Transforming Constructivist Learning into Action: Design Thinking in education

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In an ever changing society of the 21st century, there is a demand to equip students with meta competences going beyond cognitive knowledge. Education, therefore, needs a transition from transferring knowledge to developing individual potentials with the help of constructivist learning. Advantages of constructivist learning, and criteria for its realisation have been well-determined through theoretical findings in pedagogy (Reich 2008, de Corte, OECD 2010). However, the practical implementation leaves a lot to be desired (Gardner 2010, Wagner 2011). Knowledge acquisition is still fragmented into isolated subjects. Lesson layouts are not efficiently designed to help teachers execute a holistic and interdisciplinary learning. As is shown in this paper, teachers are having negative classroom experience with project work or interdisciplinary teaching, due to a constant feeling of uncertainty and chaos, as well as lack of a process to follow. We therefore conclude: there is a missing link between theoretical findings and demands by pedagogy science and its practical implementation. We claim that, Design Thinking as a team-based learning process offers teachers support towards practice-oriented and holistic modes of constructivist learning in projects. Our case study confirms an improvement of classroom experience for teacher and student alike when using Design Thinking. This leads to a positive attitude towards constructivist learning and an increase of its implementation in education. The ultimate goal of this paper is to prove that Design Thinking gets teachers empowered to facilitate constructivist learning in order to foster 21st century skills.

Key words
Design Thinking; education; learning process; Constructivism, 21st century skills

Introduction

The mandate of schools is to unfold the personality of every student and to build a strong character with a sense of responsibility for democracy and community. This implies developing skills of reflection, interpretation of different information and other complex meta-competences. Science, business and social organisations alike describe a strong need for a set of skills and competences, often referred to as 21st century skills (e.g. Pink 2006, Wagner 2010, Gardner 2007) or key competences (OECD). These include communicative, social and creative meta-competences in addition to cognitive skills (Carroll et al. 2010). Schools are the only compulsory place for most young people to develop abilities and qualifications. Therefore, educational systems are getting more and more demanded to facilitate the development of such competences and skills. With the complexity of everyday life increasing, globalisation, fast-changing technological advances, product cycles getting shorter and economic competition tightening, innovative capacities comprised in the 21st century skills have become crucial for individuals to survive in an ever changing society (Dikmans 2011). Most of them are related to knowledge management, which include processes concerning information selection, acquisition, integration, analysis and sharing of knowledge in socially networked environments (de Corte 2010). It is important to equip not only academics with those skills at university, but to already start with each students in the schools. Content learning is important, but in order to effectively internalise knowledge, metacognitive competences, attitudes, values and action skills are crucially necessary (Weinert 2003). Teaching such metacognitive competences needs to go beyond isolated information acquisition in certain subjects, towards a holistic learning through experience and reflection in projects. So-called CSSC learning, which enables learning processes that are constructed, self-regulated, situated in real-life context and collaborative (de Corte 2010) is recommended by educational experts. The question intrudes: how does a format look like that successfully implements CSSC learning in the school context? How to make phenomena understandable as a whole, going beyond their fragmentation into mono-disciplinary subjects? How to account for complexity rather than focussing on isolated parts of knowledge? We believe, the crucial point is to get teachers motivated and enabled to effectively implement CSSC learning, acknowledging side effects of projects like chaos and crisis as learning opportunities. It is necessary to equip them tools and methods, which create a positive classroom experience while exercising project work. We furthermore claim that Design Thinking can serve as such a format. Design Thinking, here defined as a team-based

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learning method, helps to deal with complex problems by sustaining in-depth learning processes on problem perception and diverse solution paths (Kröper 2010).

Objectives of this paper are to synthesise research on issues related to constructivist learning theory and teaching design, to identify problems of realising CSSC learning in the school context, and to offer a solution to meet those difficulties with the use of Design Thinking in order to facilitate and foster constructivist teaching and learning in the school context (e.g. high school). Research Questions are: Can the facilitation of CSSC learning be advanced through the use of Design Thinking? What is the classroom experience like, when using Design Thinking? Is the use of Design Thinking valuable for the teacher?

The claim on education: Developing 21st century skills through a constructivist learning design

From educational researchers to business men and politicians, society is calling for so-called key competences in order to be able to deal with any sort of complex problems that dominate all facets of our society and business world (Pink 2010, Gardner 2010).

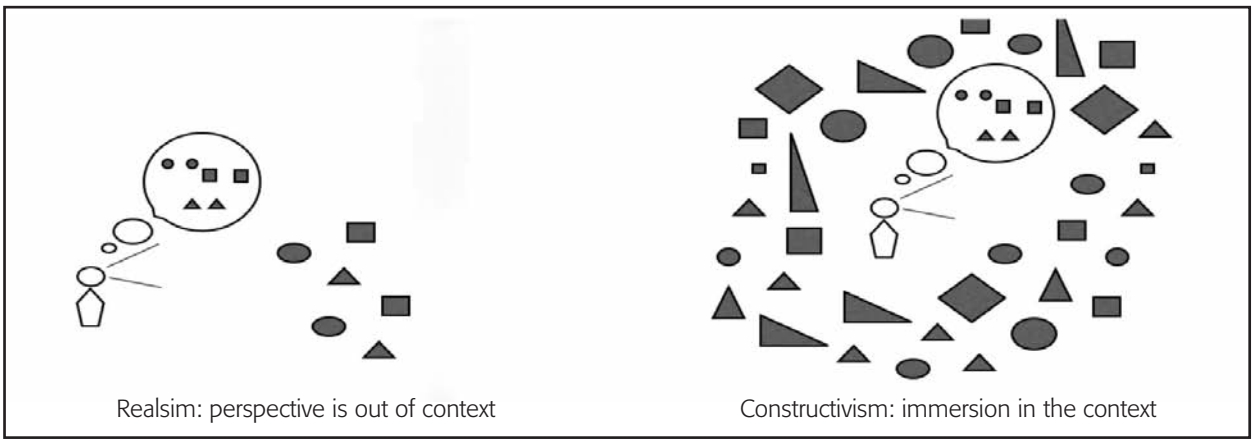
Those key competences involve knowledge, skills, attitudes and values (Weinert 2003). Harvard professor Tony Wagner calls them the "seven survival skills for careers, college, and citizenship" (Wagner 2011):

- critical thinking and problem solving;
- collaboration across networks and leading by influence;
- agility and adaptability;
- initiative and entrepreneurialism;
- effective oral and written communication;
- accessing and analysing information;
- curiosity and imagination.

Pedagogy science states that such accounts can be met especially well through a holistic constructivist approach (Weinert 2003, Knoll 1993, Reich 2008). One method of which is learning in interdisciplinary projects (Dewey 1913). In constructivism, learning is a process of individually self-organising knowledge. The process of learning is unpredictable, and knowledge constantly altered through new insights, which are gained through individual experiences (Reich 2008, Kolb 1984). As opposed to realism, in which the learner is regarded as an independent observer of objects. In contrast, constructivism integrates the learner within his own observations in a cycle of creation and observation. An interactive relation between the observer and the observed arises (for an easier understanding see figure 1). The educationalist and philosopher John Dewey regarded the interaction between the subject and the world with all its complexity as essential for gaining knowledge. Dewey's understanding identified learning as a multi-facetted process of structured interaction of humans with their natural and social environment. These interactions produce experiences which modify further interaction.

"There is no me without us" (Dewey 1931:91). Perception and knowledge is only developed in relation to and through interaction with the object and its context. Therefore, learning in the constructivist perspective is a process of constantly adapting to situations, which consist of ever-changing relations between subject, object and context. However, constructivism is neither a method nor a universal model, and it does not provide concrete didactic indications for the teacher to implement.

In contrast to constructivist beliefs, education today is centered around specific disciplines and isolated subjects, which is the result of breaking down a complex real-life phenomena into little parts. Small information parts are thought to be easier to absorb for the student. Concentrating on one aspect of phenomena and distributing knowledge rather isolated from its complexity



Realsim: perspective is out of context

Constructivism: immersion in the context

Figure 1. The learner and his environment, Andrea Scheer 2011

might be better manageable for the teacher. However, this disregards that *the whole is different from the sum of its parts*. In addition, splitting up a complex phenomena into subjects and only examining isolated facts makes it hard for the student to recognise links between facts and phenomena. A connection to the real-life context is missing. However, theoretical findings about the advantages of constructivist learning (the holistic approach, real-world challenges, motivation i.e.) and criteria for its realisation are distinct (Reich 2008, Dewey 1916). The practical implementation itself does not yet take place effectively (Gardner 2010, Wagner 2011). We believe that teachers are demotivated and helpless in making use of constructivist learning theory and realising holistic project work in the classroom, due to negative classroom experiences with project methods. This is partly because of difficulties in assessing performance in project work. It will always be easier to let students do a test, asking for logical and analytical thinking only (computer-like). These tests are linear, sequential and time restricted. It's still difficult to measure more complex and social oriented 21st century skills. But still the old saying is true: What you test is what you get. Ministries of educations therefore take this issue seriously right now. Over the last years, there has been a big effort, in many western countries to integrate 21st century skill assessment into major, mostly centralised tests, as the A-level, or German *Mittelstufenabschluss*. This is still a struggle but has already proven to open the education systems to a new group of students, focussing on those with actual potential, regardless of their educational background.

Another reason might be missing recommendations of designing constructivist learning and project-work. The latter shall be in the focus of this paper. There is a missing link of transferring theoretical findings of pedagogy science into practical implementation, which leads the teacher to focus on approved and easily conductible content learning methods, denying constructivist learning projects. Wagner is referring to it as the "Global Achievement Gap", the gap between "what even the best schools are teaching and testing versus the skills all students will need for careers, college, and citizenship in the 21st century" (Wagner 2011). We want to fill that gap by proposing Design Thinking as a meta-disciplinary methodology which offers teachers the needed support through a formalised process. Teachers, as facilitators of learning need to be equipped with up-to-date skills and tools to actually practice on the needed key competence learning. Otherwise, there is a risk that such competences will even more decline. There are high stakes in teacher education.

Criteria for a constructivist learning and teaching design

Learning is a process of understanding, which leads to modifications in the behaviour of the learner (Hasselhorn and Gold 2006). According to constructivist theory, this is achieved through experience. The teacher as a facilitator of learning should consequently be able to design learning experiences. So, what is needed for constructivist learning design? In his concept of CSSC learning, Erik de Corte points out four main criteria for competence oriented learning: to be constructed, situated in context, self-regulated by the learner and collaborative (de Corte 2010). As participation and engagement of the student is a crucial characteristic of constructivist learning (Reich 2008), the teacher needs to involve the student in the learning design, e.g. to look at the students interests in order to propose a problem statement or project challenge. Even more so, they need space to try out different mental models and methods to connect abstract knowledge with concrete applications and thereby, being able to convert and apply abstract and general principles (acquired through instruction) in meaningful and responsible acting in life (acquired through construction).

The following three aspects are essential for a convenient constructive learning design:
- involvement of students;
- experience space;
- balance of instruction and construction.

In sum, a good lesson design needs to be a balanced composition of instruction and construction, or as Dewey would say "construction through instruction" (Dewey 1913, Knoll 1993). A lesson design should answer, *How* students can experience certain situations, and how teacher can enable this experience. A good learning design is in what schools mostly fail until today. The *How*, e.g. the instruction to execute constructivist learning is either too open (free construction only) or too detailed (instruction only).

Teaching complex phenomena – approaches for implementation

Abstract approach: Dewey's Problem-Solving method

Dewey's understanding of learning was a direct process of a structured interaction of humans and their natural and social environment. These interactions produce experiences which modify further interaction (Dewey 1913) – learning took place (see definition of learning above, Hasselhorn and Gold 2006).

Thinking and doing are very much intertwined as the one defines the other and vice versa. This reflects a holistic

process of thinking and doing as education. Dewey suggested a method of constructive problem-solving. Dewey's method is centered around an inquiry in context unfolding a problem or difficulty, which then motivates for further analyses and exploration. New insights are the foundation for an explanation of that inquiry, and are followed by a plan of action to solve the problem according to the explanation.

The following criteria are needed to realise this method:
- challenges situated in real-life environment of the learner;
- action – interaction of thinking and action plus interaction and sharing of knowledge between learner and teacher;
- application – solving the problem and applying the insights, reflecting and understanding through applying ideas.

In conclusion, Dewey's perspective on learning and education is centered around a real-life inquiry, which has to be analysed in its complexity. The inquiry acts like "a magnet for content", it motivates further analysis of content and input of several disciplines in order to explain and solve that complex inquiry as a whole" (Dewey 1931). In that, the Dewey approach meets the main aspects of constructivist learning. It involves the student throughout the learning process, suggests to balance instruction and construction, and more or less allows experience in real-life situations. Although Dewey described his method theoretically, the complexity and abstractness of these recommendations is the crux of the matter for teachers to actually implement them into schools. His recommendations are not enough to get over the difficulties of teaching complex phenomena in a holistic constructivist manner. That might be why education today is still focused on breaking down complex phenomena into smaller, isolated subjects. This is because they are easier to implement and distribute to students in the first place. This is why we compared Dewey's method to Design Thinking, as we believe that Design Thinking can give concrete recommendations for distributing a complex phenomena without abstracting too much, but still being digestible for the student and implementable for the teacher.

Concrete approach: Design Thinking in education

> Design thinking understood as a meta-disciplinary methodology loosens the link to design as a profession. Even though Design Thinking was explored and developed in connection with professional designers at first, strategies have been identified that are relevant to all disciplines and professions (Lindberg et al., 2009:4, emphasis as per original).

Thinking like a designer involves different kinds of abilities and competences in different fields of knowledge: conceiving, planning and making products (Buchanan 1999). Those are cognitive processes manifested in design action. Designers are used to deal with complex problems, and by generating diverse high-scoring solutions, analysing and evaluating them in order to gradually improve them (Dorst 2006). This is what students should be enabled for and what the so-called key competences are all about: dealing with complex real-life problems by analysing and evaluating them in order to act solution-oriented and responsible. Design Thinking realises what is recommended theoretically in constructivist theory. Especially learning through experience and complex problem solving among other aspects are met in Design Thinking and can be employed at all age groups, e.g. extensive experiences at the K12 program at the d.school in Stanford, USA. Design Thinking is a constructivist learning design, because of its qualities in training certain skills, which are predispositions for a constructive way of learning: motivation for exploration, openness for new ideas, creative thinking and other metacognitive competences (Noweski 2012). In a Design Thinking context as described in the phases below, such predispositions are met to ensure 21st century skills development. Students are motivated for exploration, trust is build up between student and teacher to give confidence for self-exploration, and team competences are fostered to express ones opinion and share knowledge. A formalised process guides the teacher towards constructivist learning. Design Thinking can be realised in short sessions integrated in a highly specialised A Level biology class, as in interdisciplinary full project weeks.

Pioneering this approach, the Nueva School in California states that Design Thinking is taught, applied, and explored in three strands:

> "Some projects aim to take students through the entire design-thinking process. These experiences include a 'Secret Service project', (kindergarten), 'Cooperative Games' project (second grade), year-long Design Engineering classes, (grades 4–5), and the 'Solar House Project' (grade 6). Integrated projects require students to use aspects of the design-thinking process as tools to solve real problems presented in homeroom or subject classes. These include STEM projects like 'Electrical Switches' (second grade), 'Catapults' (fifth grade), 'Roller Coaster' (sixth grade), and 'Cell Membranes' (eighth grade). They can also include social problem-solving activities like the 'Service Learning Fair' (third grade), and the 'Social Issues Project' (fifth grade), and art projects like the 'Electronic Arts', and 'Digital

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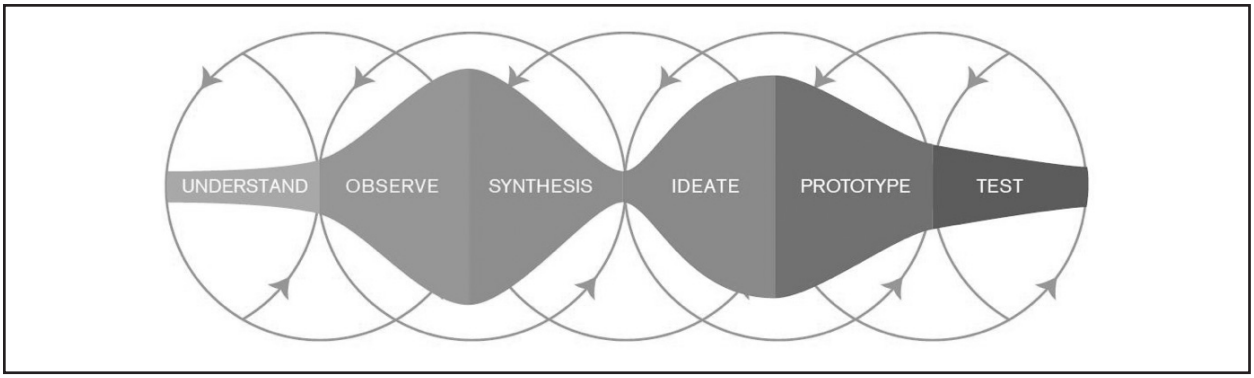

Figure 2. Design Thinking Process, author unknown

> Storytelling' electives. Other pursuits involve independent exploration. Individual students, clubs, and teams use the school's design-thinking and engineering resources to deepen their own skills during recess, electives, and the after-school program. Projects have ranged from designing model houses to robotics competitions." (Nueva School, Design Thinking Overview)

The Design Thinking process fosters several competences in different phases, in which expansion and consolidation take turns. This is the heartbeat of Design Thinking. The phases are as follows:

Understand and Observe (Expanding)
The first step in the design process is to build up empathy and understanding of the people and the situation the problem or challenge is set in. The goal is to get a clue of relations between the problem and its context, and to find out hidden needs. Empathy is the competence of recognising feelings, thoughts, intentions and characteristics of others.

Synthesis (Consolidating)
In order to solve a problem and generate meaningful ideas, one has to define the problem and its context. As seen in the phase of understanding, there are different perspectives on one particular problem and a lot of information is generated to describe the problem. In the synthesis phase, all this information needs to be interpreted and condensed to meaningful insights, in order to be able to generate actionable solutions. It involves critical thinking and interpretation skills to condense a lot of information into a compelling point of view and clear direction for ideation.

Ideate (Expanding)
Ideation means opening up the mind, being imaginative and generating lots of ideas for solving the problem. Brainstorming in the team helps to build on the ideas of others and collaboratively transforming the knowledge about the problem and its origins into actionable problem solving ideas. This is what pedagogy describes as the competence of applying knowledge.

Prototype (Consolidating)
The prototype phase is all about experimentation to bring ideas alive, to make them tangible, actionable, testable. Learning more about the ideas, its possibilities in form and function through building them. The goal of prototyping is to be able to share ideas with others, to specify your abstract imaginations and to get the mental concept of an idea into the physical world.

Test (Expanding)
Testing means bringing the idea, the solution generated through the design process into action in order to get feedback on which to build on. Feedback from other persons, from experts, from novices, from users, everyone involved in the problem context. Through testing a lot of information is gathered, in that it is similar to the observe and understand phase. However, this information is focused on the solution, and shows how well the problem has been understood. It is important to be able to communicate the idea you want to get feedback on, and to capture and interpret that feedback in order to refine your idea.

Iteration
Basically, the process follows these six steps that build on each other while preserving a cyclical and iterative nature. The star's outer lines and imagined arrows illustrate that it is possible and desired to move from one phase to any other at any point of time, as well as to repeat the whole process or certain stages. The testing phase already implies a smooth transition to the observing and understand phase, as the problem context has changed with your idea. Its iterative nature unfolds the whole

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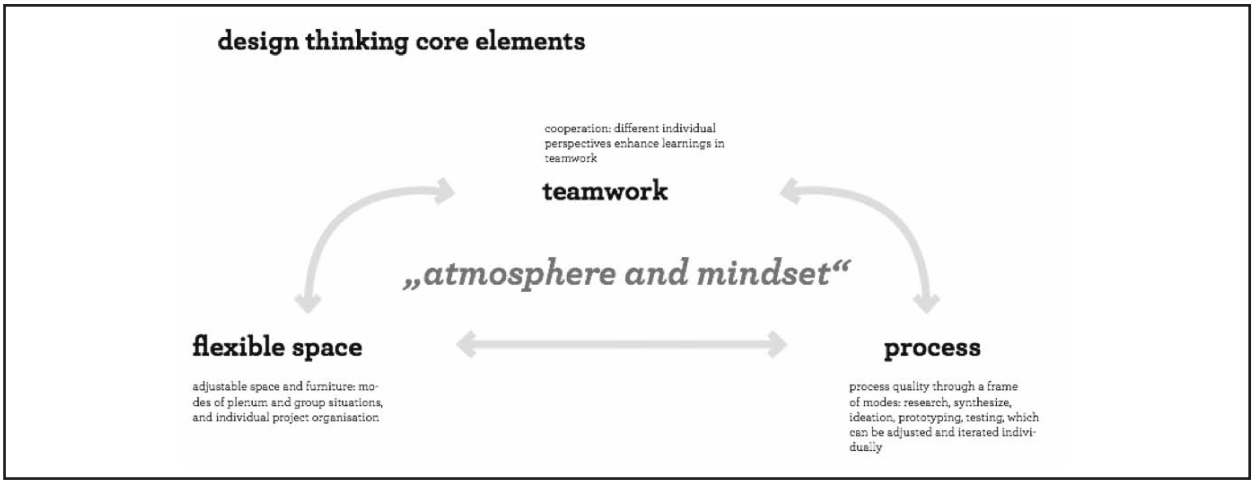

Figure 3. Core elements of Design Thinking, Elias Barrasch 2012

concept of constructivism – there is no such thing as a fixed and one dimensional reality, rather different situations apply different perspectives and new perspectives generate new situations. Knowledge is individually self-organised, and proofed in and adapted to the context.

Design Thinking comprises of three core elements (figure 5), flexible space, team work and the design process into a systemic approach on problem solving. In that, it is not only a process of learning, but a whole mindset and atmosphere.

There is a high degree of student involvement as Design Thinking is constantly giving opportunities for experiencing complex phenomena and reflecting on insights. A balance between instruction and construction is accomplished through the iterative manner of the learning process.

Figure 4. Design Thinking Workspaces in the classroom, Fabian Schülbe 2011

As theoretically described, Design Thinking as a formalisation of constructivist learning fosters the development 21st century skills and is a method for team-based learning in holistic projects. In our case study the success of realisation of Design Thinking in a school context, and its usability for teachers was tested.

- Do students like to work with Design Thinking and do they actively participate?
- Do teacher like working with Design Thinking and are they likely to use this method again?
- Does Design Thinking built up a positive learning atmosphere between teacher and student?

Case study

Design Thinking was tested with 10th grade high school students (aged 15-17: tenth grade is the last general school year before College in Germany) in order to analyse and evaluate Design Thinking as a teaching method in comparison to Dewey's recommendations. The students and teachers motivation, the learning atmosphere and the development of cognitive and social competencies were the main criteria for analysis. An empirical study was set up to prove the above stated hypotheses with the use of quantitative questionnaires and the Inventory of Social Competence – ISK (Kanning 2009). A three-day case study took place in a secondary school in Potsdam, Germany, involving 125 students and a team of twelve teachers and coaches (assigned by coincidence, Dewey groups were school teacher, Design Thinking groups were coached by d.school coaches, all the coaches chosen to be similar characters (end twenties, highly motivated, open for new methodologies and experts in their domains (project teaching with students/Design Thinking coaching), all of them participated in a briefing to

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make sure their knowledge level of the methods would be equal). The students were divided into 22 teams of five to six students each, to face the real-world challenge "New Media in the classroom – How can we help teachers to use new media efficiently in the classroom?" The Design Thinking process, as described above was used by eleven teams. One Design Thinking coach was facilitator for two teams. These eleven Design Thinking teams were compared to eleven teams using the project-based method (Kilpatrick 1918). One teacher was facilitator for two teams in this experimental category. The coaches were prepared in a training session. Here, they got information to intensify their already existing knowledge on their pedagogical approach. When the students arrived in the morning, we told them which teams they had randomly been assigned to, giving attention that gender and classes were as equally dispersed as possible. There was a facilitator for each room (6 teams), supporting the teacher and students with organisational and methodological difficulties, but the main challenge was left to the coaches and students themselves. They knew their challenge, the time frame and the method they ought to use and all of them were told to have as much fun as possible. All teams were set in an ordinary classroom of the high-school (six teams per room) and equipped with whiteboards, bar tables and stools, working-, research- and prototyping material, as well as one laptop and a beamer for presentations.

Everyday, students and teachers had to fill out several questionnaires, but spending no more than 20 minutes altogether per day on it, except for the Inventar Sozialer Kompetenzen – ISK (Kanning 2009, see chapter III How does Design Thinking contribute in developing 21st century skills?), which was filled out by the students in their regular class settings before and after the workshop. To see what impact the workshop had – if any – on the social skills of students, pre-post comparisons (that is: gain-scores) were calculated. In sum, students of the Design Thinking condition profit more than students of the Dewey-condition. Even though not all differences in gain-scores are large enough to reach statistical significance, the picture is pretty consistent: In an eighteen out of 21 scale the gain-scores are more favourable for Design Thinkers. In particular, the gain-scores differ with statistical significance ($p < .05$) on the following scales, favouring Design Thinking: Self-Expression, Direct Self-Attention, Self-Monitoring and Reflexibility. Close to significant ($p < .1$) are differences of gain-scores on the following scales: Assertiveness, Flexibility of Action, Indirect Self Attention and Person Perception.

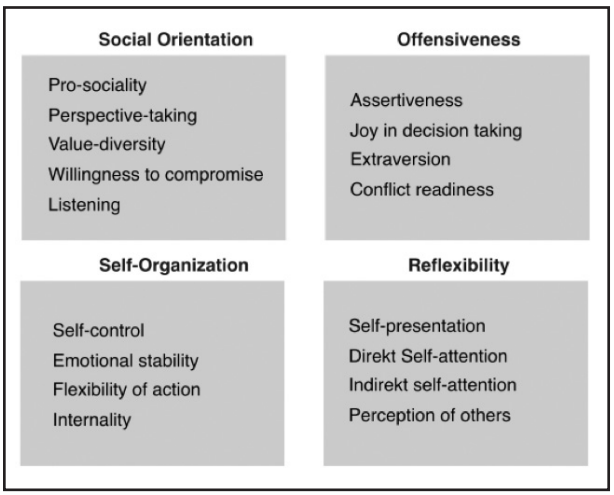

Figure 5. Scales of the Inventar Sozialer Kompetenzen, based on Kanning 2009

Results

Design Thinking fosters metacognitive skills and competences explicitly by using a formalised process. Such a process offers the teacher support in realising constructivist learning and gives recommendations for methods (e.g. method for effective reflection, brainstorming rules). As described in the theoretical part above, Design Thinking projects focus on constructivist learning and integrate content. What is crucial in Design Thinking are the process phases which need to be run through. The teacher can put different emphasis on different phases, according to the learning goal and individual needs. But only the process as a whole, with all its steps sets the frame for constructivist learning. Encountering new content and complex interrelations of information, solving team crisis and getting feedback for intermediate results are difficult aspects of such a project-learning, but also crucial for developing metacognitive competences. This is realised through the Design Thinking process as a whole, or as Dewey would point out the whole act of thinking. With the process on hand, the teacher is prepared for these challenges, being confident in solving them and thus more motivated in using the process and actually realising constructivist learning. In that, Design Thinking serves as a first standard for constructivist teaching regardless of the scope of ambiguity of teacher motivation. Once succeeded in the process (solving of challenge, mastering the process), the teacher gets positive feedback and the development of students social competences can be assessed (Noweski 2012). This success leads to motivation of both students and teacher in realising more constructivist learning.

1.) Teachers describe the students as more participatory than usual at school if a constructivist teaching method is applied.

Question answered by teachers: How did the students come across throughout the workshop?							
	-3	-2	-1	0	1	2	3
	☐	☐	☐	☐	☐	☐	☐
more interested than normally at school							less interested than normally at school
more receptive than normally at school							less receptive than normally at school
less independent than normally at school							more independent than normally at school
more friendly than normally at school							less friendly than normally at school
less engaged than normally at school							more engaged than normally at school
less emotionally involved than normally at school							more emotionally involved than normally at school

Figure 6. Average teacher judgments regarding the question: "How did the students came across throughout the workshop?" rated on a scale ranging from -3 to +3; negative values indicate the left characterisation applies more; positive values indicate the right characterisation is more applicable

2.) Teachers consider Design Thinking a highly valuable teaching method – more valuable than the Dewey approach.

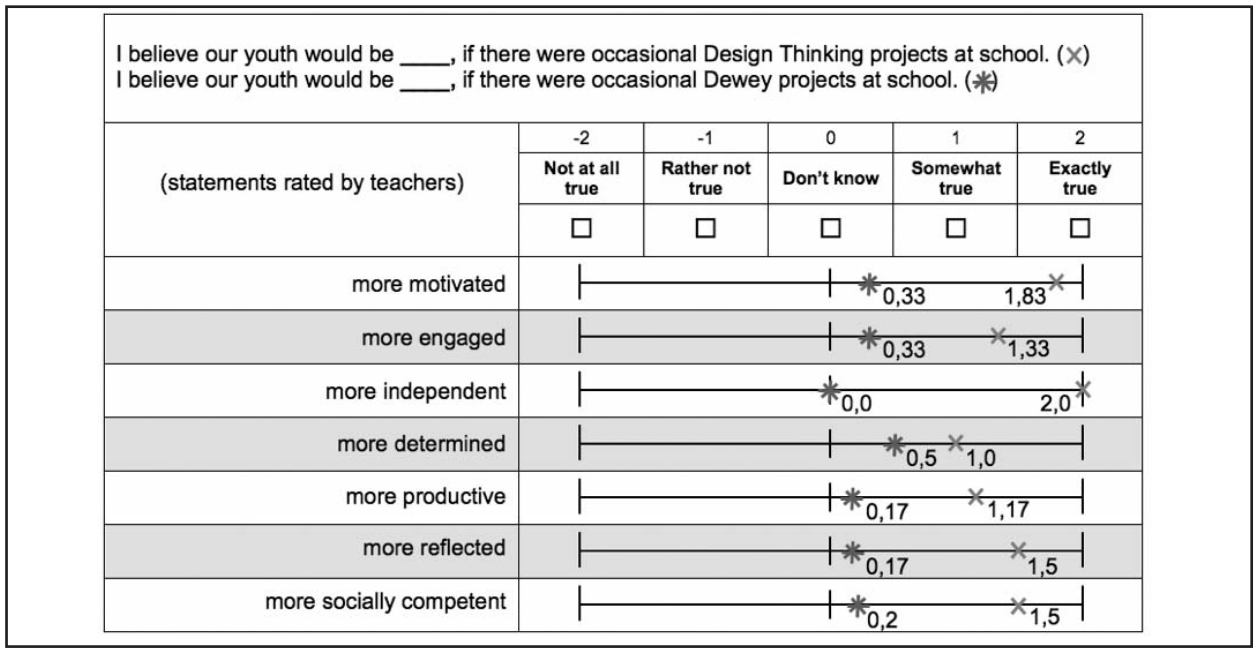

Figure 7. Average teacher judgments regarding the expected impact of Design Thinking or Dewey's project work at school

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3.) Teachers state they are very likely to pursue a Design Thinking project if possible. Whether they would carry out a Dewey project is much less certain.

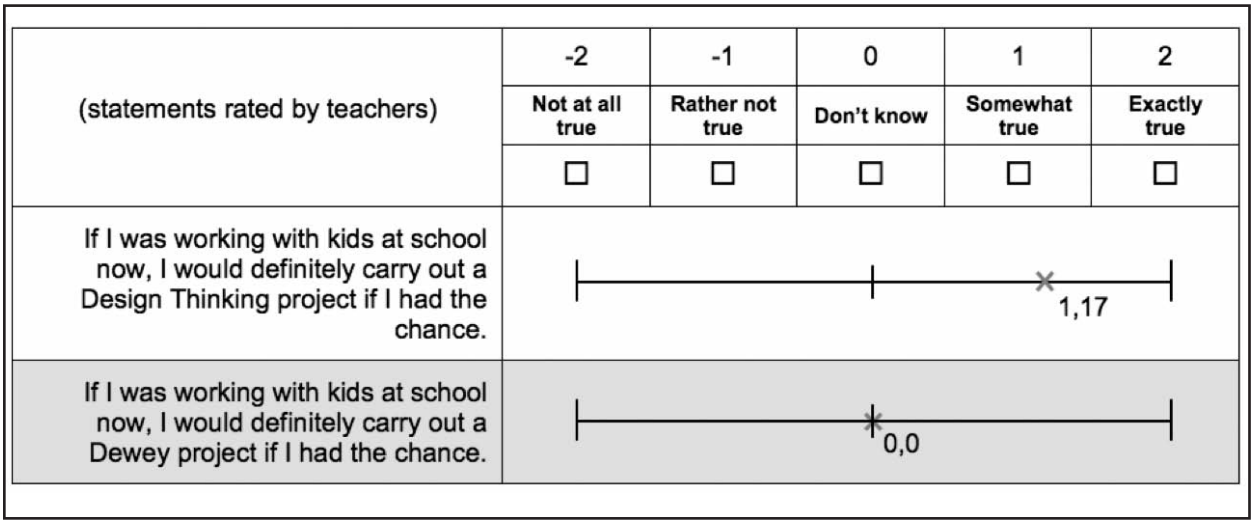

Figure 8. Average teacher statements regarding whether or not they are likely to carry out a Design Thinking or Dewey project at school

4.) The teacher-student relation is positive in Design Thinking and in Dewey projects. In Design Thinking projects it is even more positive than in Dewey projects, and this consistently so.

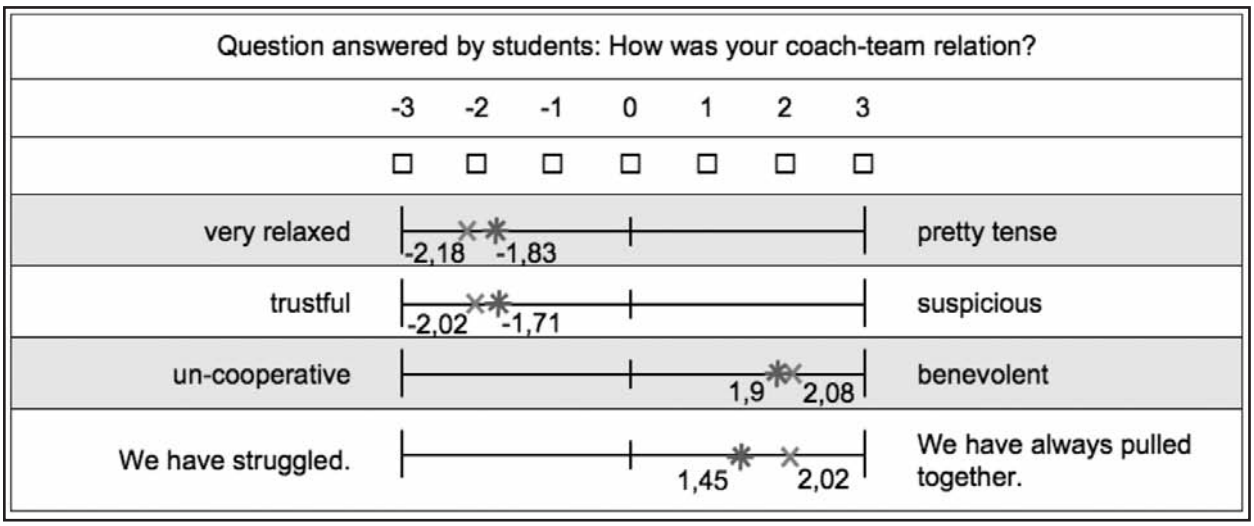

Figure 9. Average student ratings of coach-team relation in Design Thinking (×) versus Dewey (✳) projects

5.) **Students appreciate the Design Thinking and the Dewey method. Consistently, they value the Design Thinking method even more than the Dewey method.**

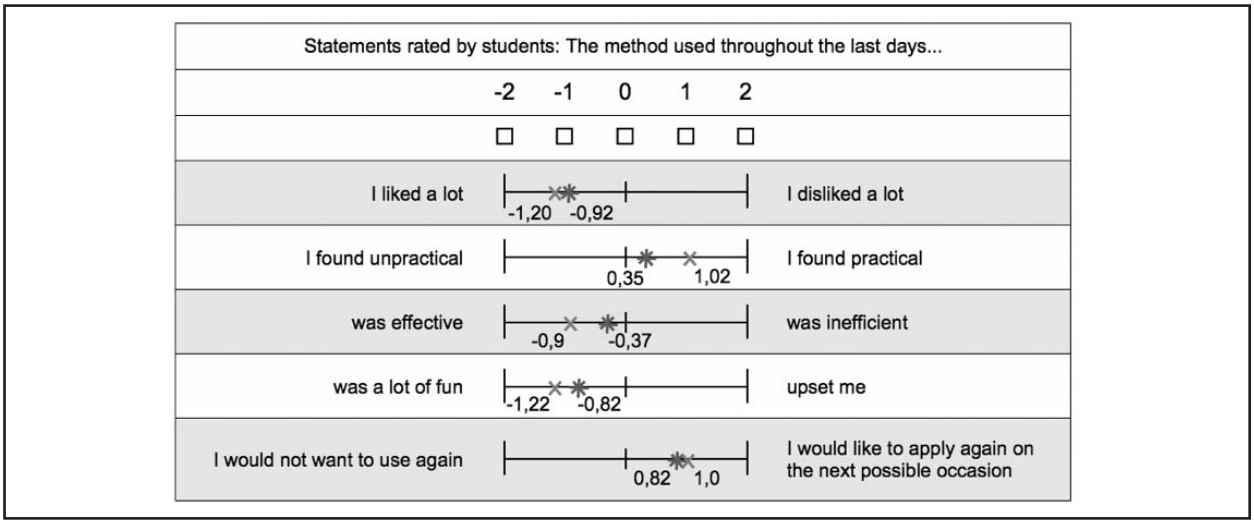

Figure 10: Average student ratings regarding the Design Thinking (×) versus Dewey (✱) method

6.) **Mood assessment** On each workshop day students and coaches specify their mood: in the morning, at midday and in the afternoon. The mood scale ranges from -10 (extremely negative) to +10 (extremely positive). There is one additional point of measurement for coaches due to their day of preparation ahead of the workshop.

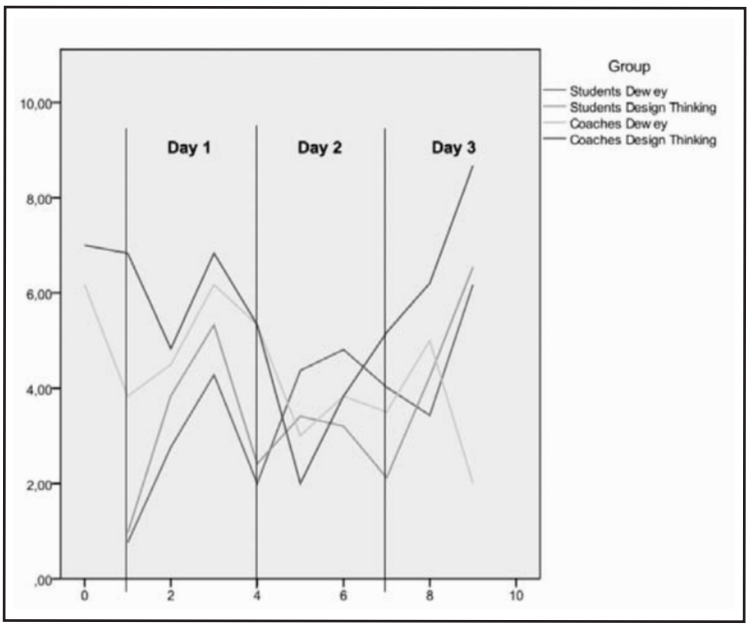

Figure 11. Positive sentiments

Students and coaches report positive sentiments throughout the whole project. Indeed, at each single point of measurement all four groups (students Dewey, students Design Thinking, coaches Dewey, coaches Design Thinking) report an average mood in the positive realm (above zero).

Daily trends. At all three project days there is a trend that the mood improves from morning to afternoon.

Final sentiments. Students leave the workshop with a very good sentiment both in the Dewey and in the Design Thinking condition. For the coaches, an immense difference becomes apparent: The mood of Dewey coaches drops drastically while that of Design Thinking coaches takes off.

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Conclusion

The impact of Design Thinking in teaching and learning at schools is promising. The case study has resulted in a positive experience for the participants. Design Thinking gives teachers faith in their creative abilities through a process to hold on to when facing difficulties during the project. We can conclude our hypothesis confirmed that a teacher would be more likely to repeat constructivist teaching in a real school scenario when applying the Design Thinking process. This was mainly evaluated through measuring the self-perception of teachers (Mood measurement, Questionnaire). In further research external evaluation could be applied to enhance the results. As can be seen in figure 12, the ambiguity of the teachers personality at the beginning of a project still relies on openness (hope) towards constructivist teaching. Nevertheless Design Thinking can give especially critical minded teachers a guiding framework and support, until a dynamic sets up motivating and hopefully leading to confidence.

Design Thinking can serve as the missing link between theoretical findings in pedagogy science and the actual practical realisation in schools. It meets the crucial criteria for effective 21st century learning by facilitating interdisciplinary projects, approaching complex phenomena in a holistic constructivist manner. It thereby leads to a transition from the transfer of knowledge to the development of individual potentials. It enhances the implementation of CSSC learning by giving teachers more confidence in creating and exercising collaborative project work. Furthermore, Design Thinking fosters a positive relationship between teacher and students. In addition, the corresponding paper by Noweski (2012) confirms the fostering of student's social and metacognitive competences through Design Thinking. It became clear that it is a difference to possess the knowledge of project methods and to be able to actually apply them. Teachers do need confidence and the expertise in facilitating constructivist learning. There is a need for Design Thinking in teacher education, which could be analysed in further research.

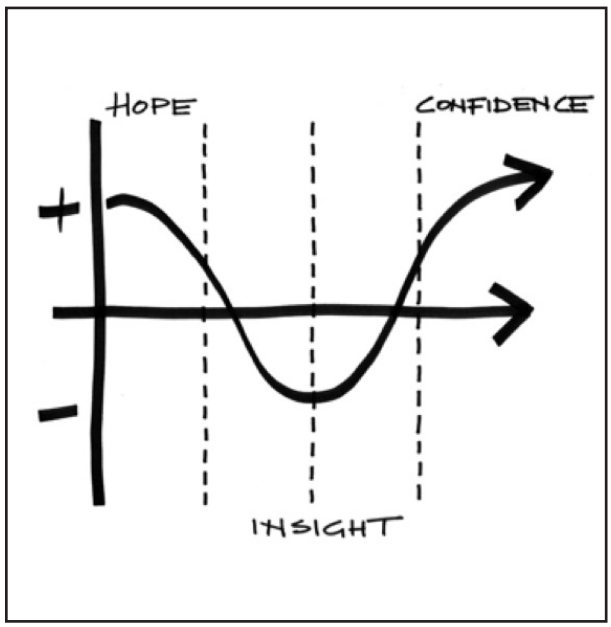

Figure 12. Development of teacher motivation, Mia Konew 2011

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