IT IS A MATTER OF BLUENESS OR REDNESS: ADULTS' MATHEMATICS CONTAINING COMPETENCES IN WORK

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In this paper, a social and critical perspective on mathematics education is operationalized through the concepts of habitus, field, and foreground. As part of an on-going project, we have made a tentative analysis of how reliance on colours in the field of workplaces can be seen as signs of mathematical aspects of a person's workplace competence. The analysis of this initial qualitative case study, suggests that making this kind of hidden mathematics explicit, contributes to an understanding of what mathematics may "become" in work. Our assumption is that this point of departure, in the long run, can contribute to a deeper understanding of mathematics' function in workplaces, in society, and in school.

Keywords: habitus, field, foreground, workplace, mathematics containing competence

INTRODUCTION

Adults' mathematics containing competences are in focus in a new project led by professor Tine Wedege, Malmö University. The purpose of the project is to describe, analyse and understand these competences – including social, ethnic and gender related aspects – in relation to demands made on students' qualifications in formal vocational education. One underlying aim for the project is to reverse the often assumed direction of knowledge distribution to be mainly from school *to* work to also include the process of school learning *from* work. Consequently, the name of the project is "Adults' Mathematics: In Work and for School." Taking part in one of the project's qualitative studies, we have conducted two out of twelve observations in workplaces within the sectors of nursing/caring and vehicles/transport. The observations will be followed by life history interviews, later in the project.

WORKPLACES AND MATHMATICS

The fact that mathematics at work appears to be different from what is taught in schools is well described in the literature (e.g. FitzSimons 2012; Hoyles, Noss, Kent & Bakker, 2010; Wedege, 2000, 2004). In work, mathematics is often hidden in machines, technology, routines and competences (Wedege, 2004). Often adults show resistance towards mathematics. One example is given in Wedege (2000), who interviewed and observed people who referred to mathematics as something they didn't know or didn't use. This was in contrast to the fact that they told stories of, or participated in, activities where it was obvious that mathematics was involved. In contemporary workplaces, constantly evolving technical development and division of labour are changing the

conditions of work. This could be seen as a widening gap between conception and execution of mathematics containing work tasks (Jablonka, 2003). The objective of this paper is to explore the concepts of habitus, field, and foreground as tools for investigating mathematics containing situations in work and how they are connected to the fields of workplace mathematics and school mathematics. The term mathematics containing competences is used by Wedege (2000), and relates to the relation between everyday knowledge and school knowledge. In this paper the term is used as a broad interpretation of mathematics in order to understand differences between work and school. What is considered as mathematics in one field may not be viewed similarly in the other. Furthermore, we want to discuss the relation between the individual and the social and how different practices can be understood where mathematics is concerned. As Valero and Zevenbergen (2004) describe it:

> ... practice is social because it is historically constituted in complex systems of action and meaning in the intermesh of multiple contexts such as the classroom, school, the community, the nation and even the globalized world. (p. 2)

ANALYTICAL TOOLS: HABITUS, FIELD AND FOREGROUND

Our understanding of the concepts of habitus, field and foreground includes how they are related to each other and to mathematics in work and at school.

Habitus

When connecting individual experiences to structural and social factors a theory that takes both levels into account is required. One account of this view is presented in Salling Olesen (2008). He writes about how individual workers "carry their specific social history with them into the workplace, and they embody the experiences learned in the workplace in their subjectivity" (p. 123). In this paper we adopt Bourdieu's (1991) concept of *habitus* to approach the dialectics between the individual and the social structure. This dialectics is built into the concept of habitus. It is conceptualised as a system of dispositions grounded in biographical experience, which is by its nature purely individual. Members of a certain class or group can, however, share ideas and habitus in the form of a class habitus but the essence of habitus is something unique for each individual (Bourdieu, 1991). In other words, habitus can carry both conscious and unconscious dispositions to act in the social world. Habitus is a complex system consisting of preferences and motives for individuals to act in the social world. An explanation of habitus, given by Bourdieu, is that of having a sense of how a given situation should be tackled. Then the individual has a "feel for the game" (Bourdieu, 1995).

Habitus and field

The above mentioned structures are described by Bourdieu (1991) as social fields and he argues that the socialized body with its habitus generally carries the same history as the social field where it is acting in establishing an infra-conscious corporal awareness. In a certain field people are willing to play the game with the rules set by the field. A field has its tensions due to the battle between the newcomers trying to find a position in the field and the established actors who dominate the field (Bourdieu, 1991). Bourdieu (1989c, quoted in Grenfell & James, 1998) states:

> the relation between habitus and field operates in two ways. On the one side, it is a relation of conditioning: the field structures the habitus, which is the product of the embodiment of immanent necessity of a field (or of a hierarchically intersecting sets of fields). On the other side, it is a relation of knowledge or cognitive construction: habitus contributes to constituting the field as a meaningful world, a world endowed with sense and with value, in which it is worth investing one's practice (p.16).

Two fields: school mathematics and workplace mathematics

Wedege's (2000) examples of how one person can argue that s/he does not know mathematics, while simultaneously actively applying mathematics in work illuminates workplaces and schools as two different fields. In the preface to the Swedish translation of the book "Les règles de l'art: Genèse et structure du champ littéraire", Broady (cited in Bourdieu, 2000) explains how the concept of field can be understood, which is that social fields have similarities with physical force fields. However he warns that one should be careful when using the concept of field. A school, for example, can be seen as a field for teachers and staff members while it is not a field in the same sense for students who are passing by this field. We will return to this below, in the discussion. The following statements can be construed as differences in the rules of the game of mathematics, as a part of other rules set by the field. Wedege (2000, p. 197) lists several differences between the fields of "task-driven" school mathematics and workplace mathematics. Table 1 highlights two of them. (See also FitzSimons, 2012.)

Work	**School**
There are often different solutions to a task. Accuracy is defined by the situation and the veracity can be negotiated.	There is only one correct solution, the accuracy is defined by the teacher and the veracity it not something that can be discussed.
Reality is the reason for using mathematical ideas and techniques. Solving tasks has practical implications	The task operates as a pretext for using mathematical ideas and techniques. Solving tasks has no practical consequences.

Table 1: Differences between the fields of school mathematics and workplace mathematics

Habitus and foreground

Skovsmose (2012) describes how the notion of foreground was first developed by in 1994, and he elaborates on his earlier explanations. Drawing on Skovsmose, we understand students' foregrounds as the opportunities society makes visible and possible for individuals. Skovsmose (2005) suggests that it is important not only to focus on students' backgrounds but also their foregrounds. "Foregrounds are not panoramic and coherent pictures of possibilities" (Skovsmose 2012, p. 2). Nevertheless, foregrounds have "objective" elements such as social, economic, political and cultural parameters. Still, foregrounds should not be understood as an objective affair. Instead foreground is formed by the person's interpretations of the possibilities the circumstances provide. "In this sense the foreground becomes a complex mixture of subjective and external factors"(Skovsmose, 2012, p. 2). Foregrounds are dynamic rather than stable. Construing foregrounds should be seen as an on-going process and Skovsmose (2012) suggests that it is relevant to talk about *foregrounding* (as an action). Wedege (2011) suggests a local integration of Skovsmose's notion of foreground with Bourdieu's theory of habitus. When investigating the theoretical relevance for, and the advantages of, the integration of habitus and foreground, she concludes that they should be complementary because both frameworks are based on the idea of action and dispositions to act, and, furthermore, both are rooted in a critical perspective. As Alrø, Skovsmose, and Valero (2007) note:

> Learning-as-action can only take place on the grounds of the person's *dispositions*, that is, on the person's readiness to find motives to engage in action. Dispositions can be seen as the constant interplay between a person's *background* and *foreground*. (p. 7, italics in original)

METHODS AND TRANSCRIPTS

The research design of this study is a multiple case study (Bryman, 2008), with comparative elements. In this paper, the comparison is related to previous research and our own experiences from school. Things taken for granted by those in the field can be noticed by an outsider and consequently made the object of attention. In this process an important feature is reflexivity (Hammersly & Atkinson, 2007), and the assumption that researchers affect situations, while at the same time being affected in return. In the research design of the qualitative part of the project, the video-recordings described in this paper, are the first step of data-gathering and analysis. One way of interpreting a setting that is not ours can be to notice what is not the case, or what could have been the case in our own settings. In other words, to be attentive to hypothetical situations without letting go of the actual situation: "Doing critical research also means to explore what is not there and what is not actual. To research also what is not there and not actual means to investigate what could be" (Skovsmose & Borba, 2004, p. 210).

Earlier studies show that mathematical elements in workplace settings are subsumed into routines and are highly context-dependent. Moreover, the present mathematics is constituted through a variety of semiotic resources (e.g. written texts, symbols, speech) including artefacts (e.g. tools). Here we draw on multimodal social semiotics (Van Leeuwen, 2005; see also Björklund Boistrup & Selander, 2009). This has consequences for our transcripts, which are made multimodally. In Table 2, we identify Time, Body (what people do including resources and artefacts), Speech (what people say and how they say it), and Gaze (where people look). The significance of including resources other than speech in the transcripts also has connections to habitus as an embodiment of the field (Bourdieu, 1995). The films are transcribed in the software Videograph.

A MATTER OF BLUENESS OR REDNESS: EXAMPLES OF ANALYSIS

Here we start by introducing a part of the transcribed observation from the garage.

The garage

The first transcript starts when a mechanic, "Anton", has just finished a check-up of antifreeze/cooler by using a measuring device and comparing the value shown on the device with a value on a certain scale. Without letting his focus go from the work or the car he says: "So washer fluid is the next check-up to be done" (our translation). In the transcript, *A* stands for Anton and *R* for the researcher.

Time	Body	Speech	Gaze
14:19	A: Walking to water tap with bottle in hand	A: It is very concentrated so it has to be mixed with water. R: Okay	A: Looking at researcher
14:31	A: Pouring water into the bottle	R: How should it be mixed? What is the – how much water should there be, so to speak	A: Looking at the bottle
14:33	A: Stops pouring water and walks back to the car	A: I don't know exactly but it R: But how exact is it then, how precise is it? A: Well it is…	A: Looking at R
14:55	A: Pouring the mixed liquid into the tank in the car	A: It is the colour [inaudible] that is how exact it should be But it ought to be quite blue anyway	A: Looking into the tank of washer fluid. Looking at R

Table 2: Transcript from the garage [selection]

The transcript from the garage shows that the mechanics Anton was going to refill the tank with washer fluid. What cannot be seen in the transcript is that the tank in the car contained a little wash fluid already. In order to complete the task, he had to estimate the volume required to fill the tank. He also had to be aware of which concentration the liquid should have, compared to the one in the

tank. He used concentrated washer fluid that was to be diluted with water. For this purpose Anton had to estimate or measure both how much there was already in the tank, how much concentrated washer fluid he needed to add, and how much water to add in order to get the proper concentration when he had filled the tank. He had been told by his boss that the concentration should be 50/50. As observed by Wedege (2000), accuracy in the workplace field is defined by the situation. This could mean that the blueness may need to be changed due to conditions such as outdoor temperature. In some way the blueness functioned as a security for him and he said: "It ought to be quite blue anyway," by which he probably meant that rather a little bluer than running the risk of freezing washer fluid. This also corresponds to Wedege's suggestion of tasks in the work place having practical implications. During another the part of the observation, Anton answered a question about where he had learnt to estimate the volume of another liquid. After a little thinking he responded by talking about his early interest in cars and motor bikes. He didn't learn it from school, however, he said. The competence seemed to be so well integrated into his habitus that he did not even think of himself as having learnt it, but rather as if he were born with it, or at least as being a natural part of his body and mind. In the terms of Bourdieu (1995), his socialized body with its habitus carried the same history as the field where it was embodied. He was actually so confident that he did not follow the advice from the boss to make a concentration of 50/50. Anton relied on his capacity of judging the blueness accurately as he relied on it when measuring the other liquid. Maybe his early interest in cars and motor bikes, and his competence, could be seen as a part of his foreground for choosing this kind of work.

The hospital

At another workplace, a semi-emergency unit at a hospital, we were invited to follow a nursing aide, Anita, in her work. During our observation she made a check-up on her patients. When the round was completed Anita went to a computer to put the values into the digital hospital record. While doing this she took a chart with colours from her pocket (Figure 1).

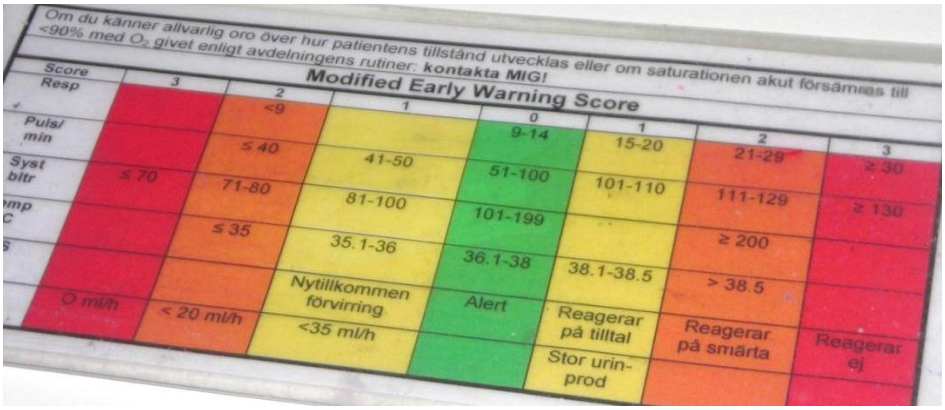

Figure 1. Chart with colours

The chart (Figure 1) was coloured outwards, from green in the middle (0), then yellow (1), orange (2), and, finally, red (3) at either end. In the green, middle column, the ranges of values were considered normal. Each column was given a score, and a certain total score needed immediate attention from a doctor. The check-ups were done every fourth hour and included examinations like blood pressure, pulse/heart rate, temperature, volume of urine, and oxygen saturation. All the time, she had to change her priorities due to other more tasks that had to be taken care of. Therefore she kept the values from the patients in mind. When there was time she wrote them down on a piece of paper.

During our observation one patient needed a further check-up of the oxygen saturation. When the blood sample was taken by a doctor, Anita had to interrupt her work and go to a digital laboratory to get an analysis of the blood sample. After the sample was put into a measuring machine, she did not wait for the result, which would automatically be filled out in the patients' hospital record. She explained: "This will take one minute, but one minute is a long time so I will not wait for it." During the observation Anita was handling multiple tasks simultaneously. She also continuously compared the values given by the patients' supervising monitors and with questions to the patients or with taking the pulse manually. Although she was gathering numeric values they were surprisingly absent in her documentation. The values seemed to be a part bodily consciousness of the field and nothing worth mentioning. The expression "to have a feel for the game" (Bourdieu, 1995) could be said to be a relevant description of Anita's work. The nursing aides even had their own expression for this. They called it "the third eye", which meant just knowing what to do. Only once did she use values/figures explicitly; to encourage a patient whose values were much better than previously. For nursing aides like Anita, the critical feature was that the values should not enter the red sections of the chart.

Similarities and differences with regards to mathematics containing competences and the context

The observations were made in two very different settings. The second observation was in a clean, hygienic area, with a majority of women, mostly clad in white, taking care of humans. The first observation was in a more dirty area, with a majority of men, clad in blue, taking care of cars. The situations observed could be viewed as being very dissimilar, taking place within such different settings. Nevertheless, they have a commonality in that they rely on devices and colors, even using the colors as a security system. The mechanic relies on the blueness of his solution to determine the concentration of the washer fluid, and the nurse concentrates on her patients' values not getting into the red zones of the chart. One difference in the reliance on colours is that the mechanic's use of the degrees of blueness may not be easily communicated to others. Each mechanic has to make their own judgment of the blueness. In the case of the nursing aide, the well-defined colour system was presumably

implemented to facilitate communication within different levels of organization, and thereby increase the security for patients. Workers in both case studies used measurement in potentially critical situations, but there was an absence of explicit numbers which, it seemed, was replaced by a focus on colour.

DISCUSSION

We have made a tentative analysis of how reliance on colours could be seen as signs of mathematical aspects of a person's workplace competence. As analytical tools we have chosen the concepts of habitus and field from Bourdieu's theoretical framework combined with Skovsmose's notion of foreground. When the observed workers, in the next step, contribute their mathematical life histories, a more profound construal of habitus will be added to the analysis. We think that our chosen tools will then have greater application. We suggest that the tools can make visible individuals as agents construing their foregrounds and directing them towards certain fields. This may not be a straightforward affair. However, the individual's habitus and foreground, as analytical tools, can also shed light on the possibilities for him/her to affect the rules of the field.

As a possible consequence of what we have observed so far, vocational education needs to be careful when contextualising tasks. It should consider that the rules of our school field are embodied in our habitus and can easily be taken for granted. At the same time, school can be seen as an arena where students try to work towards their intended foregrounds. Some may already have experience from the field of work. A task like the washer fluid concentration could not be solved at all with school mathematics. The volume in the tank is unknown as well as the concentration. Therefore, the volume and the concentration to be added are also unknown. The only parameters known are that the final result is to be a full tank with a concentration of 50/50. The context that we as mathematics and/or vocational teachers may produce to inspire and help the students could instead make it more difficult. Normally, students need to decontextualize the task to compare it with the real world they know or in order to find mathematics hidden in the context. There may also be a gap between conception and execution in both fields, although noticing the colours in the workplace could be seen as a way of securing the execution. In a mathematics classroom there will most probably be no colours to rely on. From our experience it is not unusual that the mathematics, instead of being highlighted, is embedded in a language or a kind of mathematical 'conjuring' that is not familiar to all. For students with experience from the field of work, their understanding may be linked to the mathematical rules of that field, with its practical applications. Sometimes there may even be no practical implications in the workplace. The washer fluid could, for example, have been diluted in advance using more mathematical measurements. Yet, the social rules, formed by the structure of the field, and the agents in the field may be equally strong as

the mathematics rules. As noted above, in school there is often only one correct solution and its veracity is not open for discussion. However, in the case of the hospital observed, the accuracy could not be negotiated either. Yet, in a mathematics classroom, construing and constructing charts would most probably not be done under time pressure, while simultaneously handling other tasks. In a modern society, fields may to some extent be floating when new professions grow and individuals are mobile, and these may contribute to the changing conditions and rules in the fields of work. In this we see a challenge for schools to investigate the rules of their own field, and to understand the rules of workplace fields in order to make mathematical tasks accessible to different students. Our aim with the forthcoming research is to contribute to this understanding. Habitus and field, connected to foreground, could be useful as analytical tools for this purpose.

ACKNOWLEDGEMENTS

This paper is written as a part of to the research project "Adults' mathematics: From work to school", which is supported by the Swedish Research Council in 2011-2014. We thank Gail FitzSimons and Tine Wedege for constructive comments to an earlier version of the paper.

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