Real Time Color Codes in a Classroom
Position Paper

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Abstract: This paper is a next step after establishing a new system for real time classroom and virtual learning process evaluation. In a previous paper a theoretical system from three colour codes was established: red for "have a problem", yellow for "work in progress" and green for "job done". The hypothesis is that Colour code usage improves learning process evaluation, teacher's reaction ability and learning pace. An experiment was conducted to test the hypothesis and the Colour code method in a real learning environment. In this paper first experimental results in a real classroom are analysed and discussed. Experiments took part in the first grade (7-8 years old children) and in the fourth grade (10-11 years old children) in Latvia. The results suggest that there are less and lower implementation barriers for the children in these age groups as thought before, and children are eager to use the new tools and mostly aren't bothered by the extra effort needed to remember to use the system tools. The biggest challenge seems to be in the teachers' side - in adjusting the flow of the learning process and start using the system in advanced mode for data gathering. Another conclusion from this is that the colour code system is easier adopted in vocational education and for teachers and trainers that work with changing learner groups. Teachers and learners would benefit also because the colour code system serves as a good tool for changing teachers' tacit knowledge to explicit knowledge which can benefit in knowledge sharing and operationalization. Another interesting conclusion was that the colours in the colour tool need to be complemented with graphical or other colour independent pattern to use with people with colour blindness. Overall it is now clear that the system works and the next step can be taken to test the method in the computer based learning environment.

1 INTRODUCTION

Key focus for organizations today is 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.

The epistemological dimension distinguishes between tacit and explicit knowledge. Tacit knowledge is subjective, deeply based in personal experiences. Tacit knowledge is understood to be more sensitive to space (Howells, 2012) as it is acquired through interaction, demonstration, imitation, performance and shared experiences (Schmidt, 2015). On the contrary, articulated or explicit knowledge is objective and can be untied from the situation by which it was acquired. This knowledge is related to the rational, theoretical, and scientific activities in a positivistic sense. These

characteristics make explicit knowledge easier to express and transmit than tacit knowledge (Martı´n-de-Castro, 2008).

Possibility to evaluate and improve the learning process is getting more and more topical. It is spoken a lot about 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 found 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 much other systems depend on the educational system to experiment with education blindly, since knowledge is the chief resource in our economy (Drucker, 2000).

Analysis on a situation can be one of the observational results' processing cases. In the analysis of a situation, the same as in observation, a set goal is needed about what exactly is analysed – action, psychical phenomenon, teacher's or students' behaviour (Šteinberga, 2011).

Pedagogical experiment definitely is one of the best research methods in pedagogical psychology. A specific characteristic of an experiment is a particular pedagogical or psychological method, manner or shape usage in an experimental group that are different form the ones used on every day basis. As a result, a comparison is derived between students' satisfaction rates, assessment and self-evaluation using experimental and traditional methods. The interpretation of the results gives and information about method utility, about further research etc. (Šteinberga, 2011).

In the classroom learning process the speed of completing tasks differs from child to child. Some children complete the tasks fast and start to get bored or talk to each other; others need bigger teacher's attention and have more questions; some just work slower. To make teacher's work in a class more effective and the teacher could react faster to the needs of every learner, the author proposes this new method.

In this way students' exhausting need to keep their hands raised for a long period of time is reduced. The raised hand also doesn't allow to use the time efficiently and start completing other tasks while waiting for teacher's assistance. Another gain that is predicted is teacher's possibility to react operatively and decide about extra tasks. Furthermore, the usage of Colour codes forces the pupil to be more responsible about his/her learning process and to evaluate his/her work process. On the other hand, teacher can evaluate the overall process in the class and identify problem situations and unclear tasks easier.

Raising hand is considered to be inefficient method to follow the learning process successfully. A more sophisticated learning process division is needed as opposed to the two states of hand ("hand raised" and "hand down"). There are also situations, when students are ashamed to raise hand because it attracts to much attention and/or causes a sensation of student's "failure" to understand is revealed to the teacher and fellow students which consequently causes a sensation of shame.

Author proposes to use the Colour code method to reduce the problems connected with raising hand and communication with teacher in an efficient way. But there are be certain setbacks to implement the method – as all new things the method integration into existing learning process and content demands extra cognitive resources form both students and teachers; it is important to understand about amount of extra effort needed and is it small enough to overcome it. There is also a risk that method won't work because of other reasons. The hypothesis is that Colour code usage improves learning process evaluation, teacher's reaction ability and learning pace. An experiment was conducted to test the hypothesis and the Colour code method in a real learning environment.

2 DESCRIPTION OF THE EXPERIMENT

The experiment took part in the November – December of 2016 in the Cēsis town (<20 000 inhabitants) in Latvia. The town profile is low industrial activity and rich culture and history heritage, in recent years different creative industries emerge.

2.1 Colour Code Method

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

In all cases (school, adult, non-formal distant or blended learning environment) the main principle of the method is as follows: there are three colour codes which are used by learner to show teacher the progress in every moment of the learning process.

Proposed cardboard tool is shaped as a triangular prism with each of the three prism faces representing one of the three codes. The codes are defined as follows:

- "Red" is used to show that the task is not clear or difficulties have appeared during the process and an assistance is needed (in the form of teacher or some extra learning materials);
- "Yellow" is used whenever the task is being done and everything is clear – no need for assistance;
- "Green" is used when the task is done.

In the case of using colour tools in a classroom environment every child is provided with a tangible

colour code tool. In the most simplified way code (and thus progress) changes are not recorded digitally, and provides teacher with a visual real time information without any external data analysis. The simple tools were used in the experiment described in this paper.

These tangible non-digital tools are meant to be put on a desk for a teacher to see a one face of the prism. Children turn the face accordingly to any changes in their learning state. And teacher is able to quickly evaluate the class in every moment of the lesson and react accordingly.

In the non-digital code tool version it is not possible to get a lot quantitative data, but teacher can observe process characteristics and analyse learning materials accordingly, but still a teacher's subjective view remains in the conclusions. The next upgrade offered by the Colour code method would be introduce a digital code tool for every learner. In this case a lot of quantitative and tangible data would gather in the database continuously, and data sets allow to make personalised learning interface for every learner and teacher as well. The data gathered for digital tools would give a possibility to introduce benchmarking and compare students, as well as give every student an objective external view of his/her learning process.

Making the digital code design, it is important to maintain the possibility for the teacher to see real time codes in the classroom. In case of distant learning, the codes should be installed so that the learner could click on the appropriate colour on the screen conveniently in every moment of the learning process.

2.2 Experimental Group Description

During the experiment, the method was introduced in a primary school environment. Since the possible target group for method implementation is very wide – from children to adults and from classroom to e-study environments, author decided to scale down the target group to primary school for this particular experiment as method reality check.

The author of the paper observed lesson process in 1st and 4th grades that mostly corresponds to 7-8 years old children and 10-11 years old children with 23 children in the 1st grade and 24 in the 4th. Teacher introduced the children with tools before the observations: in two lessons in the 4th grade and in three lessons in the 1st grade.

Each pupil has a separate desk, making four desks in six rows. Pupils sat by height – shorter ones in the front rows and taller in the back rows.

The author observed during math test in each class. Tests were to be filled by writing (not oral) and consisted of a paper sheet with a few exercises/questions that need to be solved. The tests were identic for the whole class and each pupil filled the test independently from other and at their own pace. Each math test lasted for one academic hour (40 minutes) and at the end of the lesson pupils had to hand in the filled tests.

2.2.1 Observations

The code tools were in a box and every pupil took a tool and put on the desk before the lesson. Teacher wrote the meaning of codes on the blackboard: yellow = I'm working, green = I've finished, red = I don't understand. This approach was the tool integration interpretation of the teacher. When the teacher saw that children are finishing the tasks, she wrote on the blackboard which tasks are to do next and where to find them.

The biggest part of the 4th grade students turned the yellow side of the tool for the teacher to see. A small activity in code tool usage was observed in the beginning of the lesson, when children had some qualifying questions about the tasks in the test. In the end of the lesson the activity increased – both because of some questions and because of finishing test.

Table 1: Main experiment parameters and observations.

Parameters	1st grade	4th grade
Children in the lesson	23	24
Lesson type	Individual Math test	Individual Math test
Max red at the same time	8	4
Minutes of red maximum (range 1-40)	15-20 30-32	25-28
Max green at the same time	6	7
Minutes of green maximum (range 1-40)	35-37	30-36
Children count that raised hand	6	2
Cases of raising hand	12	2
Cases of forgetting to take the code tool	2	0

If we compare 1st and 4th grade students, there were some differences observed. In the 1st grade students switched the colour codes more, because they needed teacher assistance more often. 4th graders used colour tool to attract teacher's attention and almost didn't raise their hands, but some of the 1st graders forgot to use the colour tool and still raised hands. This happened for one of the two reasons: either children went impatient because teacher didn't react to the red

code as quickly as they wanted and seemed to worry weather teacher is noticed the red colour at all; either children had forgotten about colour tool and, when remembered about the code, put the hand down quickly and turned the code tool.

Most children from the 4th grade didn't have any need for teacher's assistance, so there was little action with the red code. Most action was observed in the third part of the lesson when children were starting to finish the tasks and turn the green colour. In the 1st grade in contrary there was a lot of red colour usage during all lesson. There were some students in the 1st grade that didn't need any assistance (and thus red code) at all, but the proportion was small, and those were also the ones to finish the test quickest (and turn the green colour). Overall it was observed that younger children have more questions and confusion about tasks, and need teacher's assistance more, which is normal situation, and the younger also struggled more using the codes.

3 RESULTS AND DISCUSSION

Despite the fact that children were introduced to the Colour codes only recently, they accepted and used the code tool remarkably naturally. From the interview with the teacher, it was discovered that after the scientific observations in the class has ended, children in the next lessons were so used to the tools, that many of them took the tool form the box even without teacher saying anything about using them. That means that children get used to the tool indeed fast and the usage of the codes comes quite natural and without big cognitive load. This is with consistency of the hypothesis in the author's previous paper introducing the Colour code method concept.

In the 1st grade it was observed that children needing the teacher's assistance more, also were the ones raising the hands and forgetting to use or turn the colour codes the most. That shows evidence of children having trouble to understand the tasks also need more time to adapt to the Colour code method. It seems that for those children Colour code method could be of more cognitive load while adapting to it. This information need to be taken into consideration when introducing the method.

The observations also showed that especially for younger children the way of introducing the Colour code method is important. In the 1st grade it was a common situation that 6-8 children had turned red colour to the teacher and start to fidget impatiently and worriedly, some start to raise hand because think, that teacher haven't noticed the red colour (which is

sometimes right) if teacher doesn't come right away. In this case, when a "jam" is formed, a previous preparation is of great importance.

If the teacher tells children what to do, if she/he doesn't come right away, unnecessary stress among the students can be avoid. One solution to this would be telling the children to proceed with other tasks until the teacher will come and help. In this way children are not wasting the time on waiting and worrying. In such a way students are also developing a skill to work not only linearly, but also plan their time and make a decision about the order of completing the tasks to gain the maximize the output. Another solution to lower the stress about teacher not coming is to introduce a system of addressing students in row so that in every moment every student can predict when teacher is coming and avoid a situation when teacher doesn't notice the code or helps first the ones that are closer and not those who are waiting the longest; children are tended to react to this kid of "injustice" feeling hurt and thus adding to the stress levels.

Colour code method usage gives teacher a way to see differences in children behaviour because of change of seat and task type. The codes show the change in more objective and quantitative way than intuitive way used so far. Teacher can subsequently faster identify the characteristics of a learning group and individuals that need more attention. Teachers mostly learn these things without any tools working with the same group daily, but the Colour code method helps to do it faster and more objective – possibly before teacher has developed subjective conclusions about the learners, which can be false.

The Colour code method will help teachers to bring out the tacit knowledge, formulating the process in the class quantitatively and making the results more transparent and understandable for others in this way improving knowledge sharing. Afterwards the newly gained explicit knowledge about the learners' behaviour allows to combine the tacit knowledge with the explicit brought by objective tools like Colour code method. In this way perceptions about learning process become more profound and objective.

This approach is especially important in the knowledge intensive processes (KIP), and such is an educational system and learning processes within this system. Data gained from the Colour code method may not mean the same in different environment, for example, in schools in different countries. Spatial distribution crucial in the way knowledge is made and transferred. Cultural, historical and political differences can have a significant effect on the results (Schmidt, 2015).

The experimental observations also suggested that the risk of using the codes intentionally misleadingly or not using at all is not very relevant in the age group of 7-11 years old that corresponds to primary school in Latvia. The cultural and spatial characteristics and learning culture could be influencing factor for mentioned risk and would be advisable to observe learners from other cultural, historical and geographical backgrounds for more valid results.

4 CONCLUSIONS

From the theoretical research, experience so far and the experimental data, in can be said with certainty that method is applicable in wide range of the learners – from kindergarten children to the adults and distant learners, and that is because the method is simple, doesn't require any particular user knowledge or skills. The effectiveness of the method is largely dependent on the teacher that implements the method, analyses and react on the data brought by the colour tools. Children that have more difficulties in understanding the tasks, also need more adaptation time to the Colour code tool.

Teachers and learners would benefit also because the colour code system serves as a good tool for changing teachers' tacit knowledge to explicit knowledge which can benefit in knowledge sharing and operationalization. This approach is especially meaningful in the Knowledge intensive processes, and educational system can be perceived as one.

Overall in the experiment it was observed that younger children (1st grade) had more questions (code "red") than older (4th grade) and consequentially 1st graders turned the codes more often. 4th graders also didn't forget to use the codes while 1st graders sometimes raised their hands instead of using the code either because of forgetting about the code or getting impatient after turning red code to the teacher and not receiving the attention as fast as they wanted.

The codes in their simplest (not digitalized) version are relevant to use for bigger groups than 10, because small groups don't require so much resources to understand the dynamics. In a case of big groups, the size of the colour tools builds relevance as well, because there is a need of teacher seeing the codes clearly from several meters away.

In accordance to E. Eriksen (Wallerstein, 1998) classification children from six to twelve-year age (which correspond to primary school age) need to learn to make a choice between initiative and guilt. Since Colour codes are connected to a degree of self-initiative and self-regulation, it is highly possible that

the method could contribute to the development of age appropriate psyche development.

From a teacher's feedback the author concluded that colour codes need to be complemented to some graphical symbols or other colour non-attached codes that allow to use the method also for people with colour blindness. It needs to be taken into consideration since as many as 8 percent of men and 0.5 percent of women with Northern European ancestry have the common form of red-green colour blindness (NEI, 2015), and 99% of all colour-blind people are suffering from red-green colour blindness (Colblindor, 2016). In the computer based learning the colours could be complemented with shapes: diamond shape for red as the figure represents a static situation with a possibility of activity and movement; circle for yellow since this figure gives an impression of smoothness, movement and process; square for green since this figure gives an impression of stability and completeness.

After observations and based on the experience, it was concluded that the Colour code method would be very useful in the vocational, non-formal and distant education field where teacher mostly meet with their audience for a short period of time or very rarely to be able to understand the group dynamics and individual needs properly. From this situation may suffer both: teachers because of the high stress levels and need to be flexible and agile all the time as well as learners that get a poorer learning experience and teaching/mentoring quality. The Colour code method can contribute to solving these problems because:

- It helps to frame learning event and defines a few basic rules already at the beginning. Some framework is necessary to remove stress levels connected with learners not understanding the learning process goals and learning management process. This framework is especially important for the learners with sensing mode that corresponds the temperament of artisans and guardians (Keirsey, 1998), that desire concrete experiences, structure, and sequential learning (Stokes, 2001).
- It helps react to learning process without guessing so much and without a need to build experience of being able to "read" the group.
- It decreases the cases of someone dropping behind the learning flow if raising hand (or similar activities) to attract teacher's and/or other learners' attention is too resource intensive. Not willing to raise hand can occur from low self-esteem two cases: (a) "my question/confusion is not relevant enough to bother others with it" and (b) "what will others think", as well as from

unconcern about the learning process and its results, basically, low learning motivation. These issues can be decreased with the Colour code method since it requires very little effort to change colours and inform teacher, and it is done in a very discrete manner without driving big attention from others. When time resource is limited, and in the vocational and non-formal education it is especially true, teacher doesn't have possibilities to resolve learners' emotional and personal problems (if only it is the goal of the event), and need to concentrate on the deliverables. And teaching in the most convenient and comfortable way for the students lowers negative stress levels, which hinder the knowledge building and sharing.

It can be concluded with certainty that system works and the next step can be taken to test the method in adult educations and computer based learning environments complementing learning with differently shaped and coloured process evaluation buttons - codes.

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