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Groundwork: preparing an effective basis for communication and shared learning in design and technology education

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Abstract

In Dutch Design and Technology Education the beginning of a process of learning is usually determined by the teacher. In this paper it is argued that a beginning, determined in interaction with the students, is more profitable as the interaction will lead to joined-up exploring, creating and thinking and an increased motivation to learn. Furthermore, students are empowered to treat an activity as a means rather than an end. The interaction acts as groundwork in advance of the assignment.

Groundwork is something that is done at an early stage and that makes later work or progress possible.
Literature does however not cover the groundwork topic for children in the four-eight year age bracket. Therefore a model for the groundwork phase, consisting of five components, was designed and tested. The components are: context, communication, integration of acting and thinking, presentation of instruction and presentation of the problem. In this paper two case-studies, which handle groundwork in different ways, are described. The groundwork was in both cases addressed in group activities, aiming to prepare students to commence a process of learning. The cases show that, when used in combination, the five components appear to make groundwork successful. Careful communication gave added value. A communication link was configured between teacher and learner, between learners, and between subject and learner. Through groundwork the teacher shared both thoughts and knowledge with the students and this created a base for effective classroom communication and a common approach.

Keywords

self-expression, communication, collaboration, integrated acting and thinking, instruction, context, problem-solving, designing, primary school

Introduction

The Dutch Design & Technology (D&T) Education curriculum originally focused on Technology activities but is now changing to Design Learning and problem solving with technology. The Council for Primary Education formulates this view as “Science and Technology is a view on the world commencing at wonder” and relates it to the development of the so-called 21st century skills (PO Raad, 2013). Thus, there is a need to find guidelines for teacher education to activate “wonder” and to enable children to explore different opportunities.

However, readiness in the pupils is necessary to enable the activation of wonder.

At the moment, two kinds of approaches are practiced in education at large and in Design & Technology to achieve readiness;

- one starting with wide-ranging exploration of a context and
- one with formalized instruction.

Both approaches can be based on a realistic or a constructivist view of learning. The realistic view regards the learner as an independent observer of the context and the constructivist view regards the learner as a part of the context, with an ever changing view on that context. However, experience with D&T education in various Dutch schools learns that both approaches have a number of important drawbacks. The first approach is too open and overwhelming for most pupils, while the second approach does, in general, not lead to wonder and questions arising from the child (Dewey, 1938). Too much information has an overwhelming effect, swamping student's already existing vital though small experience, and stops self-expression (Dewey, 1910). Lately this opinion is confirmed by scientific research, concluding that the mind cannot handle too much information at one time (van Gog, 2013). Therefore, we developed an alternative, namely the groundwork approach. A simple definition of groundwork is that something is done at an early stage that makes later work or progress possible.

A foundation for wondering and collaborative exploring has to be laid at an early stage. We looked at factors that improve readiness of the children and evoke wonder. A way to achieve this is to conduct groundwork; a set of activities taking place prior to the actual start of the assignment aiming at joined-up thinking. Through these groundwork activities the teacher shares thoughts and knowledge with the students and motivates them by making them feel "I can think. I can know. I can have wonderful ideas." (Oldfather, 1992). To ensure sharing, the binding factor in groundwork must be careful, small communication. One must realise that the experience of the student is, at this age, basic in comparison to the experience of the teacher. Inundation should be avoided. Apart from being modest, the information has to fit through the straight and narrow gate of sense-perception and motor activity (Dewey, 1910). For this reason, we expect that small, shared, physical experiences are an ideal way of shaping this communication-link between teacher and student, between students, and between students and subject, in order to achieve readiness and further exploration.

Educational D&T literature does not yet cover the groundwork topic for four-eight year olds. Since the above cited literature demonstrates the importance of groundwork, our central questions are; "How to shape groundwork in design and technology education for children aged 4-8 year?" and "What are the effects of groundwork on the subsequent process of exploration and learning?".

The paper is organized as follows. In the section 'theoretical framework' I develop the theoretical framework about the various components of groundwork. In the section 'two case-studies' the implementability and the benefits of groundwork in practice is showed by describing two case-studies, that were executed by means of ethnographic research. Each case-study handles groundwork in a different way. Furthermore the observed effects of groundwork, supplemented with an interpretation of these effects, are described. The last section contains conclusions and recommendations for the design of educational experiences in D&T.

Theoretical framework

How can we prepare the pupils for exploring, creating and learning by means of groundwork? A key element to prepare pupils for wonder and shared exploring is the development of an effective communication link between teacher and student. Effective communication is characterized by shared, common thoughts and knowledge concerning a subject. To make this happen, incomplete knowledge has to be completed and various aspects of knowledge need to be transformed, to become shared knowledge. To accomplish the transformation from isolated to shared knowledge five principles are important:

1. context - simple or familiar with a focus on one aspect;
2. integration of acting and thinking - enabling the construction of personal meaning;
3. communication - effective by means of shared language and shared skills;
4. presentation of the instruction - handling the process more than the content;
5. presentation of the problem - clear and simple.

Taken together these five principles, presented in a modest and illustrative way, can make groundwork successful. Below, we show insights from the field of science teaching, D&T education, educational psychology and pedagogy on these five components.

The context

Within the field of science education a study by Cakir (2008) deals with the fact that learning commences with the own natural ability and interests of the learner in order to be effective and draws the conclusion that for education, on a group basis, various learners have at the same time and in different ways to participate actively in learning. In the field of educational psychology, it is known that at a group level the offered data can have the same content, but at an individual level this same data can have a different meaning to various learners (Piaget, 1978; Vygotsky, 1978; Ausubel et al., 1978). This can be bridged by a well-chosen context, which is attractive for the whole group of students. Then the context can be discussed leading to a shared meaning of the context. Such a context can be found in ordinary classroom problems about toilet-use, organization of the class-activities, whose turn it is, how to handle class material, etc.. Also ordinary household problems are a rich source of contexts. The teacher should either concentrate on one aspect of a familiar context, or make the context easy to oversee (Montessori, 1912). These contexts offer space to try out different mental models and methods to connect abstract knowledge with concrete applications, thereby being able to convert and apply abstract and general principles (acquired through instruction) in meaningful and responsible actions in life (Scheer et al., 2012).

Integration of acting and thinking

A study in the field of D&T education research (Mioduser, 2009,) claims that integrated acting and thinking is the skill of learning technical problem-solving (TPS) and is essential to everybody, as the world is filled with designs, inventions and machines. Thus technology influences everybody. To integrate acting and thinking the learner has to recognize a task as a means, instead of as an end. The effort for the student is to understand why the task has to be done, instead of just performing the task (Aalst and Truong, 2011). McCormick (1997), an author from the field of D&T, stresses the fact that learning is a mental process for students, structured by context, activity, available tools and the interactions with other people. Therefore, in daily life, technology-knowledge is structured by the use of technology. McCormick cites Vygotsky (1986), who sees an interrelated relationship between knowledge and action. Kimbell and Stables (2007) speak of the interaction of mind and hand. The learner images and models the knowledge inside the head and confronts the knowledge with reality outside the head. Hannaford (2005) describes a similar process. She uses the terms Logic and Gestalt. She views human functions connected to one of the two brain-hemispheres. Lave (1988) however, sees more of a development of a social anthropology of cognition in practice. At school introduced concepts cannot be plainly transmitted to students, but students have to become active and make an attempt to fit the introduced concept into their own already existing models.

Communication
In the field of science teaching, Lemke studied the importance and effect of shared language. A well-functioning communication link is 'paved' with social interaction and related language (Lemke, 2000). In the field of D&T at Primary level Levy and Mioduser (2007) considered the development of the ability of young children to explain complex behaviour of a self-regulating robot composing a shared language during the 'warming up' phase. This shared language was used later on to facilitate the discussion of tasks.

The presentation of the instruction
In the field of D&T I encountered an interesting project, making use of demonstration to instruct, not in the scientific literature, but on YouTube. The teacher connects the assignment to the YouTube film demonstrating the building of a seat, according to a Catalyst (the structural support for a chair). After this demonstration the student is tasked with finding materials and developing construction skills, in order to build a seat him/herself (www.wikiseat.org). To begin the problem is simple and clear, but the elaboration can be handled in various ways. In the field of pedagogy, this type of instruction is characteristic for Montessori education. Montessori designed arrangements to make 'how to learn to do' possible. In such arrangements, all instructions have to be given at the start and the overall purpose of the project has to be addressed (Montessori, 1912). A recent study in the field of educational science, handles demonstration as a way of instruction (Van Gogh, 2013) at the start of the task. According to these various sources, demonstration appears to be an effective way of instruction.

The presentation of the problem
The presentation of the problem has to be modest and uncomplicated, enabling it be tried at home by the students. Above this, the problem has to be open. The solution to the problem must not be controlled by the teacher, but should grow through self-expression.

Besides these five components, the presence of some further aspects are necessary to make groundwork a success. To start exploration, a preparation process (enabling group attachment, sufficient self-expression, social behaviour skills and attention skills) is needed. This preparation process needs many learning processes and is a team effort. Its strength lies in the growth of shared experience accompanied by a shared language of the experience. Social behaviour skills in handling work atmosphere and bonds are necessary to make group attachment possible. By paying attention to the various aspects of the work atmosphere, and deciding as a group how to handle each aspect, a common understanding of this atmosphere arises and enables social interaction. In addition, attention skills are necessary with regard to focusing on an offered task. The focus can be the ability to recognise elements to set oneself a task. Another focus can be the ability to recognise a personal challenge. Feeling attached, together with well-developed focus/attention skills, makes a child ready for self-expression.

Two case-studies

Research context

Next, two case studies have been developed in which these five principles have been applied, each handling groundwork in a different way. The first one deals with self-expression through development of shared perceiving skills, accompanied by shared language. The second case-study deals with self-expression through 'hands on' learning, under the condition of ample room for experimenting, collaborating with and observing other students.

The applied research methodology was ethnographic research. I did not apply any exclusion of children; the whole group participated in both case-studies. The type of school was a Primary Montessori school. The traditional Montessori doctrine, of freedom with discipline, creates control of behavioural, perceiving and organizational skills (Montessori, 1948). In this way, the teacher avoids the separation of thinking and its experiential context, which often leads to drudgery. In the publication ‘Education for a New World’ Montessori expresses this idea as following: “The directress must help the child to act for himself, will for himself, think for himself; this is the art of those who aspire to serve the spirit.” (Montessori, 1946, p. 69). The teacher's role is to prepare the environment and to adapt it if necessary, in order to enable the children to start their own learning. The children need to know where to focus on to start the learning the teacher has in mind. Montessori named it: ‘Open the window (the focus) to give a view on the world.’ The children’s role is, if necessary, to collaborate; the more experienced children are supposed to help the less experienced ones.

The first study was executed with approximately twenty five pre-school children, in the four to six years old age group. At the time of the case-study, I was their regular teacher for five days a week. There was no special time set aside for the activities; they took place within the everyday teaching situation.

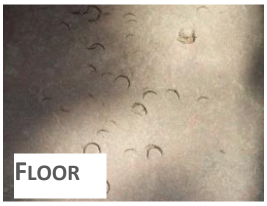
The second study was executed with approximately forty children in the seven to eight years old age group. These children were divided into three similar research groups of eight to twelve children. The children were assisted by myself (as technique teacher) and their regular handicraft teacher. The children’s previous knowledge was pulleys. In the educational museum, Museon, they experienced the use of pulleys in the Roman period. A special part of the week was set aside for the activities, during handicraft-hours.

The first case-study; perceiving exercises

Set-up
The perceiving exercises are based on the book of Keri Smith (2008), 'How to be an explorer of the world' Her main message is that, by exploration, people are able to perceive things from various perspectives, while non-explorers perceive only from one perspective. The small perception classroom experiments used in the case-study are all explorations from Smith adapted to pre-school children.

Execution
- *Testing the usability in a daily teaching situation:*

Week one. In a spare ten minutes, while all children were sitting in a circle, I tried out one exploration (Smith, 2008, p. 29) by saying "Look around you. When I call your name, mention one thing you have not seen before". The children had various observations such as a small hole in the ceiling, screws in the walls. All children mentioned something, even the youngest.



The assignment for the following week was: "Lets 'look around', all the time, in order to solve all sorts of problems in the classroom." I applied the intense observing to the exercise of the conative skill 'controlling oneself' (Marzano and Heflebower, 2012) by regularly asking the whole class: "Look around, who is behaving as agreed to be nice for everyone in class?" Most of the time, the out of control children copied the controlled behaviour of other children. If they did not do this immediately, they started to copy, when other children drew their attention to nice behaviour, by verbalizing it. For instance; 'holding all needed stuff close to you', 'speaking softly', 'check your surroundings, avoid injuring a classmate by toning down play' Guided perception thus led to increased control of oneself.

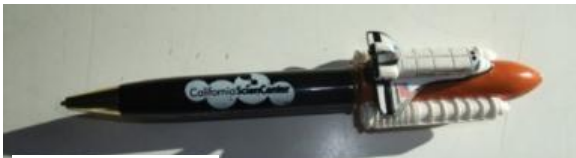
- *Expanding perception:*

Week two. I read to the children an adjusted description of Corita Kent of the creative process (Smith, 2008, pp 38): "An artist never is bored. He/she explores and collects everything. He/she rejects nothing and is uncritical. Experiencing a problem, an artist is going through his collections till he/she finds something useful for the problem. The 'something' from another collection is given new meaning and so every problem can be solved." I connected this description to the theme of 'look around' and said "You are a real artist in an activity when you know how to carry out that activity or when you know very much about the activity, along with the ability to observe the activity" The next instruction was to tell in turn; "In what activity or subject are yóu a real artist?" They often mentioned a hobby, like horses, building huts, drawing. But also behaviour in class or at home was verbalized, like; tidying up, comfort my little brother. This batch wise, but individual defining of a real artist brought us to shared view about a real artist and resulted in shared language . With the shared language we were able to apply it to other situations. For example; 'not know how to choose or how to do something, resulting in not doing anything'. We came to the conclusion that in such a case 'Look around and check what other children are doing and then choose yourself' could be a possible solution. If children chose something, but are unaware how to do it correctly, they can watch other children doing the same activity or ask a classmate to show them how to handle the material. As a result, most of the time problems were solved

I concluded that trying to be an artist led to an increased ability to manage oneself, a conative skill (Marzano & Heflebower, 2012).

- *Focus on details:*

Week five. A third experiment took place a few weeks later. I read an exercise on intense exploration, called 'one thing' (Smith, 2008, p 48), covering and solving boredom. I adjusted it into: "You have to observe for some time the upper section of an object and later on the underneath section. If you find it boring, you have to double the observing time. When you continue to find it boring, you double the time again. You should repeat these steps, until you stop thinking about the object as boring and start discovering new details." After the



SOUVENIR PENCIL

instruction I demonstrated the exercise myself using a souvenir pencil, which a child of my class gave me after visiting the U.S.. I held the pencil in my hand and said; "this pencil is from the U.S.". "First I observe the upper section for a while." "Oh, yes, familiar, the space-shuttle. I have seen it before, boring…." "So I have to observe for longer, until I stop finding the object boring." "Oh, I see the American banner. I also see the windows in front. Not boring at all!" "Now I have to observe the underneath section." "Oh yes, I can use that part to write with. That is familiar, boring!" "Observe for longer." "Oh, I see letters, 'California ScienCenter'. And I see a golden end on a black pencil. I begin to see more and more. What would happen if I turn the spaceshuttle round?" The children were strikingly quiet. I concluded at this point that the effects were uncertain. But, after these exercises continuous effects were showing during regular activities. For example, two weeks later I told a story, concerning little dissimilarities in humans and showed an illustration with a lot of fishes on it. The children were observing these fishes for a long time, before they started to verbalize. They noticed several differences between the fishes. I interpreted the children's behaviour as a spontaneous reversion of a first glance into a thorough observation. I asked the children "What made you all observe in such an accurate way?" Several children mentioned the exploration 'one thing' as the reason.

INLINE FORMS

In week nine it seemed that two thirds of the class were spontaneously drawing geometric figures. I asked the class why they were all making this figures at the same time. One child answered that he discovered the inline forms while looking for interesting material and that the other children joined him. The children observed each other, and worked together, invented new variations in form and colour. In week ten, during a project week about sea, dunes, sand, we arrived at an activity, where we were supposed to watch a movie "The most beautiful fish of the sea". I gave the children the choice; first watching the movie or colouring. Twenty six out of twenty seven children chose …. colouring! They took their time to fill in the figures. Just one child was scratching in order to finish quickly. That movie; we did not watch it at all. In week twelve I detected that the skilfulness of observing in an artist way was spreading to home situations. A mother reported, that she noticed her child observing the light falling on the walls in his bedroom. Not once, but several times. He did this in a particular way asking himself how the light fall would fall if the walls were placed differently.

Interpretation and results
The case-study covered a period of three months and illustrates that sharing knowledge about a process such as perceiving enforces skilfulness, because it leads to collaboration and shared language. The achieved skilfulness was unusual for children of this age. The modest style of the three teacher guided exercises enabled all children to express their observation. In three months, the children discovered how to observe accurately and work in a neat and thorough way, resulting in motivation and enthusiasm to do so.

The second case-study
The communication link in this example of groundwork is a batch wise demonstration of a clear, small problem, accompanied by a simple question. The most important features of the problem are simplicity and the chance to try it out at home. The whole case-study was designed in such a way, that the children could execute all stages autonomously.

The case-study encompassed four episodes. The first episode was a demonstration to start the reflection about the key principle. The following two episodes were in experimental hours. The last episode was in a tinkering hour.

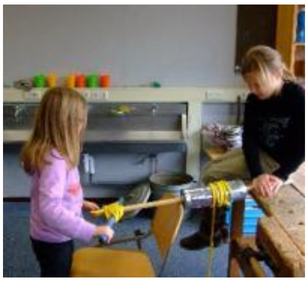
Execution

- *First episode: Demonstration to set an anchor for shared thinking on the key-principle*

I started with a demonstration of lifting a weight hanging on a rope. At first I was standing on the floor. Later on, I was standing on a chair. I asked the children: “When do I have to pull harder; standing on the floor or standing on a chair?”

- *Second episode: Experiments to make the children figure out the mechanism behind simple phenomena:*

This second episode took place a week later. I started with a demonstration of the various exhibited machines and tools and I verbalized rules, covering danger or possibility of break down. Then, I repeated the question of the demonstration: “When did I have to pull harder; standing on the floor or standing on a chair?”, I asked the children to vote (by raising a hand) for standing on the floor. After counting and discussing the rules, the task was set: “Try all sorts of material and think about the function of the used wheel(s). Collaborate, if you want to.”



WINDLASS

PULLEYS

gearing wheels

K’NEX

HAND-DRILL

CORKSCREW

CRANKSHAFT GAME

In the handicraft classroom, two installations made from scrap-materials from the book “Wheels at work” of Bernie Zubrowski (1986) were displayed; one windlass installation and one with pulleys. Also other tools and machines were displayed, e.g. a gearing wheels box with about thirty gearing wheels of the same size that could be combined. On another table was a pulleys installation constructed with K’nex and on the last table were tools and applications such as a lever corkscrew, hand drill, K’nex cars with various gearing wheels and a crankshaft game. The children played with all machines and applications. The three pulley K’nex installation particularly provoked experimenting (observing and analysing effects of actions). The big installations provoked playfulness (the installation performed a role in a role-play). During the activity, I sometimes asked questions to draw attention to phenomena or suggested collaboration. Children who were finished with the machines could choose a handicraft task, but this did not happen. All children worked in a serious and concentrated way.

Some children were quick in discovering new appliances of the machines, other children got caught up in researching the working of tools. Some children showed at first untargeted activities, like watching, feeling and searching. They started researching after finding something familiar, like the corkscrew or the hand drill. After manipulating these daily life tools, they started researching other machines.

- *Third episode: experiments to make the children perceive mechanism in complex phenomena.*

In the classroom, a windmill installation, a water wheel installation and a music machine were displayed, all built according to Zubrowski. At the start, the windmill installation was driven by a fan, but the fan did not make the windmill turn. Because of that, children tested a cold hair blow dryer. This made the installation work well and with a screen held half in front of the wind mill, it turned even harder. The children could also play with a number of installations that I designed and put together myself; two small water wheels from waste material, and two music machines from K’nex. Besides this, the children could fold three varieties of paper pinwheels. The pinwheels were not that easy to fold, but the result was firm and easy to handle. The music machines did not work very well. Even so the children tried to get music from the machines.

WINDMILL

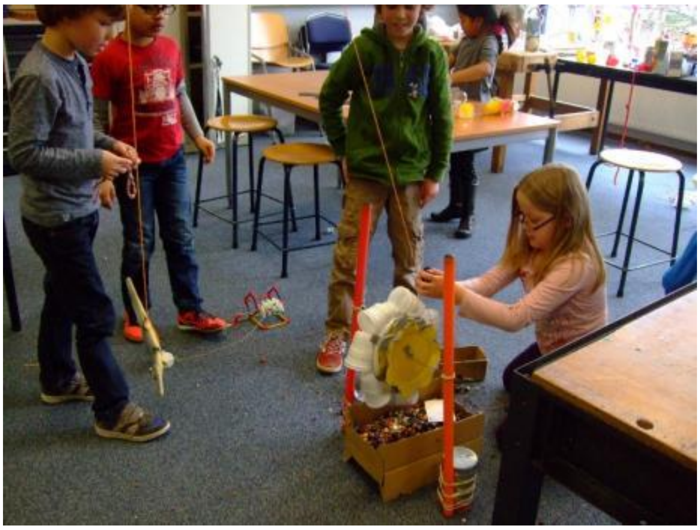
WATERWHEEL

MUSIC MACHINE

PINWHEEL

- *Fourth episode: Tinkering hour to bring forth the results of the hands-on learning.*

In this last episode, the children had to make something themselves. The given instruction was: "After experimenting you have to make something yourself. You can make what you want. I am interested to see what you are going to make. It is nice, when you make something that has several combinations, and all the parts making a big machine. You are allowed to use material and components you experimented with earlier". The children could choose between the making assignment described above or a handicraft task. Thirty nine of the forty children choose to do the making assignment The fortieth child first chose the handicraft task, but after ten minutes she selected the making assignment, because a plan to make a guitar came up. All children started quickly. Eighty percent of the children worked till the end of the working time on the task. The children spontaneously collaborated in groups of four, three or two children. Some children preferred to work alone. When asked, they informed me, that they wanted to make a special machine. I saw a lot of interaction and interest in each other's work: other children passing them by, watching and asking them questions.



WATER-WHEEL, DRIVEN BY MARBLES

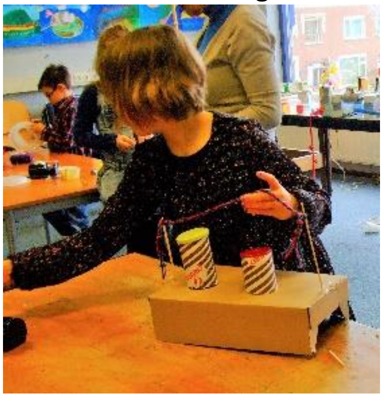
I do not have many quotations of the children, because, when questioned, most were unable to verbalize their actions. They gesticulated, but did not have appropriate vocabulary to express their experiment.   All children invented something new and not seen before. They often used the principle of chain reaction. Sometimes they applied the lever principle.

The children's enthusiasm to make things that produced sounds was especially remarkable. Sometimes they fantasised about lifting something, that could drop water or sand in order to make another thing move, but they did not actually know how to make it. Two girls managed to create something new. One girl tried to make a music machine with strings. She could explain her plan very well, but a successful execution was too difficult. Another group made a musical water-wheel, driven by marbles and buttons, instead of water (because water was forbidden). The wheel was winding a rope, led through a pulley on the ceiling (which already was there…) to a set of sound making objects on the other end of the rope. Another girl made an underground litter bin with an above-ground part with various lids, which opened when trash was deposited in it. She showed great involvement and enthusiasm. This was remarkable, because most of the time this girl does not show self-expression and she needs lots of stimulus during working in class. All children worked in a serious and concentrated way.

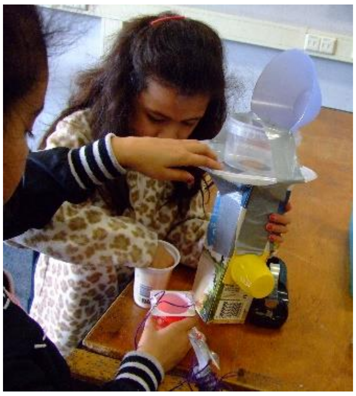
Interpretation and results
The most important features of the first episode appeared to be simplicity of the demonstration, the absence of an answer and the chance to try them out at home. The second and third episode evoked interest in making and developing original machines. It was notable that all children chose to do the 'making' assignment and in all episodes ALL children worked in a serious and concentrated way.

The attractiveness of the not properly working sound machine was remarkable. Was the imperfection waking inquisitiveness? In the last episode all children were very creative in inventing something new and not seen before. The inventions showed a lot of practical insight, based on the knowledge, gathered during the playing and collaborating in the first and second hour. My plan, to make the children construct parts, which could be put together to make a bigger machine, did not work out as I expected. Apparently the children were still in a trying out phase.

Last but not least, even children, with a passive stance during regular courses, started active, enthusiastic and targeted.



MUSIC MACHINE WITH STRINGS



UNDERGROUND LITTER BIN

Conclusion and recommendations for the design of educational experiences in D&T.
From the results of the two case-studies we learn that, by using the groundwork model with its five components, every teacher can educate in such a way, that it has high impact on all students. By applying groundwork, the dilemma, that a teacher has to choose between starting exploration in a too wide-ranging context or starting exploration with a too formalized instruction, is by-passed.

Because of the groundwork provided, the level of teacher engagement can stay low in the subsequent exploring and creating processes, while at the same time the level of student engagement is high. The case-study findings show that groundwork made the children motivated and even compelled to search for meaning and mechanism of a phenomenon. Groundwork makes activities and tasks grow from just finishing an assignment to experimenting (Aalst and Truong, 2011).

The above described behaviour is the consequence of the effective communication link, produced by the groundwork approach, and characterized by shared thoughts and knowledge. The combined application of five components; precise handled context, integrated acting and thinking, effective communication, the small presentation of the instruction and the small presentation of the problem lead to the completion of incomplete knowledge and transforming of various, individual knowledge into shared knowledge.

Comparing the two case-studies, it is worth mentioning, that the first case-study worked well, because of the application of the perception experiment in daily practice and the verbalization of it by all children. This element is missing in the second case-study. As a result the children did not have enough words to express their activities. This showed especially during the tinkering hour.

This can be explained in the following way. The contrast between the two case-studies is that the learning process of the first case-study was a marked team process, initiated by the teacher with a demonstration of the instruction 'how to observe', followed by verbalizing of the personal observations by all participants. This lead to intense focusing and shared language. The team process contributed to the development of the skills, noticing, controlled colouring and pro-active self-direction.

In the second project the teacher set up the environment, but not the tasks. The task was 'play'. As a result the learning process was in some respects a team process and in other respects undefined. The initiation of the learning process, the demonstration of the simple problem, was attended as a group. Batch wise demonstration of instruction was absent.

The two cases are similar with respect to working in groups, combined with free choice in how to experiment; individual or in collaboration. According to literature working in groups is profitable, because socialization and a shared language originates from collaborating in groups; students can discuss between themselves all the ins and outs (Lemke, 2000).
For effective collaboration, free choice is important, because collaboration is the consequence of interest in the view and actions of others, aiming to increase one's own self-expression. Free choice is vital to enable inquisitiveness and interest and teachers should allow a level of free choice in the start activities as well as in the subsequent processes.

This principle also determines effective teacher communication. When the teacher communicates on an equal level with the children and instruction is small, the ideas of the children get the chance to affect the ideas and further instruction of the teacher. Then genuine communication can take place (Dewey, 1910) and joined thinking occurs.

From the result of the first case-study is to learn that the increase of fine motor control smooths the way to self-contentment and increases self-expression. This confirms the assertion, that skills and knowledge are best developed in advance to enable self-control. Control of the unknown is impossible. Skills and knowledge concern all dimensions of the environment; classmates, teacher, tools, furniture, books, teaching material, the arrangement of the classroom, playground, building and so on.

Some practical recommendations:

- Plan small, targeted instruction, before starting a task.
- Use demonstration to instruct 'how to do something'.
- End the instruction with verbalizing of personal ideas or observations by all participants.
- Plot a small, simple problem, to start the thinking about a phenomenon.
- Use demonstration to set the problem.
- Working in groups furthers collaboration and discussion.
- End the working with reflection in the gathered group. Verbalizing of personal ideas and observations by all participants leads to shared thinking.
- Free choice furthers playful behaviour, inquisitiveness and feeling attached.
- Small questioning can help children to verbalize ideas.

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