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How focus creates engagement in Primary Design and Technology Education

The effect of well-defined tasks and joint presentations on a class of 9-12 years old pupils

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Abstract

During a Design and Technology class, engagement is both required to start creative hands-on work and a sign of pupil's creative thinking. To find ways to achieve engagement, we can look to the Montessori tradition. Due to the fact that learning is regarded as feeding insight through experimenting, tasks have to offer pupils the opportunity to gain knowledge about isolated details of the learning situation. This is realised by brief, simple and objective tasks combined with liberty to approach the hands-on work in one's own way. Applied to Design and Technology, we can define brief, simple and objective tasks with a focus on a technique as an isolated detail of the learning situation. Offering liberty during hands-on work enables creative thinking.

The deployment of well-defined tasks with a focus on a technique is possible by dividing a complex assignment into a collection of brief tasks with single problems and working towards single objectives in the topic, making use of a single technique. Such a collection is a format that has the potential to enable ongoing engagement.

This case-study researches the actual effect of a stepwise organised collection of tasks on the design performance of pupils of nine to twelve years old. The results show that the tasks turned out to be useful in initiating engagement. In combination with joint presentations, ongoing engagement was achieved resulting in well-considered designs and products. In addition, dialogue with disengaged pupils delivered solutions towards engagement. As a side-effect of dialogue the teacher-pupil relationships and the pupil-pupil relationships improved.

Keywords

engagement, active Montessori approach, Design and Technology, creative hands-on work, stepwise approach, joint presentations

Figure 1: Exposition of chairs

1. Introduction

Creative hands-on work, creating something with a technique as a means, is an essential element of the Design and Technology class. When pupils in class are disengaged, they not only signal absence

of creative thinking, but they are also unready to instantly start creative hands-on work and they can distract other pupils in class.

An important part of creative hands-on work is discovery towards insight. Discovery only can arise when pupils are experimenting. To allow experimenting, liberty is necessary. Pupils have to be in charge of the determination of the focus of their attention to be enabled to accomplish the spontaneous activity that accompanies experimenting. The hampering of pupil's liberty, by forcing or nudging them to do something in a certain way, blocks the process of discovery. Not only liberty determines pupils' situational autonomy (Candy, 1987), but also the complexity of the learning environment. Overwhelming them stops the process of discovery (Dewey, 1910). Both the learning situation and the demands of the teacher can overwhelm them.

Figure 2. Montessori learning material for learning to sort from large to small, thick to thin, high to low

Montessori views a task as an experiment. In the Montessori tradition it is therefore common practice to apply the principle of liberty and the principle of avoiding overwhelming complexity. According to Montessori, liberty will lead to spontaneous activity. Therefore freedom of procedure during the performance of a task is required. The provocation of unnatural effort hampers liberty and blocks spontaneous activity (Gutek, 2004, p. 124). For the avoiding of overwhelming complexity pupils require brief, simple and objective tasks (Gutek, 2004, p.124). About her method, Montessori writes: "(my) pedagogic experiments are designed to educate the senses" (Fig. 2) "(From earlier research with 'deficients' I know that) the education of the senses is entirely possible." (in Gutek, 2004, p.153). "(With normal children) it (the education of the senses) provokes auto-education" (in Gutek, 2004, p.154). Auto-education is the opposite of training. Auto-education could be defined as self-constructing the own knowledge.

Design is another part of creative hands-on work. Design by its nature is adapting reality. For adapting reality is insight required. Insight can be acquired by experiment. Insight has to be understood as an accurate and deep understanding of reality. Insight can function in unknown situations as an anchor. The deep understanding of a situation can be applied to a comparable situation (Barsalou & Weimer-Hastings, 2005).

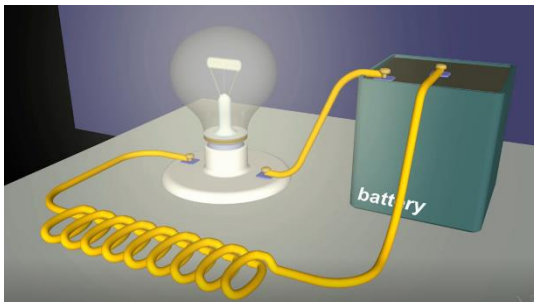

Figure 3. Electrical circuit.
(The Editors of Encyclopaedia Britannica, n.d.)

A simple example of a Design and Technology task that enables both aspects of creative hands-on work is the making of an electrical circuit (Fig. 3). When the pupils have a battery, a light bulb and wires, we can give the pupils the task to make the light go on (brief, simple and objective). The focus is on connecting the light bulb to the battery in a suitable way (technique). Experimenting is desirable. The pupils first have to discover the effect of the battery on the lamp. For that reason they have to design a circuit and try it out. Trial and error, tinkering with the wires, design and failure will lead to the discovery of a stable circuit and to growing insight. Ongoing experimenting will lead to an efficient stable circuit and to accurate and deep understanding of the phenomenon of conductivity of electricity.

Discoveries are required to guide insight. Thus one profit of the practice of creative hands-on work during a Design and Technology class is the generation of insight.

Applying the idea of Montessori that her experiments are designed to educate the senses, for the Design and Technology class we can design experiments that educate the techniques. Thus another profit of the practice of creative hands-on work during a Design and Technology class can be the practice of the tasked technique.

An according to the Montessori approach a well-defined Design and Technology task will be brief, simple, objective and designed to educate one technique. Dividing the mastery process of a complex Design and Technology topic into brief, simple and objective tasks, focusing on one technique, can be a way to achieve creative hands-on work towards mastery. Such a division naturally leads to a collection of tasks (Fig. 4). The tasks can differ from each other by variation in tasked technique, but also by variation in the requirements of an objective associated to the topic. The differentiation of tasked technique can result in a stepwise approach, but also into a collection of tasks around a theme. The differentiation of requirements of the objective will result in iteration of the performance of the task.

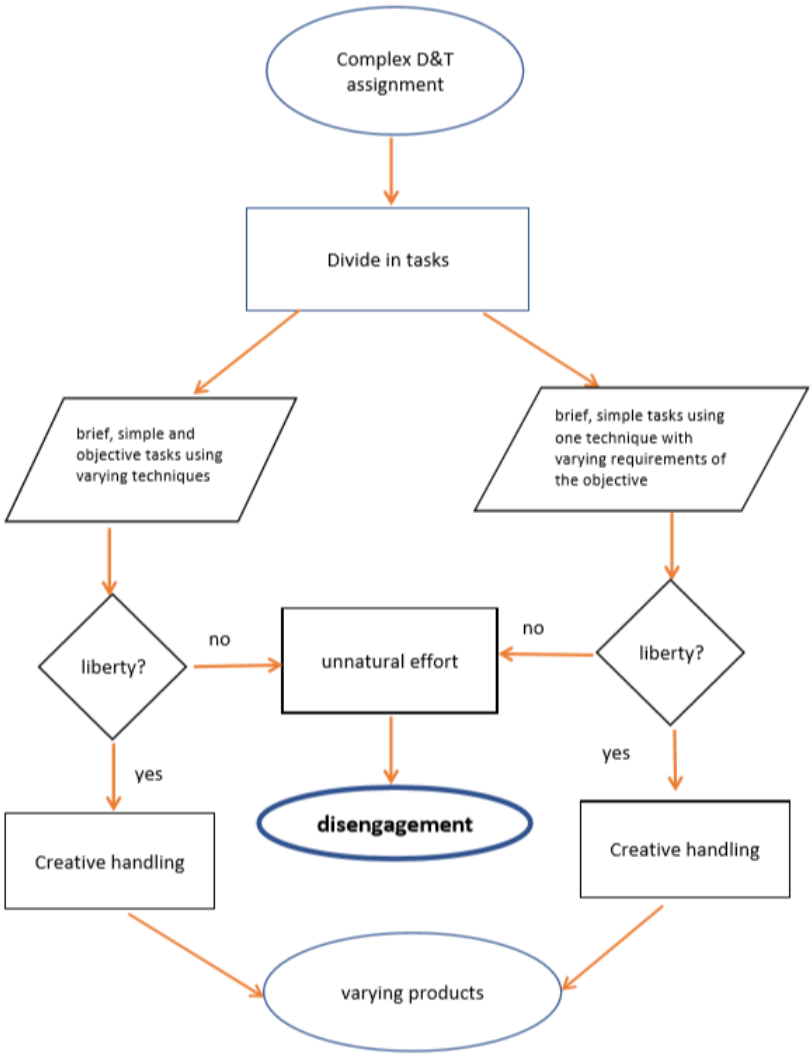

Figure 4. The transformation of a complex assignment in a collection of well-defined tasks

Formative reflection serves iteration, but also a stepwise approach. To get this done regular non-judgmental data collection is necessary. A joint presentation delivers an excellent opportunity for data collection, followed by reflection (Fig. 5). When the data collection is discussed on the basis of

the question “What can we learn from this data?” followed by the question “What more do we want to know/accomplish?”, increasing insight can arise for all participants. Such a joint presentation and discussion offer opportunities for active dialogue. Active dialogue transforms knowledge towards shared knowledge (Krauss & Chiu, 1998; Lemke, 2000; Mercer, 2013). Therefore, dialogue facilitates the increase of insight of all participants. On the base of shared insight, the participants together can determine the requirements of the next objective. Thus the formative reflection triggered by the questions “What can we learn from this data?” and “What more do we want to know/accomplish?” helps to set the next well-defined task.

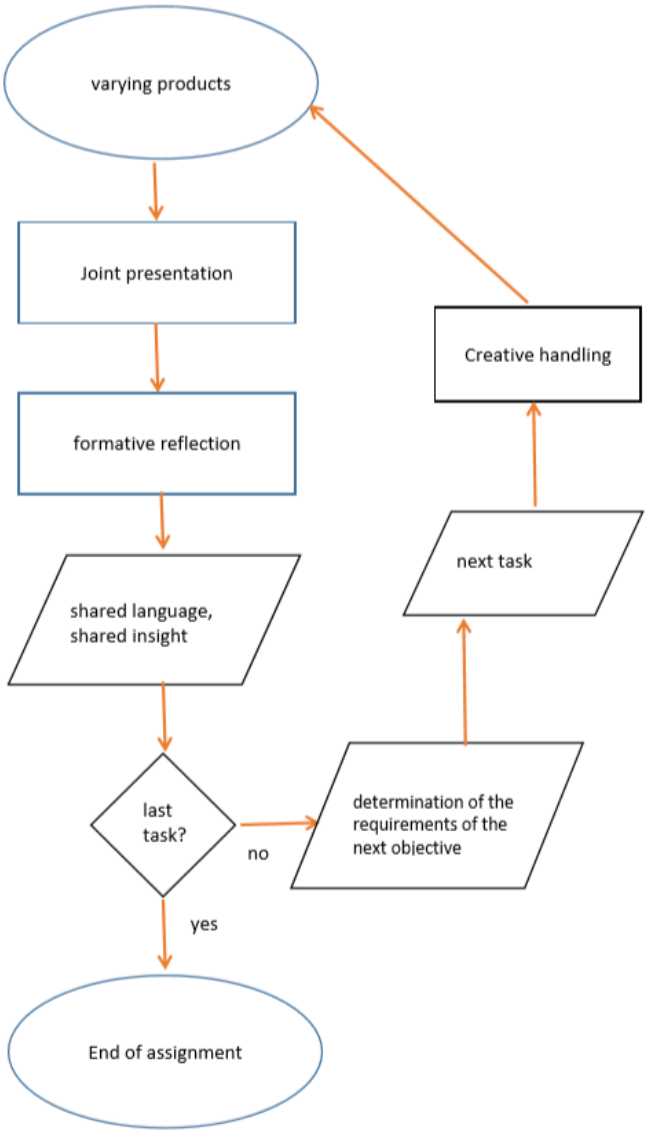

Figure 5. The functioning of joint presentations

As we have already researched a variant of this approach without variation in tasked technique, but with variation in requirements of the objective, with six to nine year olds, resulting in ongoing discovery and well-considered products (Looijenga, Klapwijk & de Vries, 2015), we wanted to know if a stepwise variant of the approach also should work. We also wanted to know if the approach should work for older pupils in a somewhat different stage of their knowledge and personality development

than six to nine year olds are. Therefore we selected pupils nine to twelve year olds. If the underlying assumptions are right, the well-defined tasks should also work for these older pupils.

The paper is organized as follows. In the second section we describe the theoretical framework. In the third section the research design of the case study is presented. Section four follow with results and in section five the conclusions. We end with a discussion and implications for education and further research.

2. Theoretical framework

Literature supports the importance and the feasibility of creating well-defined Design and Technology tasks. A teacher can create curiosity at the start of an activity by questioning pupils about an isolated detail of their everyday reality. Such an approach can start - even for young children - creative hands-on work (Chusilp & Jin, 2006). Presenting young pupils with design challenges that make use of their knowledge and skills can result in ongoing, iterative creative hands-on work (Strawhacker & Bers, 2014).

By starting with a focus on an isolated detail of their everyday reality, the elimination of curiosity - as a result of overwhelming information - is avoided (Dewey, 1910; Kirschner, Sweller, Clark, 2006; Wade & Kid, 2019). When the task also encompasses clear requirements of the objective, referred to by Hattie as success criteria (2012), situational autonomy arises (Candy, 1987). This situational autonomy is exactly the autonomy pupils need to start and continue creative hands-on work.

The effectiveness of the Montessori practice to divide a topic in brief, simple and objective tasks, is confirmed by Dolin, Black, Harlen and Tiberghien (2018). They view learning as making sense of new experiences. To make progress, learning has to be seen as making steps. Decisions about these steps are informed by evidence of what pupils already know and can do, in relation to short-term goals of activities of a particular lesson. Japanese Lesson Study also confirms the effectiveness of brief, simple and objective tasks (Doig & Groves, 2011). Goal setting and planning are the critical underpinning of a Japanese Lesson. According to Takahashi (2006), “a Japanese mathematics lesson is designed around solving a single problem to achieve a single objective in a topic” (p. 40).

Additionally, Japanese mathematics lessons make use of joint presentations of all data, followed by formative reflection. The collection of the individual presentations results in a data set. Then, the data set is discussed on the basis of the question “What can we learn from this data?” followed by the question “What more do we want to know/accomplish?”.

“In the structured problem-solving approach, Japanese teachers emphasise that one of the most important roles of the teacher during a lesson is to facilitate mathematical discussion after each student comes up with a solution. When the teacher presents a problem to students without giving a procedure, it is natural that several different approaches to the solution will come from the students. In order to do this, teachers need a clear plan for the discussion as a part of their lesson plans, which will anticipate the variety of solution methods that their students might bring to the discussion. These anticipated solution methods will include not only the most efficient methods but also ones caused by students’ misunderstandings. Thus, anticipating students’ solution methods is a major part of lesson planning for Japanese teachers. Towards the end of a lesson, a teacher often lead the lesson to pull all the different approaches and ideas together to see the connection. Then, he or she summarises the lesson to help students achieve the objective of the lesson. The teacher often asks students to reflect on what they have learned during the lesson.” (Takahashi (2006, p.42)

Joint presentation by means of active dialogue are in line with an aspect of the Montessori approach, figured out by Maria Montessori after the Second World War. She added active dialogue to her

approach with the objective to provide children with experimental insight towards peace (Montessori, 1972). The active teacher acts as a representative of society and provides the pupils with opportunities to discuss and transform their opinions towards insight in responsible well-thought out opinions. This approach is highly topical, because current social challenges such as racism, discrimination and so forth, call for responsible well-thought out opinions. In this active approach the teacher not only creates a learning environment and defines tasks, but also participates in class through dialogue with the pupils. Such teachers not only prepare themselves inwardly, but are also open for the essence of dialogue; knowledge transformation towards insight (Christensen, 2019).

The idea of joint presentations is clearly elaborated in a book about the significance of Hannah Arendt at work. The essays on professionalism in education, care and well-fare highlight the important role of having different point of views around the table. Hannah Arendt calls this way of discussing 'the Greek Solution' (Berding, J. 2017; Arendt, 1958/1998). Around the table all participants can 'en plein public' explore a question. This exploration ideally results in a sharing of experiences and perspectives on the topic, whereby truth, in the form of solutions and answers are of less importance. An important characteristic of this joint presentation of thoughts and ideas is therefore the absence of moralising. Such a joint presentation leads to critical self-reflective thinking and understanding.

For Arendt, as for Aristotle, education is the means whereby pupils achieve personal autonomy through the exercise of independent judgement and attain adulthood through the recognition of others as equal but different. The teacher takes during education the role of a represent of society (Arendt, Kohn, 2006).

> "The teacher's qualification consists in knowing the world and being able to instruct others about it, but his authority rests on his assumption of responsibility for that world. Vis-à-vis the child, it is as though he is a representative of all adult inhabitants, pointing out the details and saying the child: This is our world."

We can find the same idea of joint presentation in the appendix to the Dutch lesson "geblinddoekte race" (blindfolded race) in the "Buitenlesbundel-2018" (Outside lessons collection 2018) (Jantje Beton & IVN, 2018) from the project "The power of play". This project is a collaboration of the Dutch organization "Jantje Beton" and the international organization "Right to play". The appendix describes the RCA method, that is used at schools in Rwanda. RCA stands for Reflect, Connect, Apply. This methodology puts the child at the centre of their learning. After participating in an activity, children are led through a series of questions, encouraging them to consciously reflect on the activity, connect the gained knowledge to earlier gained knowledge in the past and then think about future applications.

3. Research design

The case study reported in this article has a history. A few months before the case-study even was considered, the researcher, a trained Montessori teacher, did a pilot study on a different location of the Montessori school, where the final case-study should take place. The idea was to find out more about the relationship between the format of activities in class and the engagement of pupils in class. For that reason the researcher cooperated with the Arts and Crafts teacher at that location, who taught several classes of six to nine year old primary pupils. The cooperation resulted for the pupils in increased engagement and, for the researcher and the teacher, in enlarged insight on the effects of the format of a task on the engagement of the pupils. The researcher learned from the teacher that focusing a task on a technique enabled the pupils to design freely. The teacher learned

from the researcher that a single problem combined with a single objective created the required situational autonomy to enable pupils to start designing.

In response to the success of the pilot study the school board requested a case study of the nine to twelve year olds on another location. The Arts and Crafts teacher on that location agreed to participate in study. The school board granted permission for the publication about the case study and for the associated off-line video recordings.

In preparation for the case-study an orientation period took place, in which the researcher assisted the Arts and Crafts teacher concerned in order to get acquainted with her approach and the situation during her Arts and Crafts classes. During the orientation period the researcher noticed the existence of confusion and disengagement in class, probably partly due to missing shared routines and language (the Arts and Crafts lessons had only just started at this location).

The researcher concluded that this particular situation would offer an excellent chance to research if the stepwise variant of the approach with well-defined tasks and joint presentations should work. In addition, it could be researched if this approach also should work for older pupils of none to twelve year olds. If the underlying on active Montessori approach based assumptions are right, the well-defined tasks combined with joint presentations should have a positive influence on creative hands-on work, showing in engagement of the pupils.

The goal of the case study was to identify the effect of an intervention in which the teacher – with assistance of the researcher – introduces a design assignment in the form of a series of well-defined tasks combined with joint presentations at the end of each lesson. The central research question was:

> *"What is the effect of dividing a complex Design and Technology assignment into well-defined tasks, combined with joint presentations?".*

The sub questions were:

- *"What is the effect on the design performance of pupils aged nine to twelve years old?"*
- *"What is the effect on collaboration in class?"*
- *"What is the effect on the teacher?"*

When the approach would turn out to have a positive effect, we can continue with quantitative research in order to find out more details about the effect of well-defined tasks in the Design and Technology class.

3.1. Participants and intervention

The preparation and implementation of the lessons, by means of dividing an entire assignment in ten brief, simple and objective tasks, each centred around a specific technique, was done by the Arts and Crafts teacher assisted by the researcher (the first author of this article).

The STEAM assignment "Make a mini chair" (Fig. 1) (Petiet, 2009) was chosen, because it suited the dividing in tasks. It also suited the specific experience of the teacher, because the Arts and Crafts teacher was an experienced furniture designer, who did an additional study to become a qualified Arts and Crafts teacher. Each task was brief, simple and had an unambiguous goal, defined by clear and concrete objective (Table 1). The objectives linked the tasks to the use of specific techniques. The subject 'chair' was chosen, because a chair is a familiar object. At the same time a chair can take many different forms and offers pupils freedom to design and model the object in an individual way.

Table 1: task succession in case-study "Make a mini-chair"

Nr	task	objective
1	design a chair on a piece of paper	Sketch a 2D chair, that can be transformed to 3D parts
2	draw the components of the chair on paper	The components fit in a 3D construction of cardboard
3	cut out the components with scissors	The components are replicable in cardboard
4	assemble the components with glue	The assembled paper chair fit together
5	if necessary; re-design	Replication to cardboard parts towards a firm and comfortable chair is possible
6	draw the components on cardboard	The paper components are replicated on the cardboard in a fitting way
7	cut out the components with a knife	Handle the knife in an appropriate way
8	assemble the components with glue	The cardboard parts fit together
9	if necessary; solve construction problems	The chair is firm and comfortable
10	paint and finish your chair	The chair is good looking

The same lesson took place three times a day to groups of eight to thirteen pupils, all aged nine to twelve years old, in total 49 pupils. Each group received four different lessons. The composition of the groups was done by the two class supervisors. Each group comprised of pupils from both school classes.

3.2. Data collection and analysis

The type of research was action research, because of the (corresponding to the active Montessori approach) required active role of the researcher and the teacher. Data was collected in real time by the researcher through observation and questioning of the pupils. After the lesson additional data was collected by the researcher through discussing the events with the teacher. During the first three sessions the researcher observed and noted in a log the course of the class with special attention for pupils' engagement as an observable expression of creative thinking. The researcher shared her observations on the fly and after class with the teacher and noted the discussed observations and the teacher's reactions also in the log. During the verbal sharing of observations the researcher highlighted the relationship between the course of the class and the accompanying appearance of

engagement as an expression of creative thinking. All sessions were video recorded from a fixed place, with the objective to have an extra, impartial eye to review the sessions. At the fourth, last day of the sessions the researcher was absent, but the teacher reported the events to her, by phone, after the lessons.

4. Results

The proceedings during the four sessions for the three groups are described below.

4.1.The first session. The teacher started the lesson with a PowerPoint introduction about the function of a chair and the purpose of the assignment. Then, in short, she presented all ten tasks to each group of pupils. Next all pupils started the first task, 'designing a chair on a piece of paper'. When finished, they could start the second task, 'drawing the components of the chair on paper'. After this, they were allowed to continue with the third task, 'cut out the components with scissors' and subsequent task 4,

Figure 6: Working with paper

'assemble the components with glue' (Fig. 6). Dependent on pupil's contentment with their paper model, they could 're-design' (task 5) or start to 'draw the components on cardboard' (task 6). At the end of the first session the pupils were working on various tasks of the assignment. Where a single pupil was already getting around with task 7, 'cutting the cardboard components', one third of the pupils were still in the 'draw components on paper' task 2. A few pupils did not get past task 1 'design a chair on paper'.

During the first part of the first session many pupils had trouble to start the sketching of a chair in an experimental way. When asked, they answered that they thought they had to produce a nice chair in one attempt. The teacher and the researcher were busy with explaining to the pupils that the task was meant as an experiment towards the objective, using sketching as a means to get a feasible design.

An example of this situation is a dialogue between the researcher and three pupils. The researcher showed some samples made by other pupils and guided these pupils' attention to the details that make chairs solid and comfortable to sit in. This guidance did not result in them working. Therefore the researcher suggested that they leave class and come back another time, because the pupils apparently were not intending to start working as there was only 10 minutes working time left. Starting a new task would not be very meaningful. Responding to the suggestion of the researcher, Pupil 1 asked "Can I transfer my sketch to the cardboard now?". The researcher answered: "No, you first have to make a proper paper sketch of a chair, that meets the objective of solidity and comfortable sitting. When you have managed to make such a sketch, you can start making a carton copy." Pupil 1 responded; "It is already proper". The researcher responded: "I cannot see anything that is proper; your sample can only lay down." Pupil 1: "You should make one that stands up." In

response the researcher showed him the carton copy of the chair she constructed as an example to show during the lesson. The pupil responded with: “Of course that one stands up; it is made of carton!” The researcher explained that she started with a paper exemplar and that she met many problems. She solved all these problems, one at the time, until the chair was solid when standing up. Subsequently she guided the three pupils’ attention (Pupil 2 and Pupil 3 were attentively listening) towards the specific dimensions of the parts of the chair and the differences between the dimensions of the parts of the original chair and the chair that Pupil 1 had designed. After that she guided attention to the different specific angles between the parts of both chairs.

After this instruction Pupil 1 told the researcher that he was willing to make a table. Pupil 2 agreed with him. Pupil 3 hesitantly started task 2, ‘draw the components of the chair on paper’. The researcher did not agree with the proposal to make a table instead of a chair. She made the pupil choose between an immediate redesign of his chair in class or taking time by thinking it over and bringing in a redesigned chair during next class. Pupil 1 remained distracted. In response to his distraction the researcher advised him to take some rest outside class and continue the task later on. Pupil 1 left the classroom. Then Pupil 2 started task 2 ‘draw the components of the chair on paper’, and finished task 3 ‘cut out the components with scissors’ and task 4 ‘assemble the components with glue’ very quickly (five minutes!) resulting in an original, solid chair. He even managed to finish task 6 ‘draw the components on cardboard’. The same applied for Pupil 3; he also delivered a solid chair at the end of the session.

In general, at the end of the first session the intention was to share all processes of transforming the 2D model into 3D parts. However the lesson was over before there were enough produced to share. Therefore the teacher and the researcher decided to omit the moment of sharing in all three groups.

The second session. At the start of the second session a smaller number of pupils had difficulties in starting the task. The researcher discussed the reasons of their passiveness (one at a time) with pupils who had not started. After having looked backwards, the researcher asked these passive pupils to propose a solution that would not disturb their class mates. Then, the researcher and the passive pupils discussed the proposed solutions. After this discussion most former passive pupils were enabled to hesitantly start working. It was noteworthy that the subsequent hands-on work of these pupils sometimes showed awkwardness. The scaffold of the these pupils resulted in the disappearance of hesitance. Some other pupils started with looking at peers to see how they continued the assignment. Then they started working.

An example of the effect on passive pupils of looking at peers, is the spontaneous presentation of a pupil, who had already finished the assembly of paper components with glue (task 4), to three new starting pupils. This pupil told the others about his design and creation-process. While he continued working, the new starting pupils watched his working and asked him questions. The task he was working on, was the transfer of the paper components to the cardboard (task 6) and later the cutting with the knife (task 7). The freshly started pupils watched the process of transfer from paper components to cardboard components and realised that not every 2D thought out chair would be suitable to be made of cardboard components. The effect of this realisation was that they redesigned their original design sketches.

From the moment that the teacher and the researcher experienced the effect of looking backwards, through asking for reasons of passiveness and on looking forwards through asking for their own solutions, the teacher and the researcher realised that this method not only was suitable for passive pupils, but also the other way around for stagnating pupils. They started to deploy the method of looking forwards and then backwards to support pupils’ thought processes.

An example of looking forwards and then looking backwards during task 2 was first focusing on the objective of task 9 “The chair is firm and comfortable” and then focusing on the objective of task 1 “Sketch a 2D chair, that can be transformed to 3D parts”. This was done by talking about a pupil’s design in terms of “Is it easy to make?”, “Will it be firm?”, “How do you sit on it?”. Then the pupil was questioned about the cause of to be expected failures. Looking forward helped the pupils to anticipate conditions and looking backwards helped the pupils to discover flaws in earlier stages of the assignment, leading to an eventual redesign of the chair. From this moment on the pupils also applied this support in their collaborations.

During the second session most pupils managed to start cutting out the components with a knife (task 3). At the end of the session in all groups all pupils had finished tasks 1, 2 and 3. Some pupils already managed to assemble the cardboard components with glue (task 8).

A short sharing of results and applied procedures ended this session. The focus of attention of the teacher and the researcher during the main part of this session was on the transformation from 2D to 3D and on the correct use of a knife.

4.3. The third session. During the third session all pupils were working on cutting and assembling. One pupil told the teacher that he would rather have skipped the lesson. Responding to his remark the researcher sat next to the pupil and asked him about the reason for his feelings about the lesson. She began with saying: “Your obvious aversion does not feel good for me. Are you aware of the unpleasant effect?”. Then: “Is the task clear to you?”, “Do you think the task is feasible?”, “Have you already thought out a nice design?”. Meanwhile she assisted him in the cutting job. Although the pupil did not say much, he relaxed and started concentrated working. After 5 minutes he was enabled to work without assistance.

Most pupils were showing a lot of joy during working. The pupils regularly came up with creative ideas like a ‘wobble’ chair (Fig. 7). Another pupil did a remarkable lot of measuring and redesign to make her chair solid. During solving construction problems (task 4 and 8), some pupils got ideas for fixing stability problems. For instance, paper strips were creatively used to fix absent cardboard connections (Fig. 8). Other pupils had simple ideas for a new design and started the process of making a chair all over.

Figure 7: wobble chair “Wiebeline”

Figure 8: The use of paper strips to fix connections

Half the pupils finished their chair completely. A significant number of pupils could already colour and finish the chair (Fig. 1).

At the end of the session, during joint presentation, every pupil showed his/her work and reported shortly about their creation and plans for the next session.

4.4. The fourth session. During the fourth session, most pupils finished their chair and proceeded with a self-chosen job. Some pupils had to finish their chair in a fifth session or in class. The teacher

told the researcher on the phone that the class-atmosphere was really good; pupils showed pleasure in working. The teacher also told the researcher that where she felt stressed and insecure during the first sessions, she was feeling calm and decisive during the third and fourth sessions.

At the end of the session, during a joint presentation, every pupil showed his/her work and reported shortly about the creation. The teacher made a small exhibition in the central hall (Fig. 1).

5. Conclusions

To answer the question: "*What is the effect of dividing a complex Design and Technology assignment into well-defined tasks, combined with joint presentations?*" we can conclude that in this case study the well-defined tasks resulted in growing insight in the possibilities and impossibilities of the used techniques with regard to the design challenge, showing in well-considered designs and products. From the moment that the joint presentations were deployed, a significant increase of collaboration, accompanied by an intensification of discovery, appeared.

The offered liberty caused varied ways of the creative handling of the tasked technique resulting in varied design ideas. Figure 1 shows examples of the variety of ideas.

To answer the sub question: *"What is the effect on the design performance of pupils aged nine to twelve years old?"* we can conclude that the quality of the design performance of these nine to twelve years old pupils improved by the focus on techniques and the offered liberty. Not only the quality of the designs improved, but also the intensification of the performance. The quality showed in well-considered designs and products and the intensification showed in an increase of engagement, interest and collaboration.

To answer the sub question: *"What is the effect on collaboration in class?"* we can note that from the moment on that the joint presentations were deployed, collaboration was evolving. During the joint presentations every pupil showed his/her work and reported shortly about the creation. Because the tasks were the same for all pupils in class, the design processes and design products were comparable. As a result the joint presentations were enriching each pupil's individual knowledge. The rise of shared language about shared knowledge fed the increase of collaboration.

An example of evolving collaboration was the growing attention of pupils for their peers. An example was the pupil who showed attention for the needs of three newly starting pupils by talking about his design and creation-process during working. While doing so, the fresh starting pupils watched his working and asked him questions, to which he patiently replied. This initiated their awareness about the fact that not every 2D thought out chair could be made of cardboard components. The awareness was followed by redesign. Another example occurred during the third session in the second group. One pupil showed other pupils how to handle the knife.

To answer the sub question: *"What is the effect on the teacher?"* we can conclude that the increasing engagement of the pupils created increasing room for focus on pupils' execution of the techniques, resulting in active support of hesitant pupils. For instance, during the second session the increased room for assistance enabled the teacher to assist the pupils in the transformation of the designed chair into chair parts (task 2) and the correct handling of the knife (task 7).

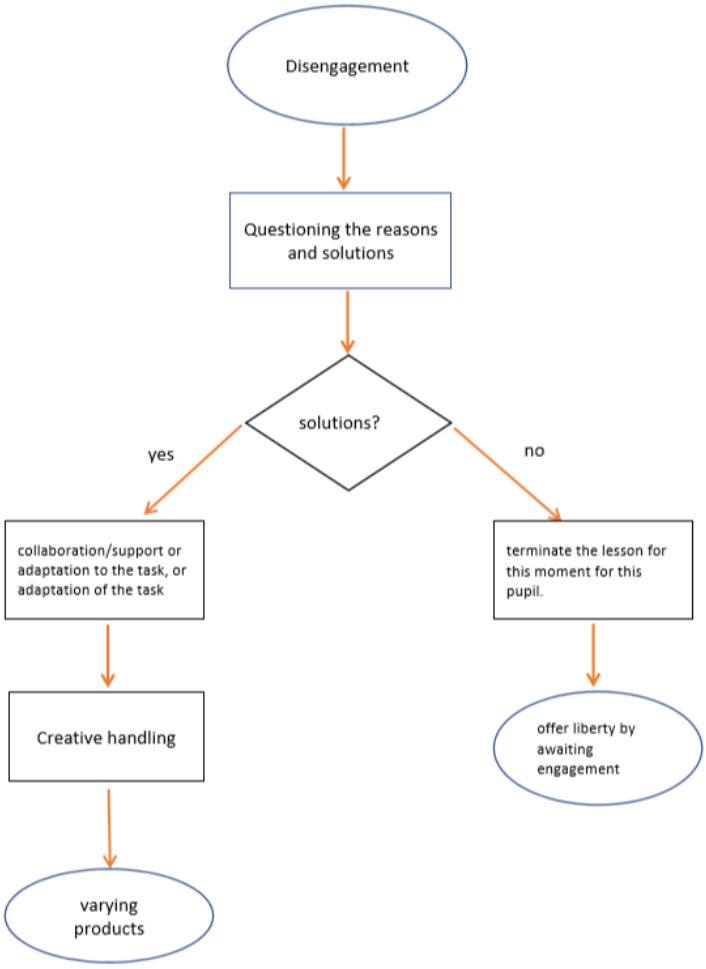

Figure 9. The functioning of liberty

Furthermore, the application of the Montessori view on the importance of liberty of the pupils, helped the teacher and the researcher to accept the disengagement of pupils. Instead of investing energy and time in forcing or nudging to stop the disengagement, this acceptance helped the teacher and the researcher to question the disengaged pupils about the causes of their disengagement (Fig. 9). This acceptance and questioning worked out well. The waiving of a demand for unnatural efforts prevented resistance. The absence of resistance left the teacher and the researcher even more time for the active support of pupils.

6. Discussion and implications

6.1. Class atmosphere

One major observation during this case study was that especially the atmosphere in class easily improved. At the start dominated disorientation and passiveness the class-atmosphere, but during the third session the pupils were showing focus and enjoyment. During this session the pupils were finishing the by themselves thought out chairs. This is an outcome of great significance, because improvement of class atmosphere is a well-known subject in the general pedagogic and educational literature. These sources often mention the strategy to improve class atmosphere through the development of positive teacher-pupil relationships. According to Wentzel (1998) positive teacher–pupil relationships correlate to motivation and school success and are therefore important for pupils. Positive teacher–pupil relationships are according to other authors also important for teachers,

because they allow teachers to experience more job satisfaction (Veldman, van Tartwijk, Brekelmans & Wubbels, 2013), teacher wellbeing (Gu & Day, 2007), and lower levels of stress (Yoon, 2002).

Where these literature sources focused on the creation of positive teacher-pupil relationships, we focused on the definition of brief, simple and objective tasks and we combined the tasks with joint presentations. We started with the creation of well-defined tasks. Secondly, during the lessons, we tried not to hamper the liberty of the pupils in any way whatsoever. Thirdly, we used joint presentations towards increasing collaboration.

As a result, we found in this study a gradually lowering level of stress of the pupils accompanied by an improving level of engagement of all pupils in class. In addition the researcher observed a gradually lowering level of stress of the teacher and an improving level of decisiveness. Both facts benefitted the teacher-pupil relationships.

Therefore, we can say that we found a different way of achieving a positive class atmosphere. We think that the employment of well-defined tasks, combined with respecting pupil's liberty will provide opportunities to start dialogues between teachers and pupils. The joint presentations feed collaboration. Both occurrences contribute to positive relationships, showing in a positive class atmosphere.

6.2. Further research

The use of well-defined tasks will lead most pupils to creative hands-on work. In this study some cases of passiveness showed up. Additional measures, such as the questioning of reasons for their disengagement, and asking pupils to invent solutions for their disengagement, appeared to be necessary. Further research is useful to understand the effect of additional measures on creative hands-on work during a Design and Technology class, and how they can be best combined.

Our observations during the case-study indicate that well-designed tasks combined with offering liberty suit creative hands-on work during the Design and Technology class. Combined with the use of joint presentations the well-defined tasks appeared to lead to a multiplication of ideas, and to developing collaboration. These observations implicate that the well-defined tasks in combination with joint presentations are probably also applicable in creative classes in other domains. Further research is necessary to investigate this idea.

Another interesting item for further research could be reproducibility. The described effects on the pupils in a Design and Technology class are found in a Montessori school. In the Montessori tradition it is customary to enable pupils to start their learning through hands-on work, with a focus on a separated feature of the used learning material. (fig. 3). After this start, application of the gained knowledge on other aspects of reality has become possible. Thus, first the hands and then the mind becomes active, resulting in the achievement of grounded knowledge (Barsalou & Wiemer-Hastings, 2005). It would be interesting to research the effects of the same intervention on pupils in a Design and Technology class in schools that pursue a more traditional educational approach. What will be the similarities and what will be the differences between the findings in our case-study and these schools?

The case-study reported in this article deals with one researcher and one teacher. Other researchers and other teachers could investigate the applicability of the approach and fine-tune the factors of the task definition and the joint presentation.

6.3. Transfer of the findings to other teachers

A suggestion, arisen from experiencing the successful collaboration with the Arts and Crafts teacher, is that it is worth trying coaching in class using well-defined tasks and joint presentations. This help can come from an expert coach or an expert colleague teacher. In class, both the coach and the person being coached will meet the same problems, but may have different interpretations of liberty and inability. This facilitates dialogue. Teachers can, for instance, through this coaching start to see new possibilities to handle pupil's disengagement. By drawing attention to clear occurrences of disengagement, coaching can help teachers to transform restraining assumptions. For example, the teacher in this case-study observed the effect of accepting occurring disengagement of pupils. Through this observation the teacher became enabled to transform her assumption that pupils require forcing or nudging in order to start them working. Instead she was enabled to question disengaged pupils about the reasons of their disengagement. She also asked the pupils to invent solutions. These interventions led to engagement (Fig. 9).

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