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Real-time color codes for assessing learning process

Laura Dzelzkaleja[a,*], Janis Kapenieks[b]

[a]*Riga Technical University, Cesis Affiliate, Piebalgas Str. 3, Cesis, LV–4101, Latvia*
[b]*Riga Technical University, Faculty of E-learning Technologies and Humanities, Kronvalda Blvd. 1, Riga, LV–1001, Latvia*

Abstract

Effective assessment is an important way for improving the learning process. There are existing guidelines for assessing the learning process, but they lack holistic digital knowledge society considerations. In this paper the authors propose a method for real-time evaluation of students' learning process and, consequently, for quality evaluation of teaching materials both in the classroom and in the distance learning environment. The main idea of the proposed Color code method (CCM) is to use color codes during the learning process: green for "job done", yellow for "being done" and red for "have a problem". Codes help the teacher to understand the learning progress and react faster.

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1. Introduction

As the increasing volume of learning content becomes freely available, it is predictable that learners will focus on learning entities for support with their learning, rather than for the delivery of content. This puts a greater focus on teaching skills and less on subject expertise. Quality teaching is defined as: "teaching methods that successfully help learners develop the knowledge and skills they will require in a digital age" (Bates, 2015). Quality teaching is inseparably related to assessment, which is a way to provide both students and teachers with information needed to improve themselves and the study course quality. Garrison (2011) states that "every learning course should provide means by which both students and teachers can assess their learning and the expected outcomes". Assessment should

* Corresponding author. Tel.: +37126148225.
E-mail address: laura.dzelzkaleja@rtu.lv

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be considered as one of the components that supports an effective and comprehensive learning, and assessment methods need to be adapted to meet the needs of a digital age (Bates, 2015). Assessment and evaluation are strongly linked to obtaining feedback – students from a teacher as well as a teacher from students. The present paper mainly focuses on providing feedback to teachers.

The issues to be addressed are *how* and *when* to collect feedback. Pappas (2015) advises not to wait until the end of the course: "upon completion learners are tired and eager to be done. In addition, you certainly can't expect them to remember every single part of the course that needs improvement after they have covered a large number of modules and different subjects. Prefer asking for comments or questions on specific checkpoints throughout the course, when the content is still fresh in your audience's minds!" The researcher meant e-learning courses in particular, but his recommendations can definitely be applied to the classroom environment as well.

Blended learning in general and fully online learning in particular require a range of skills that most instructors are unlikely to possess. Regular and on-going instructor/teacher presence, especially when students study partly or wholly online, is essential for student success. This ensures effective communication between teacher/instructor and students. One of the best guarantees of quality in teaching and learning fit for a digital age is systematic evaluation leading to continuous improvement (Bates, 2015).

In this paper, the term "assessment" is used to describe a quantitative method for evaluating ongoing real-time learning process and quality of learning items. In the research by Garrison (2011) the term "assessment" is used to refer to its role in determining students' learning processes and outcomes, and the term "evaluation" is used to refer to the act of comparing a unit, course, or program against some set of performance or outcome criteria. Here the term "assessment" is used as a combination of assessment and evaluation.

Assessment also plays a critical function by providing external benchmarks that can be internalized. Since knowledge is both externally and internally defined, assessment provides an integrating mechanism whereby external measures of learning accomplishments are matched with a personal understanding of the learning process (metacognition). Such metacognitive awareness enhances learner responsibility and control and better equips students for continuous learning. Learners are also motivated by assessment techniques. Effective instructors use assessment techniques strategically to motivate learners to engage successfully in productive learning activities. Successful learners most often rely on assessment deadlines and activities both to pace and direct their learning efforts. Students should have some input into assessment if they are to be encouraged to be self-directed and have metacognitive awareness (Garrison, 2011). It is very important to be able to gather data for qualitative course assessment. This paper addresses the quality assessment of study courses – both classroom and online courses.

One of the main criticisms of online courses is they are of poor quality (Allen, 2015). Therefore, online educators can and should deal with quality issues in their courses, and they can do it by assessing their courses holistically. A holistic approach encompasses elements such as students' perspectives, results over a period of time, artefacts created during learning, and the instructor's course experience (Allen, 2015).

Since students are unique, there are an infinite number of issues that may impede student learning during e-learning courses. To overcome these impediments, a variety of student support services must be available in conjunction with qualitative e-learning courses. These resources need to focus on the content (remedial activities for some and enrichment for other students), on technical issues (especially if the technology used for delivery support is novel, sophisticated, or complex), and on personal issues (various types of counselling support). It is only through rigorous and systematic evaluation efforts that we will be able to develop our understanding of the many complex e-learning issues (Garrison, 2011).

There are some online tools available for receiving feedback in e-learning. The authors will briefly introduce some of them: Litmos Athor's review (Litmosauthor, 2016) that offers a possibility for making collaborative reviews; Review my learning (Reviewmylearning, 2016) that is made for feedback in e-learning as comments that are visible to other users; Trivantis (Trivantis, 2016) that provides a possibility to post comments that are sent to the course developer, who can react and change the course, while the user can afterwards evaluate the teacher's reaction as "ok"' or "not ok". However, these tools do not provide a possibility for continuous monitoring of the learning process and rely on student engagement to define and report the problems identified. These kinds of tools predictably add to cognitive load because they demand to jump from a particular learning item to another window/environment and then come back.

It is equally important not to forget about conventional classroom education if talking about assessment. This can be explained by the fact that teacher and student's self-assessment and obtaining quality feedback from teachers and students are still quite new approaches: while there has been a move over the past decade to conceptualize "learning"

from a constructivist perspective, approaches to feedback have, until recently, remained obstinately focused on simple "transmission" perspectives (Juwah, 2004). Up until a few years ago "quality" in higher education was measured by the course content, pedagogy and learning outcomes (Bremer, 2012). This approach has changed to a process-oriented system where a combination of activities contributing to the education experience is considered. Activities include: student needs, use of data and information for decision-making, department contributions, as well as improved learning outcomes (Thair, 2006).

The color code method (CCM) proposed in this article offers a possibility of assessing the learning process in accordance with the statements mentioned above and receiving continuous feedback from students throughout the course. The method is described in the next subsections.

2. Methods and materials

2.1. Introduction to the Color code method

The paper proposes a novel method for continuous data gathering in order to improve learning and teaching both in the classroom and distance learning environment. The CCM has not been tested yet and needs experimental results, but it can be said with certainty that the method is applicable to a wide age range of learners – starting with school or even kindergarten children to adults. That is because for learners the method is very simple to understand and use, and it does not require any specific knowledge or skills. The success and effectiveness of the method is largely dependent on the teacher (the person who analyzes the information obtained from the method).

In all cases the basic principle is the same: three color codes are to be used by students to show the work progress or workflow in every moment of the learning process. The codes are as follows:

- "Red" is used to show that a task is not clear to students or that some difficulties or problems have occurred while completing the task, watching a video or interacting in some way with learning material;
- "Yellow (orange)" is used constantly while everything is understandable and going smoothly within student's personal learning experience;
- "Green" is used when the task has been completed or video (or another learning item) has been watched and understood.

A few data examples that can be obtained and analyzed from the method are as follows:

- Percentage of learners choosing "red" for a particular learning item, thus demonstrating the quality or ease of understanding the learning item. Different types of learning items are to be separated (tests, videos, discussions etc.) because every type is related to different cognitive load.
- Average count of "reds" during a learning item to understand if there are many cases of difficult information in the item or there is just one major setback in the learning item. Red can also mean that teacher's assistance is needed.
- Proportion of "yellow (orange)" time and "red" time in a learning item to separate slow learners from learners who have some difficulties related to understanding of the task and learning material.
- Count of "reds" for every single student would provide information about problematic learners OR learners who want to understand and know deeply – further analysis is needed to look at the grades at the tests.
- Average time for completing every learning item (time after which "green" is shown).

The teacher or a course developer can also analyze the color code data linking them to the grades and other individual parameters of the students to acquire deeper understanding of the data and also verify the data. The following questions can be addressed here:

- Are those students whose grades are the best ones the same who complete the tasks (show "green" code) more quickly? Is there the opposite situation with bad grades and late "greens"?
- Which students use 'red' code more often - those with high, middling or low grades?
- How are grades related to the engagement and motivation (equalize to color code usage) in the learning process in case of a particular student? Do students use codes eagerly or do not use them at all, do they?

- In which task types do female students use “red” more than male students? (And vice versa)
- Do male students use “red” more than female students? (And vice versa)

There can be more data sets and types derived from the method, especially combining it with other information about learners, such as grades, gender and age. The limits are set by the necessity and goal of the assessment in every particular case.

In the next two subsections we will consider in detail how and why to use the CCM both in classroom and distance learning approaches. Combining the described approaches, the CCM can also be used for blended learning assessment purposes.

2.2. Codes in a classroom

Each student is provided with touchable three color codes – green, yellow (orange) and red. The color codes can be very simple – made of cardboard or paper (see Fig. 1), in which case learners just flip the tool to show the right color. There are small stripes of other two colors on each side of the tool that show a learner which color is on the next face of the tool and decrease redundant flips.

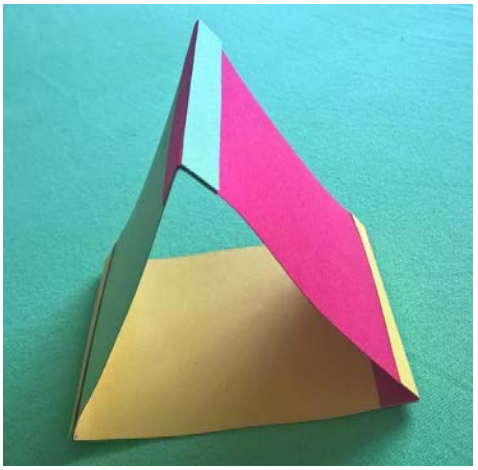

Fig. 1. Color code tool made of cardboard to be used by students.

In the simplest case, students turn the appropriate color for the teacher to see and teacher’s reaction follows. No quantitative data are obtained from this process, but still it increases the teacher’s ability to react to the learning processes in the classroom. In this simplified color code usage situation teachers can see patterns and analyze the learning materials in the classroom depending on the teacher’s personal abilities and qualities, so the teacher’s conclusions might be more subjective than objective.

Another simple but more objective way to obtain data is proposed: filming the classroom with a camera. In the case of filming the class, the teacher can afterwards analyze the filmed material. This way the teacher can more or less easily perceive the sectors in the classroom where students have more problems completing the tasks as well as the sectors where the tasks are completed faster. Some patterns can be crystalized, for example, back rows of the classroom finish the task later.

When the teacher has acquired some experience of using simple color codes and is able to analyze the filmed material easily, it is recommended to go further and add more data. It can be done introducing digital color codes that are linked to computer databases. The codes can be pressable buttons and color lamps connected to a computer gathering the information about pressing times, pressing places and person pressing the buttons. The form depends on educational institution needs and possibilities. It is important, however, to keep in the design the initial possibility for the teacher to see the overall process in the classroom and react quickly to the red and green codes.

The digital color codes provide more sophisticated data. The information about code usage is saved in the digital

database where the data are accumulated. Apart from the code data, the database should also contain information about each student's grades, age and gender for a further analysis together with obtained individual code usage data. The teacher can also add some information (metadata) about learning items, for example, type and degree of difficulty, and other information relevant to the learning process. In this case, the teacher can relatively easily link the information to learner's behavior in a particular task and theme as well as analyze patterns for the whole class not only in a particular lecture but also compare with the previous ones. Using a special interface each student (and also the teacher) can follow his/her individual progress and pattern change and find the themes and learning task types that are most difficult.

Using information obtained from the color code method the teacher can then ask students to change their seats time by time and change the types of the workflow – for example, group work, individual work with and without conversation. This way, the teacher can possibly also find some pattern of the key students that influence others. If there is a leader in the class that is eager to learn and open to constructive communication, then it is possible that students around this leader are also performing better – inspired or maybe provided with a fast quality consultation by the leader. The same can also be addressed to a case of a negative leader slowing down the process of completing the task. In the research by Gedzune (2015) it is maintained that one of the tasks of teacher education for sustainability is preparing teachers to deal with learners' social exclusion in their classrooms. It involves creating conditions for pre-service teachers to critically and reflexively evaluate the justification of their assumptions in light of their own and peers' experiences to achieve the most appropriate solution to be adopted as a guideline for future action. Social exclusion is one more aspect to consider using the CCM because in its most sophisticated version it enables teachers and students to perform a critical and reflective evaluation. Keeping it in mind, the teacher is able to propose the most effective classroom layout and siting patterns not only based on intuition and experience (that can be wrong and sometimes stuck to some stereotypes about students and processes that are wrong or changing in time) but on the data gathered from the CCM.

The data in the database can be further analyzed taking into consideration recommendations proposed in this paper as well as adjusting the analysis to particular needs of the learning community. Teacher can change the length, type and content of the tasks and themes in accordance with the patterns of the class.

At first, the CCM in the classroom can be implemented in its simplest form (no filming or digitalization). The color code tools and analysis methods are recommended to evaluate students and teachers' understanding of the method and possibilities it can give. In such a way, the gradual evaluation can contribute to lowering cognitive stress and rising positive attitude towards actually using the method in everyday learning. This agrees with the cognitive approach to learning that emphasizes the evaluation of knowledge through thinking processes and experience (Bates, 2015). After the students and the teacher have understood the principle of using the color codes and use them without additional cognitive load, more sophisticated tools and data gathering can take part.

2.3. Codes in distance learning

The main difference of using color codes in distance learning is that mostly a synchronous continuous interaction between the students and the teacher is absent during the learning process. Real touchable color codes cannot be used but instead a built-in possibility can be used in the learning management system for each learning item. In a computer they can look like circles in the above-mentioned three different colors (green, yellow (orange) and red) that are active for each learning item and can be pressed by clicking the left mouse button on each of them.

In the case of synchronous learning in form of webinar, a teacher is equipped with a monitor that shows the percentage of each color and percentage of learners not using the codes at every moment. This opportunity contributes to solving common problems in e-learning, such as the lack of physical proximity and body language used for feedback in classrooms and the limited instructor supervision over the learning process (Garrison, 2011).

In the case of asynchronous e-learning the color coding can help course developers understand which learning items are the most efficient – most understandable – and also provide the best knowledge (according to tests), as well as distinguish the most ineffective learning items.

In the case of e-learning led by a mentor or teacher, the codes provide a possibility to react more quickly to students' difficulties in the learning process without necessity for every learner to write an e-mail or find answers in discussion forums. The quicker and easier the feedback is, the bigger the possibility is that learners will use it. Thus, more feedback is accessible to the teacher. If the teacher discovers that many students have ticked "red" on a particular

learning item, he/she can leave some helpful comments on the learning item or edit the item. If the teacher notices that the learning process runs smoothly and there are a lot of "yellow (orange)" ticks and the "yellow (orange)" ticks do not last for a long time (having "green" tick soon after the "yellow (orange)" tick), the mentor/teacher can assume that there is no need to change the learning items.

It is possible to use computer based color codes for classroom based learning when students learn outside the classroom, for example, doing homework at home using the computer.

3. Results and discussion

For a student both in the traditional classroom environment and in the e-learning environment, the color code method is a possibility to be aware of his/her strong and weak sides as well as an opportunity to improve the knowledge and skills in a way that is more effective to a particular person. For example, if a learner in his/her summary of color code usage sees that it takes more time for him/her than an average student to complete the tasks requiring particular skills, then the learner can react and try to analyze why his/her skills are poorer and how to improve them. On the other hand, there can be a situation when a learner is sure of (not) possessing particular skills but the comparison to an average student shows that they are actually (above) below average. Thus, the student can get rid of the incorrect assumptions and react respectively.

Benchmarking can go far beyond one classroom if more and more teachers use the CCM and data are gathered in a common database for everyone. The common database allows comparing those who learn distantly to those who learn in the classroom as well as comparing skills, weaknesses and strengths.

The individual summaries provided to teachers and students can also be used to assess other information such as student learning type. Schmidt (1967) in his research assumed that a student could be modelled as being one of the following types: slow-learner student, normal-learner student and fast-learner student.

The CCM believably contributes to students' engagement in the learning process since they have more power both in the traditional classroom and in the e-learning environment:

- The students contribute giving feedback to a teacher/course developer with the help of color codes, which the teacher can take into consideration changing and improving the learning items. Thus, students participate in making and improving the lesson content, which is especially important for high school students and e-learners (Garrison, 2011).
- Participation in the CCM gives students an opportunity to compare themselves to others and find their weaknesses and strengths.

Due to these reasons students are predictably more engaged in the learning process and the use of the CCM. Probably the most important aspect of building a positive attitude to the CCM is explanatory work. Explanation is needed to explain the goals and function of this system. It should be done before the course starts, and it also necessary to stress the advantages and importance of using the system during the course. It is advisable to remind the class about the CCM in every lecture.

To promote the class to interact with the learning materials and show the value of their contribution using the CCM, information about changes in the course made thanks to the code assessment should be provided to the students. This way students can perceive themselves valuable to the group and not consider the CCM and learning system as a whole as abstraction but a real possibility of improvement.

There are possible risks that need to be considered using the proposed CCM. The following three main risks are distinguished:

- Students forget to use the CCM;
- Using the CCM interferes with the learning process;
- Students decide not to use the CCM or use it to mislead.

The major risk is that students do not use or forget to use the codes during the learning process. Both in the classroom and in the e-environment this risk could be reduced by reminding and motivating students. After some time, the code usage can become more natural to the students and reminding and motivating will be necessary to a lesser

extent.

Another risk is that the obligation to use codes interferes with the learning process – in the learning process a student forgets to use the code (especially in group work). Remembering this task or being reminded can cause some interruptions in the learning process and thus increase cognitive load. It is assumed that this risk is especially high at the start of using a new system and would tend to lower with time and getting used to the system. It is assumed that the CCM itself does not interrupt the learning process because it is used only in the "natural interruption" moments during the learning process – in the beginning; when a student understands that he/she has a problem and the learning is stuck; at the end of the learning task.

The third risk that is hard to predict and control is the risk that students will not use the CCM purposely, or, even worse they can press or show the wrong codes to inflict wrong results. The purposeful use of deceptive codes could be a bigger problem for children (compared to adults) in classrooms, when the tool in newly introduced to them. In this stage the teacher as a mentor and motivator has the most important role. It is even easier to decide not to use the CCM in e-learning because the process anyway needs some engagement from the learner and the use of CCM can be perceived as extra engagement. In the e-learning case the information and motivation about the need of CCS are important, as well as offering something valuable to the students – such as individual assessment possibilities for comparison to other students.

A question can possibly arise – why is it necessary to use the color codes in e-learning, if most course management systems provide tracking features that allow teachers to monitor student's behavior by showing the count of times a student has watched a video or stopped it, or for how long he/she has read the article and when switched to the next learning item (Garrison, 2011). But none of this information tells us about the reasons students do it – whether they log out due to frustration because three learning items have gone under "red" for them or maybe because they have finished and understood everything ("green"), or because they are still in process without any problems ("yellow (orange)"), just had to go for now and in the next log they will continue the started work. Without knowing the actual reason for students to act as they do it is hard for the course developer to assess the course and improve it as well as react operatively on problems and difficulties identified in the course. Thus, the CCM provides an opportunity to translate the students' behavior more accurately and not to "get lost in the translation".

There is a broad research field created by the CCM introduced in this paper. Further experimental data are needed to test this method in real operating conditions: in synchronous and asynchronous distance learning and classroom learning. There is also a need for creating and testing technological and ICT solutions for implementing digital and computer based CCM. They should be compatible with common learning management systems.

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