of online education, including discussion forums (often moderated by faculty and teaching assistants); machine-graded multiple-choice assessments; self and peer assessments; and, of course, video lectures (typically divided into segments of twenty minutes or less). However, unlike an online course at my home institution, edX courses usually do not require prerequisites, and anyone can join at any time before the course ends. This open invitation can be a boon, as it invites all sorts of non-traditional students with different perspectives; however, by the same token, it also means that instructors cannot take for granted certain levels of competency (Fenton, 2015).

2.3 E-learning Course Assessment and Evaluation

Some summary on assessment, evaluation and feedback can be found in previous work (Dzelzkaleja (2016), Dzelzkaleja (2017)). We found EU handbook Evaluating E-learning A Guide to the Evaluation of E-learning (Attwell, 2006) as a very comprehensive, structured and useful guide towards evaluating a course.

The evaluation methods and tools differ widely. What they do have in common is that they recognise the importance of evaluation and many propose that evaluation should be an integral part of any e-learning initiatives or development. In this regard, they tend to lean toward a management model of evaluation; the primary aim of the evaluation is to provide feedback to influence e-learning implementation and future development (Attwell, 2006).

Firstly, there are many online data gathering instruments for assessing, typically, the user interface characteristics of software (e.g. student perception questionnaires) and secondly, there are devices to record and analyze usage by duration and frequency of log-in, pages accessed, user profile etc. The next question that logically arises is - why do we need another evaluation method in e-learning platform? The reason is that the available assessment and evaluation methodologies do not provide enough information about the reasons of user behaviour in the real time constantly, many of these are sophisticated in their design and ingenuity but lack guidance on interpretation and analysis (Attwell, 2006).

We will try to sum up the assessment and evaluation possibilities available in different learning platforms and what type of data is available from them. Let us divide data into two parts: 1) data connected to user grades and course curricula acquisition; and 2) data connected with course quality, learner satisfaction and user behaviour in the course.

With the 1st set of data, it is more or less clear because it is easy to track and follow learners' test results. However, the 2nd set of data demands some specific knowledge in programming and (big) data analysis, that not every course developer has, and usually the course developers and learners don't have an access to the raw data. So there is a need for user-friendly data visualisations. Some good examples, where this is available, is Google Analytics Tool.

Another drawback for the 2nd set of data is that only a limited number of data types is gathered, and that data may not reflect the reasons of user behaviour or do not show the patterns of the behaviour comprehensively enough. So complementary data gathering is being researched broadly in recent years. Technologies like eye movement tracking, facial expression recognition, voice tonality recognition, pose and gesture recognition have been tested and implemented. But these often demand to use a computer built-in camera, which means some loss of privacy and may leave users feeling uncomfortable, in some cases an additional equipment is needed such as eye tracking hardware and software which also can be costly (Landowska, (2017), Rezende (2017)).

It leaves us with mainly two lower cost and easier to implement possibilities: a) research mouse movement patterns on the screen and/or b) implement additional data gathering opportunities on the screen. In the first case, mouse movement analysis can offer us possibilities to make course visual design accordingly and to make several different visual designs for the course according to the learner's type. But this kind of design is hard to duplicate from course to course. In the second case, there is a need to implement additional blocks for feedback gathering on the screen.

2.4 Description of Method and Implementation

The Colour code method acts in a similar way to voting systems - giving the user possibility to express its process evaluation by clicking the appropriate button but in addition, it also attaches chunks of valuable metadata with each click.

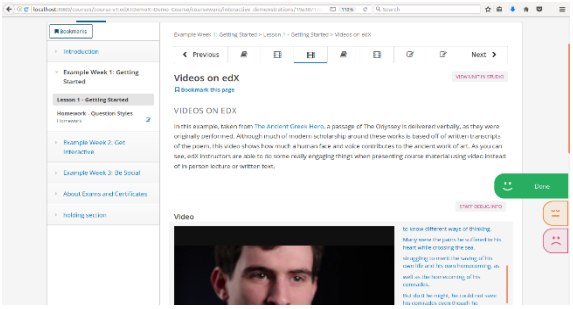

Figure 1: Screenshot of EdX with buttons.

The set of colour coded buttons are fixed on the screen in the same place at all times and is visible only at course content (Figure 1). When appropriate button is clicked information of the current state is recorded and sent to a database where all the data is gathered (Figure 3).

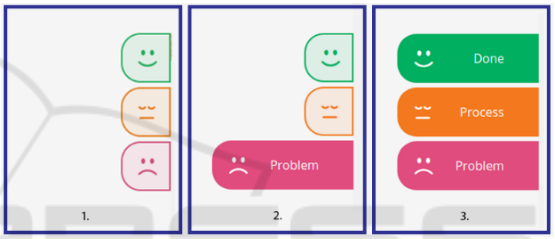

Figure 2: Button states.

The visual and interactive design of the buttons is based on basic principles of user interaction and experience design guidelines, thus implementing associated colours and playful animation to encourage more frequent interactions from users (Figure 2). Buttons are equipped with an anti-spam feature as well as feedback message letting the user know if click was recorded successfully.

As mentioned previously, data gathered from this method is complementary to already existing user data in edX platform. The type of the button pushed records the process stage at the current time (Done, Process, Problem (Figure 2)), and can be subject to change during the learning process. With every click of the button wide range of other parameters is recorded. These parameters are as follows: 1) what type of button is clicked, 2) time when it's clicked, 3) username, 4) course name, 5) course id, 6) section title that is currently being viewed, 7) video timer (if it's available), and 8) page URL.

Scripting languages, such as javascript, HTML and CSS, and programming languages, such as Python, have been used to develop the plug-in. Currently, it is not a ready-made solution and is in its early stages of development. The finished product

will be packed into edX xBlock, which will be available then to anyone, as it will be open-source. Current set-up requires jQuery code injection into edX document object model (DOM) which then renders buttons and communicates with a database. Python programming language was used to set up the database server.

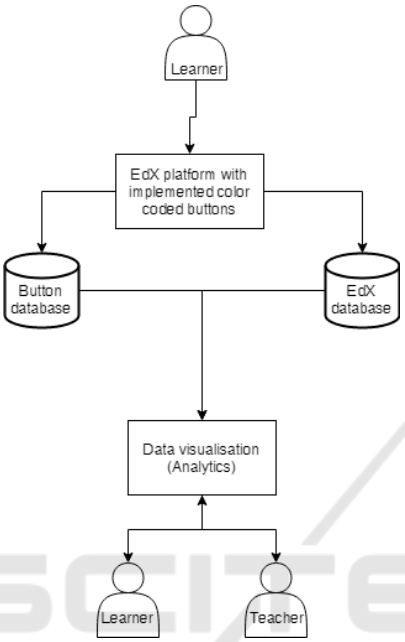

Figure 3: System diagram.

edX has a built-in data analytics feature, but it is not sufficient enough and this is why Colour coded method has been implemented.

A research of Schumacher (2018) shows that one of the most desirable features that students expect from learning analytics is a production of personalized analyses of their learning activities. And Colour code method is aiming to do just that.

As it is seen in Figure 3, there are two separate databases for collecting learner's behavioural data from the platform. Both databases are separated in order to not temper with EdX core setup. Both EdX and colour coded button method have adapted MySQL database, thus all data can be exported in different formats and analysed with chosen data analysis tool.

In this paper, a colour code button block implementation in edX is presented and tested. The next step is to convert the data into visually appealing and understandable form for both learners and course developers. This would engage learners to use the codes more often since they will be able to see the changes and patterns of their behaviour in their profile. For course developers, however, this information will immediately give a feedback on the quality of course material and student's learning pace as well as help to uncover possible issues associated.

3 RESULTS AND DISCUSSION

In this particular paper, a preliminary data analysis was done, using IBM SPSS Modeler. This is a tool that allows to process a big amount of raw data from a database and predict the future events with a help of models.

As an experimental group was chosen Riga Technical University 1st Bachelor course students. The learning subject was Entrepreneurship. Registered students' number was 106, they were split into groups, but the learning curricula was the same for all. The experiment took part in the autumn of 2017 and the database was active and started to record from October 19. The last data were mined from December 14.

Learning form was blended learning - some part of the course material was to be acquired through edX learning platform. In the beginning of the course, the learners were introduced to the edX learning platform, since it was a new platform for them, together with the Colour code method, and were asked to use the buttons voluntarily to help the research. For this experiment group, there weren't a personalized data visualizations of their activities available in edX since this experiment was mainly targeted to test the system, debug it, see how the data is gathered in the database and get a feedback from students afterwards.

The experiment is still continuing, but there are some preliminary results available. First of all, the system works as it should - the colour buttons are there and the data is gathered when a colour button is pressed. Quantitative data were gathered during the experiment. After the data were gathered and primary data processing was made, qualitative analysis was made as well.

Not all of the students used the buttons: 34 valid student IDs were recorded, and it is 32% of all 106 students. It should be noted as well that 31 of all the students haven't logged in the online course at all, so the actual proportion of those who used buttons and logged in the course was 45% of all 75 students who used course at least once.

The green button "done" was pushed the most times (67.2% of all pushes), the second largest was orange "process" (25.4%), but the least, to our surprise, red "problem" button was pushed (7.4%). Graphically it is displayed in Figure 4.

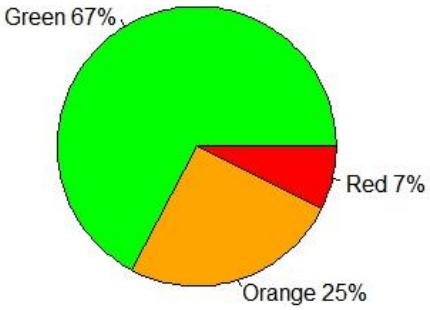

Figure 4: Proportion of pushed colours.

Mostly the codes were used in online tests (75%), but some part went to peer assessment (9%), informative learning materials (8%) and homework (5%), as Figure 5 shows.

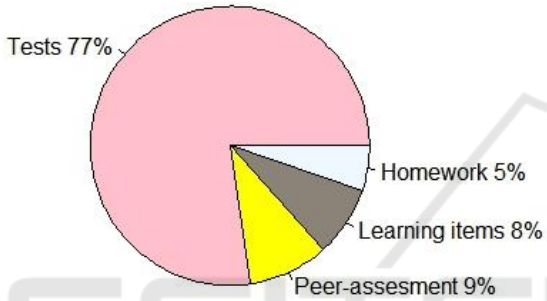

Figure 5: Code usage by learning material type.

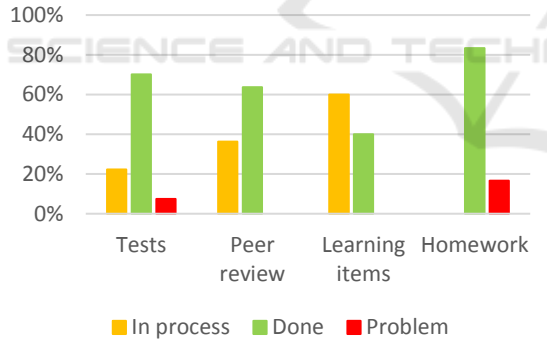

Figure 6: Buttons pushed in different learning material types.

If we analyse the gathered data about button pushes by learning material type (Fig.6.), it can be seen that in tests, peer review tasks and homework "Done" green button has been pushed the most, but it differs for learning items (meant the informative materials, not tests, homework and peer-review), and the biggest proportion here is orange "In process" button, "Done" being only the second and no problem button pushed at all. It can be seen that the "Problem" button hasn't been pushed in the Peer review tasks as well. Buti n the Homework no "In process" data has been recorded.

Partly the low activity in e-learning platform could be explained by the fact that it was a blended learning subject, and the edX learning platform was new to the learners.

Despite thr fact that buttons were used mostly in tests, the colours were distributed quite similar throughout all of the course material types. It could mean that students perceive the possibility to push the green "done" button as a reward - a symbol of work being done. The reasons for red being pushed so little could be one of three: 1) **good quality** of the course/nothing better to compare to, 2) feeling that there's **no point** of pushing red, because tutor would probably not react/the student feels it's his/her responsibility to understand and 3) **fear** from the tutor getting angry for judging/fear of getting caught not pushing the buttons (could explain the high activity of pushing buttons in tests). These are just a few ideas that could be useful explaining the results and need a further research to reveal the true reasons for this.

4 CONCLUSIONS

There are many online data analysis instruments for assessing available, typically, the user interface characteristics (e.g. student perception questionnaires) and there are devices to record and analyze usage by duration and frequency of log-in, pages accessed, user profile etc. But the available assessment and evaluation methodologies do not provide enough information about the reasons of user behaviour in the real time constantly, many of these tools are sophisticated in their design and ingenuity but lack guidance on interpretation and analysis.

edX learning platform is not among the most popular learning platforms in the world but has some important strong parts, and its influence is growing. Open source platform Open edX enables developers to build and share assessment modules, so it is possible to make changes to the appearance of the learning platform and to add an additional functionality in form of "xBlocks" which are components of edX architecture and connects different sources. edX encourages developers to contribute to their Open edX initiative, and, thanks to that combined efforts, edX platform has growing number of new features and functions.

The Colour code method acts in a similar way to voting systems - giving the user possibility to express its process evaluation by clicking the appropriate button, but, in addition, it also attaches chunks of valuable metadata with each click. The Colour code method, while still imperfect, is very versatile. In order

to offer this method for a wider audience of edX users, it has to go through severe tests and trials with possible changes and technical upgrades to the current version. Researchers are aware that current data gathering approach may not be enough and that even more advanced content marking approaches are needed.

Data analysis connected to course quality, learner satisfaction and user behaviour in the course demands some specific knowledge in programming and (big) data analysis, that not every course developer has, and usually the course developers and learners don't have an access to the raw data. So there is a need for user-friendly and easy to interpret data visualisations solution for both learners and course developers. This would engage learners to use the codes more often since they would be able to see the changes and patterns of their behaviour in their profile. For course developers, however, this information would immediately give a feedback on the quality of course material and student's learning pace as well as help to uncover possible issues associated.

The experiment is still continuing, but there are some preliminary small data set available. The conclusion is that system works as it should - the colour buttons are there and the data is gathered when a colour button is pressed. As mentioned in the discussion, only part of the students used learning platform and colour codes. The green button "done" was pushed the most times (67.2% of all pushes), the second largest was orange "process" (25.4%), but the least - red "problem" button (7.4%). Mostly the codes were used in online tests (75%), but some part went to peer assessment (9%), informative learning materials (8%) and homework (5%).

More research is to be made on this to analyse, what is the correlation between students using the learning platform and codes - whether they use codes whenever they use the platform, or only partly. Another interesting question arises - whether course design correlates to the codes used for different learning item types: for example, if 70% of learning materials in the platform are videos, then will the codes be used 70% on videos.

In this preliminary analysis descrete data was analysed – how many pushes and why. In the future it planned to deepen the analysis so that the time parameters would be included and some conclusions about session lengths could be drawn.

ACKNOWLEDGEMENTS

This research has been developed symbiotically with a support of grant from the European Regional Development Fund (ERFD/ERAF) project "Technology Enhanced Learning E-ecosystem with Stochastic Interdependences - TELECI", Project No.1.1.1.1./16/A/154, and international European Project funded under the FLAG-ERA Joint Transnational Call (JTC) 2016 FuturICT 2.0. Special thanks to Jānis Kapenieks (jun.) for allowing to experiment in his learning course and all the help.

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