

The enhancement of creativity in Technical Education

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Abstract

As educators we are focused on developing educational practice and provision and therefore pay a great deal of attention to how to enhance the development of each student's creative potentials. We are aware of our values negated where schools in Croatia are dominated by practice that enhances creativity in just a few school subjects (Croatian language, art and music), while other school subjects are often neglected.

We believe that teaching, which enhances students' creativity, is a student-centred approach and traditional didactical structure and methods, as used in our schools, does not support cooperation between student and teacher. Therefore a different approach is needed in order to support creativity in the classroom.

In this paper we describe and explain how the creativity of students can be enhanced in the process of teaching Technical Education, a subject that has undergone numerous changes over the last twenty years, often to the detriment of the creative work of students and teachers.

Keywords: Creativity; Technical Education; Action Research; Critical Friendship.

1. Introduction

This living-theory action research (Whitehead, 1989) study was carried out as we wished to improve my (Sanja) teaching of Technical Education. The subject experienced numerous changes throughout the years. It was developed with a new teaching plan and programme in 1991 and changed its name from the Basics of Techniques and Production to a new name - Technical Education. The subject's content has also changed since 1979. The most difficult time, concerning the creative work, was the period from 1999 to 2006 when students involved in this subject only dealt with the history of techniques and technology development. The introduction of a new teaching plan and curriculum in 2006 ensured that students had the opportunity to become involved in creative work. By introducing a new teaching plan and curriculum in 2006 it seemed that students would be again involved in creative work and thinking¹.

2. The context of action research

The participants of this living-theory action research study were the teacher Sanja Vidović and her students (class 7b) and the school pedagogue Verica Kuharić-Bučević.

Sanja Vidović: I graduated in 1996 at the University Josip Juraj Strossmayer in Osijek – The Faculty of Mechanical Engineering in Slavonski Brod in Croatia. After finishing the mechanical engineering study I tried to find a job in the profession but without success, so I enrolled in a further course, pedagogical-psychological education, in 2002 at the very same University but in the Faculty of Pedagogy in Osijek. This qualified me to work in a school. I started to work as a Maths and Physics teacher in 2003 and then I got the permanent job as a Technical Education teacher at the elementary school “Vladimir Nazor” Đakovo. This living-theory action research study was carried out in this school with seven grade students. The class consisted of twenty-one thirteen year old students, who I tried to get interested in my subject. I was also their class teacher².

Technical education is a subject that elementary school students take between their fifth and eighth grade (between the ages of 10 years and 13 years). The main aim of this subject is to develop an active, entrepreneurial and creative technical-technological way of thinking and provide a qualification for students applying to study ‘technical products in living environment’ (Ministry of Science, Education and Sports, 2006, p. 304). The course comprises 35 hours a year of classroom teaching, mostly delivered every two weeks as a double lesson (2 x 45 minutes). Technical Education had been a neglected subject until 2006

¹ As quoted by the authors of this curriculum, “this subject should give its contribution to various educational achievements of elementary school students, and one of these contributions is the enhancement of creative work and the strategy development for problem solving” (Vican & Milanović, 2006, p. 304).

² In Croatia each class has a class teacher who takes care of a class. In addition to regular subject lessons she/he has one lesson a week with her/his class. At this lesson he/she discuss about organisational and educational issues (e.g. organising visits, excursions, dealing with peaceful conflict resolution, health education etc.). Her/his responsibility is to cooperate with parents of students who attend her/his class.

because the practical work was missing. In 2006 [the Croatian national educational standard](#)³ and the Teaching plan and programme in elementary schools⁴, reintroduced practical activities in Technical Education.



Image 1. Sanja's classroom

I managed to get my own classroom in the old school building three years ago. The classroom is now well equipped and this allows pupils to benefit from using modern technical equipment (image 1). The classroom is intended for 15 students, however our classes sizes are much larger. I try to teach students to handle tools with care and to be cautious about injuries which is not easy given the overpopulation of the classroom. However, this does not prevent me from enhancing students' creative work and to developing their interest in the subject on a daily basis. I am a restless person and love to learn something new. So I try to improve my teaching by introducing new things and changing what is not good, in order to avoid boredom and to enhance students' interests.

Verica Kuharić-Bučević: After finishing my first degree in 1983 I become a pedagogue⁵ in the elementary school "Vladimir Nazor" in Đakovo and graduated as a pedagogy in 1984 from the Faculty of Philosophy, University in Zagreb. I encourage teachers to reflect on their teaching practice and to improve it as my professional work. My personal opinion is that the professional improvement of teachers is inseparable from everyday teaching. Thinking about how to connect teacher's professional improvement with the teaching practice I initiated a learning community at the school. According to Bognar (2003) the learning community can be defined as:

³ [The Croatian national educational standard](#) began its usage in 2006/2007 school year in first and fifth classes in elementary schools.

⁴ In the school year 2006/2007 a new Teaching plan and programme in elementary schools is used.

⁵ A pedagogue is a professional associate in Croatian schools who "monitors, explores and analyses the teaching work, and suggests ways and contents for the development and improvement of teaching and the whole educational work in schools" (Ministry of Science, Education and Sports, 2006, p.18).

... a group of people gathered on their own who in a longer period of time (from a few months to a few years) communicate about their values, create a common vision, cooperate with the goal of improving the personal learning practice, critically think about their activities and its condition. (Bognar, 2003, p. 25)

My goal was to gather teachers who wanted to think about his/her own teaching activity, talk about his/her own practice, to improve and change it through developing their relationships with other teachers in the group. The group has been in existence since 2004 and today it consists of fifteen teachers. Through the group, I try to encourage teachers to carry out action research and to act as a critical friend. I agree with Costa and Kallick understanding of a critical friend as:

... a trusted person who asks provocative questions, provides data to be examined through another lens, and offers critique of a person's work as a friend. A critical friend takes the time to fully understand the outcomes that the person or group is working toward. The friend is an advocate for the success of that work. (Costa & Kallick, 1993, p. 50)

However, it implies a change of my relationships with teachers trying to be more of a critical friend as well as being the head teacher's right-hand person. I was a critical friend to the teacher Sanja Vidović during this action research and I helped her with the report writing and we wrote the interpretation together.

3. Methodology

We first came across the term action research while participating in professional development projects initiated by Dr. Branko Bognar. He was responsible for the teacher's professional development in the Project "The enhancement of creative work in a life-long education of teachers" The main purpose of those projects was to create learning communities in several elementary schools and secondary schools. Members of those communities, including ours, were ready to improve their practice using action research. Branko was also our critical friend.



Image 2. [Professional development of teachers – members of learning community](#) (Kuharić Bučević, 2008).

Verica: I conducted my first action research project during 2005/2006 school year to help teachers improving their practice as pedagogue – critical friend. In doing so I also improved my professional practice and myself personally. I felt my communication with teachers became of a higher quality, more equal, open and mutually warmer. Today I allow myself to recognise when, as pedagogue, I do not know something, I am more ready to accept differences, I find it easier to discover what motivates teachers, and I take more care of their individual qualities. I presented results of my first action research at several professional meetings in Croatia and at the international conferences in Mostar (Bosnia and Herzegovina, 2008).

Sanja: This was my first experience of action research. I became acquainted with the creativity in a more detailed way during the school year 2007/2008 as I took the action research approach. I tried to apply what I had learned in the learning community in this action research project.

Our action research was, “systematic enquiry undertaken to improve a social situation, and then made public” (McNiff & Whitehead, 2009, p. 11). This implied improving the quality of teaching and learning as well as the conditions in schools we as teachers and students work in. We agree with Altrichter et al. (1993, p. 4) that, “action research is intended to support teachers, and groups of teachers, in coping with the challenges and problems of practice and carrying through innovations in a reflective way.”

We developed our action research within the overall plan of the project “Development of creativity in lifelong education of teachers” as represented in Table 1. We began by taking part in seminars and workshops, when we came to an agreement about how to proceed and become acquainted with the Moodle system⁶ (<http://kreativnost.pedagogija.net>). We initially videotaped and analysed Sanja’s teaching within our school learning community and on Moodle online platform. On the basis of discussion as critical friends we identified and clarified the problem we would research, planned and began our research. Using data gathered during the action part of our project we wrote a report which we presented it at the international conference in Požega (<http://ejolts.net/conference>).

⁶ “Moodle is an Open Source Course Management System (CMS), also known as a Learning Management System (LMS) or a Virtual Learning Environment (VLE). It has become very popular among educators around the world as a tool for creating online dynamic web sites for their students.” (<https://moodle.org/about/>)

Table 1. Plan of cooperation between action researchers within the project “Development of creativity in lifelong education of teachers”

	<p>Aggrement about project realisation (September and October 2008) Seaminar (19th September 2008) Enabling participants for using Moodle</p>
	<p>Initial videotaping and anlysis of teaching (November and December 2008) Critical friendship within learning communities and Moodle system</p>
	<p>Detecting and defining action reasearch problems (until the end of December 2008)</p>
	<p>Planning (January 2009) •Seminar for all participants (8th January) •Planning (individual, within learning communitiesu and over Moodle)</p>
	<p>Realisation and monitoring of changes (Februrary, March, April) •Realisation of planned activities •Keeping research diaries over the Moodle system •Critical friendship (in learning communities and at Moodle) •Data gathering (videos and photos of teaching, questionnaires, interviews etc.)</p>
	<p>Writing reserch reports by using Moodle (May, Jun, July 2009) Presentation of action research projects at the conference in Požega (September 2009)</p>

As we tried to encourage our students' creativity, within the subject Technical Education, we realised that teachers' creativity⁷ is equally important, not only in preparing and leading the teaching process, but also in undertaking the research. We consider that action research is a creative process, which cannot be reduced to following prescribed stages. Instead, it is important to adjust it to the abilities and needs of participants, primarily our students, as well as to the specific educational situation, which we intended to improve. In this sense our action research methodology is open-ended, developmental (McNiff & Whitehead, 2006, p. 30) and innovative (Dadds & Hart, 2001, p. 166). We tried to avoid methodological orthodoxies with the aim of developing self-confidence in our creative powers:

Methodological orthodoxies, be they old or new, may run the risk of turning research into a technical enterprise, in which practitioner researchers may come to adopt what they believe the institution values, rather than what their own situational creative judgement deems appropriate. Methodological orthodoxies may also run the risk of new researchers becoming dependent on the views of the research institution within which they are studying, rather than developing confidence in their own creative powers. Practitioner researchers may thus end up seeking to serve the institutional research agenda, rather than serve the needs of their research. (Dadds & Hart, 2001, p. 169)

Our creative approach was recognisable as we adjusted our initial plan to the needs and interests of students, worked on developing our own creativity within our learning community, utilized reflective approaches in our online learning community, and structured a research report in which we firstly presented the process of researching our practice to improve it, and then interpreted it in a separate chapter. By disconnecting the presentation of data and interpretation we would like to allow our readers to develop their own interpretations, and then to compare it with our understanding and explanation of the whole process.

4. The process of doing our action research

In spite of the fact that students were able to create various technical products it did not help their creativity. In fact, at the beginning of the school year students were given a box for Technical Education with the necessary material for the creation of objects drawn on their work sheets. I (Sanja) offered a product that was half-completed where their originality could not be shown. The students created most of the objects following a scheme but this did not give them the opportunity to show their own creativity. I wanted to change such an approach and enable them to be creative while they produce their objects. Maybe an innovator lies hidden in some of them.

⁷ Runco (2007) points out that "educators need to do at least three things if they wish to support creativity in their students:

- (1) Provide opportunities for children to practice creative thinking.
- (2) Value and appreciate those efforts.
- (3) Model creative behaviours themselves."

4.1. The challenge of my action research

Verica videotaped one of my lessons with my video camera on November 2008⁸. It was a traditional Technical Education lesson (video <http://www.vimeo.com/2610633>). I began the lesson revising earlier finished lesson contents from the lesson unit *Materials* using conversation as a method. Then I showed my students the educational film “Metals”. I presented new lesson contents - characteristics of metals, by lecturing. Afterwards I divided the students into groups where they carried out experiments testing metal characteristics by using a work sheet. I tested the learned content with a knowledge quiz at the end of the lesson. I thought that the lesson was creative and I was encouraging the students to think about how they could examine metals on their own. The more I watched the recorded video, analysed it, and talked to critical friends, especially to our pedagogue Verica, I realised that I did not enable students’ creativity. I recognised that the student was not in the centre of my teaching and that such an approach did not enable students to be creative. I become aware through discussion with my critical friends, particularly with Verica, that I was a living contradiction (Whitehead, 1989).

As a consequence I decided to change my teaching practice and continue to research to understand and explain my educational influence. In order to do this I stated the following question: *How do I enhance imaginativeness, creativity and originality of ideas and products in Technical Education lessons?* I wanted to use the production of pincers as an example, to introduce students to design, provide them with the opportunity to create imaginative works and to enhance their entrepreneurial spirit. Trying to enable students’ imaginativeness, creativity and originality in creating pincers I stated the following criteria: students independently invent their own pincers; sketch their ideas; make the technical drawing; and then the object itself using the respective tool; students state different possibilities of using pincers.

I planned to do activities with students to enable them to:

- create ideas using some of the creative techniques like provocation, brainstorming (Starko, 2009), six universal questions (Ibraković & Bognar, 2009);
- make an activity list⁹;
- produce a technical drawing on the basis of sketch and copying it onto the material (tin);
- independently manufacture an original, usable object according to the activities identified on the activity list;
- present their finished work and propose ideas as to how to use the final products in practice;
- devise a class installation made of pincers;
- present the installation in the school hall.

⁸ I asked parents to give their written agreement to videotape lessons.

⁹ Phases of Individual work are listed in the activity list. Particular phases are shown as pictures, schemes or photographs and when needed are additionally described. (Bartolić, Marenčić & Paleka, 2007, p.51)

I planned to gather data by photographing students and their activities during every class, videotaping classes several times during action research, keeping a research diary on the web forum (<http://kreativnost.pedagogija.net>), using evaluation sheets, interviewing students and through cooperation with critical friends in person and on the forum.

4.2. Students change the plan – the agreement

During the Technical Education block-lesson (two lessons in a row) on 23rd January 2009 I presented my action research plan. Since students did not completely accept it I offered them the opportunity to specify different ideas of what they would like to do, using the technique of writing down ideas (brain-writing¹⁰). Students said they would like to omit technical drawing from the plan and just stick to the creating pincer's scheme. Certainly, without taking into account students' opinions my orientation to student-centered teaching would be in question; therefore I decided to respond by accepting their opinions. My critical friend gave me support through the Forum:

I liked the fact that you presented your action research plan to your students and so gave them the opportunity to think about it and to input their changes. Action research is collaborative activity and it is very important to hear students' voices too. The agreement with students is necessary. (V. Kuharić-Bučević, personal communication, 24. January 2009.)



Image 3. Students create the poster with the action research plan

¹⁰ Brainwriting is a method of writing down thoughts for “solving problems which are not narrow (professionally orientated) nor too closed (with a small number of solutions)” (Srića, 1994, p.43).

Having Technical Education classes every second week I made an arrangement with my students that I would analyse their ideas from the brainstorming and that we would discuss the plan changes during the next class teacher's lesson (27th January 2009), which I planned to use along with the technical education classes to finish our work on the action research plan. The students accepted this suggestion and on the 6th February 2009 our plan was completed (Image 3).

The image 3 is intended to show what we are meaning by student-centred teaching which contributes to developing creativity. This image shows a very different practice to that in the initial video (<http://www.vimeo.com/2610633>). The space and relationships have changed to emphasise the importance of cooperative learning with the students and to permit and encourage the active participation of learners. This is consistent with the approach that Verica has taken to support teachers developing their professional practice as can be seen in image 2 and video (<http://www.vimeo.com/2612901>).

4.3. The process of action research – realisation

The process of arranging during the Technical Education block-class started on 23rd January 2009. At the same time we started some activities from the unfinished plan. I was interested in students' answers to the question "How many uses can you come up with for a pincer?" Students were asked to write down as many as possible ideas for using a pincer and to explain them. Students had ten minutes to write down their ideas and until the end of the lesson to elaborate them.

After analysing their ideas (Image 4) I found out that twenty students produced 192 ideas (one student was missing at school that day). Student I.Š. achieved 4 ideas which is also the smallest number of ideas per student. Student L.M. achieved 18 ideas which is the biggest number of ideas. Student N.R. produced three original ideas.

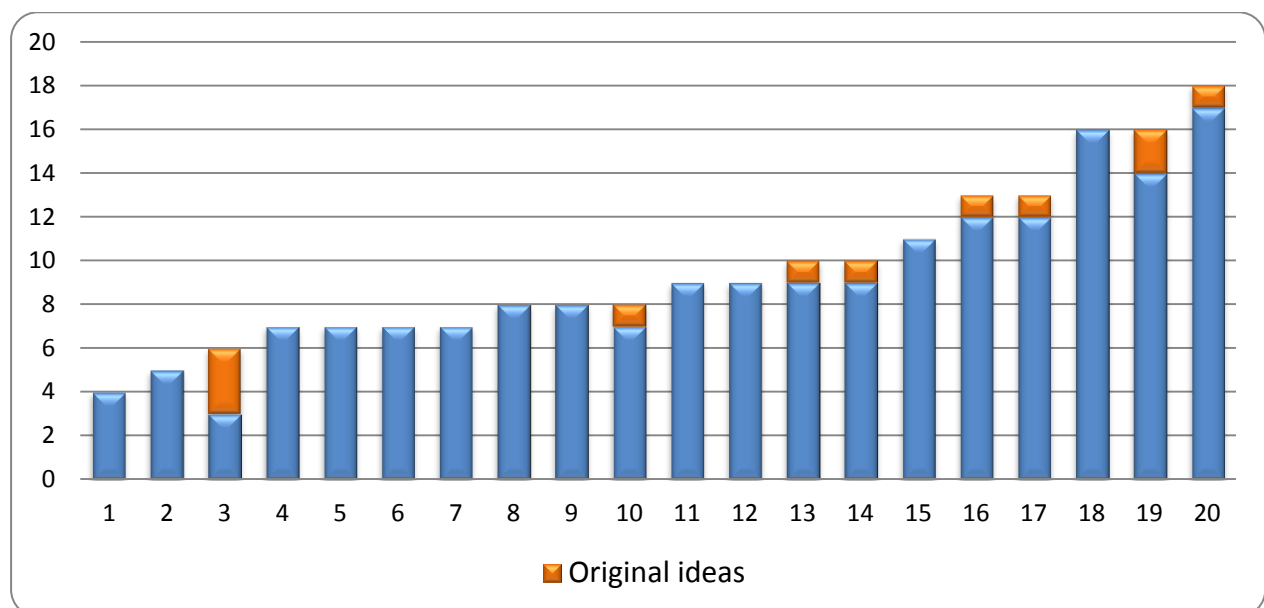


Image 4. "How many uses can you come up with for a pincer?" (fluency and idea originality)

The criteria for validation of originality was based on the work of Treffinger et al. (2002):

- the originality was not noticed - the usual pincer usage
- the originality is visible - the usual pincer usage in new circumstances
- the originality is distinctive - a new way of pincer usage.

I selected some distinctive original ideas:

- for catching flies not to bother you when they jump (L.M.)
- to take out contact lenses (K.M.)
- to take out the hook from the fish mouth (N.R.)
- to put larva on the fishing hook (N.R.)
- to mend boats (N.R.)
- to close zippers (A.S.)

I expected that elaboration of students' ideas in the previous activity would help them to devise their own pincers. Since this did not happen, I offered them the creative technique of *six universal questions*. With the technique of six universal questions it is possible to clarify a problem someone wants to solve by answering on all six questions: what, where, when, why, who and how. I assumed that the asking questions would stimulate students' thinking processes and lead them to the solution of the problem. The questions were written in the circuit scheme with answers to the questions and the picture of an imaginary pincer (I symbolically called the way to the solution "Make the light bulb glow"). Some students succeeded, some didn't. This showed that the creative techniques did not produce the expected result.

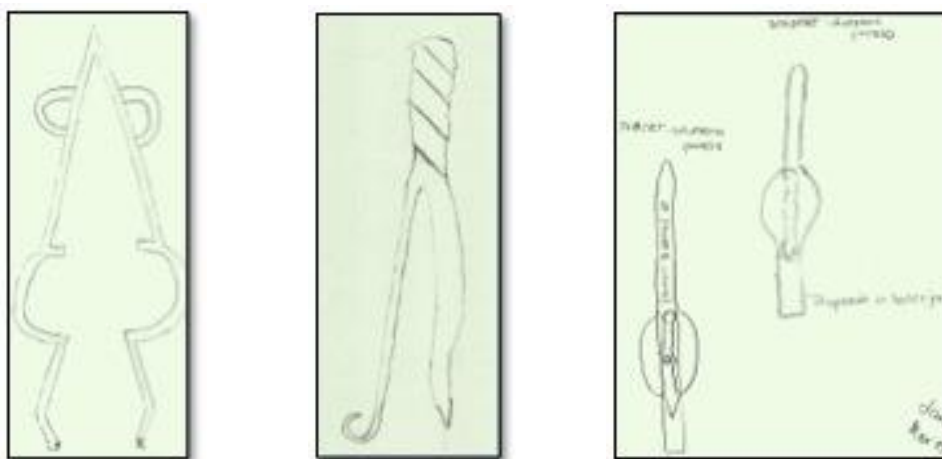


Image 5. Pincer schemes

Only after I suggested a new activity - sketching the imaginary pincer (Image 5) did I realise that I was on the right track. I saw the first really imaginative ideas and I was relieved. Some interesting schemes began to emerge. I described my feelings in my research diary:

I only began to feel relieved when they started to draw the scheme because I saw that neither my students nor I knew what to expect and that we were learning slowly and finding solutions together. The schemes were fantastic; I was surprised by their ideas. (Research diary, 27th January 2009)



Image 6. Students' portfolios

I opened a portfolio¹¹ for each student (Image 6) to put their work inside and they used it for their schemes¹². I offered several students the opportunity to elaborate their ideas through a short interview at the end of the lesson. My critical friend Verica videotaped the interview (<http://vimeo.com/5448157>). Student L.M. elaborated her idea in the following way:

So... this is my pincer. It is used to take out small things, tiny things. Here is a battery, let's say that here will be a plug connected to the battery. It will be turned on by pressing this switch. So, this on the side is the pincer's handle when something has to be taken out. Then, here is the battery's space. Here is the pincer's name. I imagined it a bit longer because it should be used for things which cannot be reached with your arm or another object. Here it is shown from the side and here from the ground. (Personal communication, 23. January 2009.)

¹¹ Students' maps (portfolios) are folders where students put their works and they are useful for self-evaluation of someone's improvement.

¹² Some students took their schemes home in order to work on them. They brought them back and put them in their maps for the next technical education lesson.

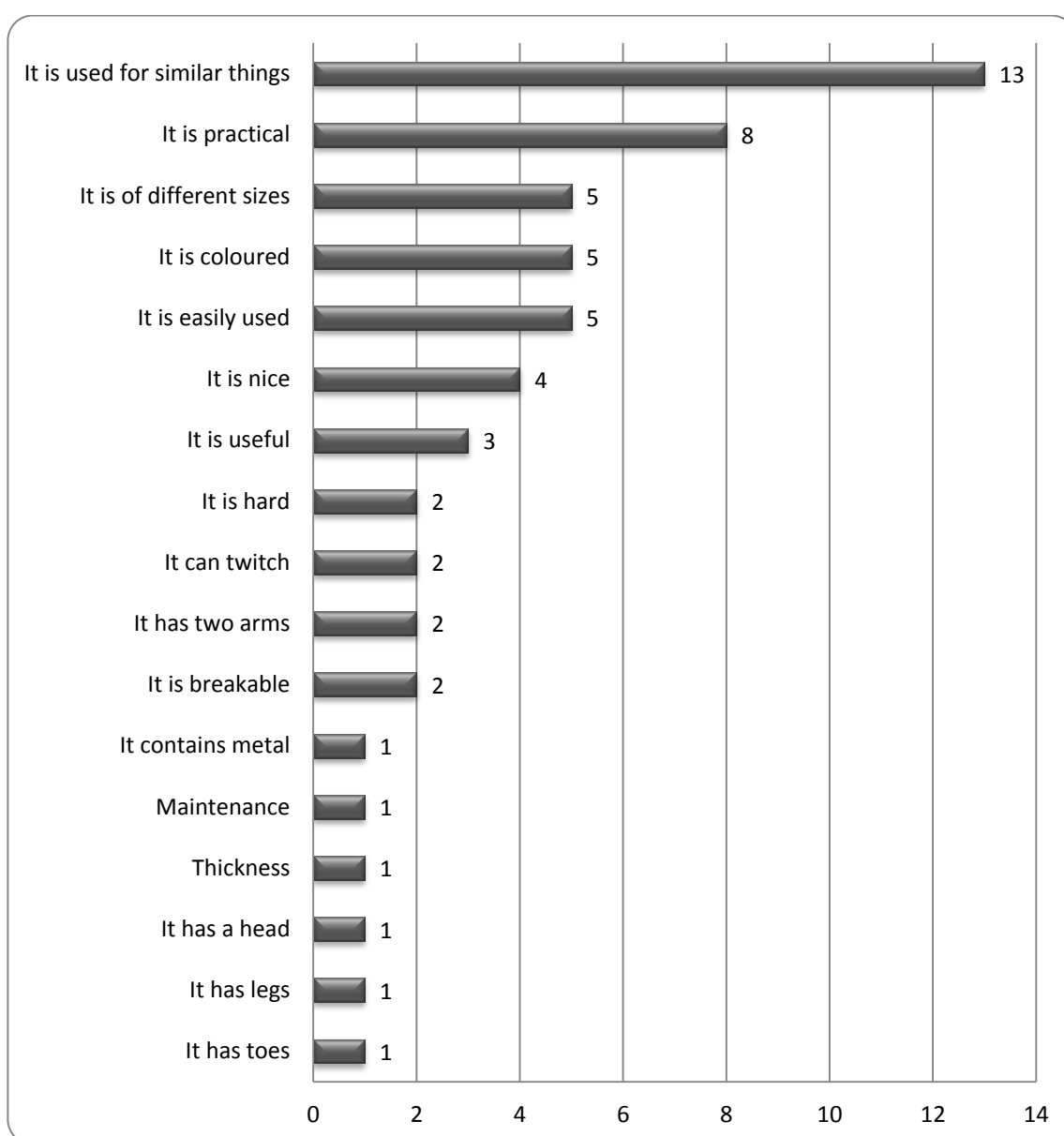


Image 7. Similarities between humans and pincers – students' associations¹³

I conducted another activity in which students had to list as many similarities between humans and pincers as possible during the next block-lesson on 6th February 2009. I considered that free association would help students to find or refine their solutions. The results can be seen in Image 7.

Students asked diverse questions about the manufacture of pincers after this activity. Each student was in a different stage of creation. I realised that each student developed their creativity at their own pace that required me to be flexible and understanding. My critical friend gave me support: "The psychological safety you give them is very important in

¹³ A total number of 18 students participated in observing similarities between humans and pincers.

achieving psychological freedom, and that is playing with ideas. It is nice to read about partnership between students and the teacher during classes.” (V. Kuharić-Bučević, personal communication, 7th February 2009)

Some students could not wait for the next Technical Education classes to start. They developed their ideas and they were keen to share them with me. Student M.G. looked for me in school on 10th February 2009, and showed me his work which was saved on a memory card. He made a pincer model in the programme Google SketchUp (<http://www.sketchup.com/>). I wrote in the research diary:

I am in a real dilemma now. We will get the materials, but then what? How to put all of this together, because he had a real technical idea which is really hard to realize, but it doesn't mean that it isn't possible. The idea is original, and I am glad that M.G. is so interested in techniques and that he came up with his own pincer. But, I don't know how to do it without the right tool and the right ways of assembling it. (Research diary, 10th February 2009)



Image 8. The evaluation of ideas

We spent our next block-lesson on 20th February 2009 trying to figure out how to make a pincer. It is called an activity list¹⁴ in Technical Education. I offered them the opportunity to create their activity list in form of a mind map. By creating the activity list students were ready to realise their ideas, to make a pincer. However, before that we agreed on how to evaluate the completed products (video <http://vimeo.com/5448328>). I used the *solo-brainstorming*¹⁵. Students wrote down what they would like to evaluate. All the individual ideas were written down on the blackboard. Previously students did not use

¹⁴ Some students took their schemes home in order to work on them. They brought them back and put them in their maps for the next Technical Education lesson.

¹⁵ The solo-brainstorm is an individual method which gives an individual a frame to stimulate the personal creative thinking and a better problem solving. (Srića, 1994, p. 43)

the blackboard often. Since the teaching in this project was more oriented to students they used all available devices in the classroom. After the idea evaluation (Image 8), students pointed out the elements of evaluation: the input effort, creativity, neatness, preciseness, originality, presentation and adaptability.

Students created smiles for evaluation while working in groups during the class teacher's lesson (23rd February 2009). They predicted five faces of feelings for each category of evaluation. I wanted the students to move away from the traditional way of giving grades (grades from one to five), but their five degrees still looked like the usual way of grading. We agreed that they would work on the feeling faces at home on their computers (Image 9).

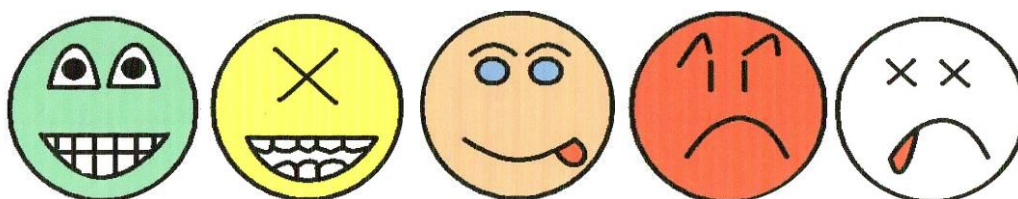


Image 9. Faces showing feelings created on the computer used for the evaluation criteria

Students thought deeply about how to create a pincer and they would stop me in the school hall to ask me how they could solve problems which came up in their thoughts because the Technical Education block-class is every second week. Branko Bognar suggested opening a designer forum¹⁶ where they could ask questions. In spite of the possibility to ask their questions on the electronic forum, students kept on stopping me in the hall. It thought it might be that they found it easier to ask me "in person" than to write to me on the forum.

All students had activity lists for the block-lesson on 6th March 2009, so they could finally start with the making of their pincers. They were full of questions because they met numerous problems, which they couldn't solve on their own. I wrote in the research diary:

Students worked on their pincers in a hardworking manner, and my role was not too big, but yet again significant to get tired. Of course, some students couldn't transfer their idea to the sheet-tin because they didn't draw the technical drawing so a lot of stuff came up. But I helped them when they couldn't go on. (Research diary, 6th March 2009)

¹⁶ A designer forum (at <http://kreativnost.pedagogija.net>) was a place where students were able to communicate with the teacher and amongst each other during the action research project.



Image 10. How we produced the final product

Students continued to make their pincers (Image 10) during the block-lesson on 3rd April 2009. My role was reduced to occasional help when students asked for it and photographing. Finally the first products came up (Image 11).



Image 11. Examples of finished students' pincers

4.4. Evaluation

While students finishing pincers I conducted a short interview with a random group of students – those who pulled out a card with a pincer picture (<http://vimeo.com/5464767>). I wanted to find out how they liked the Technical Education classes since we started action research.

Sanja: Tell me Z. how do you like this kind of work during technical education classes?

Z.K.: Good, because we all work together and this pincer... this, we can work on our own and what we want, we can make up how we want it and this is what I like. So... we have our own ideas and we do what we want. (Personal communication, 6th March 2009)

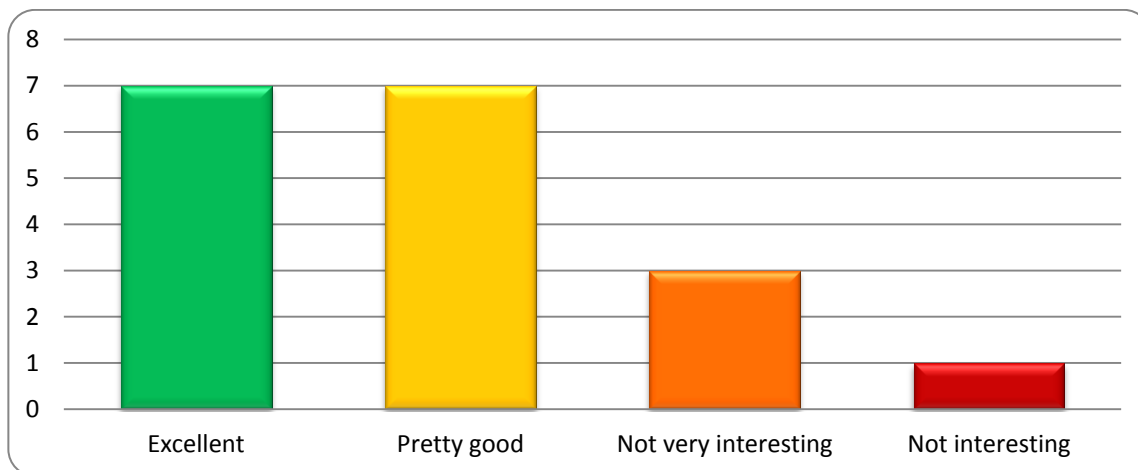


Image 12. How students experienced the lesson of technical education

All students (n=18) filled out evaluation sheets at the lesson's end. It can be seen from the evaluation sheets that most of them felt that the lessons were pretty good or even excellent (Image 12).

It was planned that students would present their products. The presentation was envisaged as a commercial promotion of the final products (<http://vimeo.com/5487389>). The finished PowerPoint presentations were put on the designer forum. Some students showed how they developed from the initial idea to the completed product in their presentations, and only a smaller number of students used the presentation for the commercial promotion of their products. This lesson was fun and we had a good laugh.

Students carried out peer-evaluations during the presentations using the agreed evaluation criteria (Image 9). The student's form of evaluation appeared to be deficient. They pointed out during the conversation that it was very difficult for them to evaluate the process of the products making because they were not able to observe each other. They could only evaluate the final product and presentation. They didn't draw the smiles instead they turned them into grades from one to five. I wasn't satisfied with that because we had agreed earlier how to evaluate but I let them proceed. It was evident that they weren't critical while evaluating each others work. This is seen in the way they awarded each other the highest grades. We also used the self-evaluation criteria. Some of the students were missing self-criticism and graded their own work with the highest grades. I agreed with some of the students' evaluations but I did not agree with others and I wanted that self-evaluation focus on improvement of their learning.

4.5. What has changed?

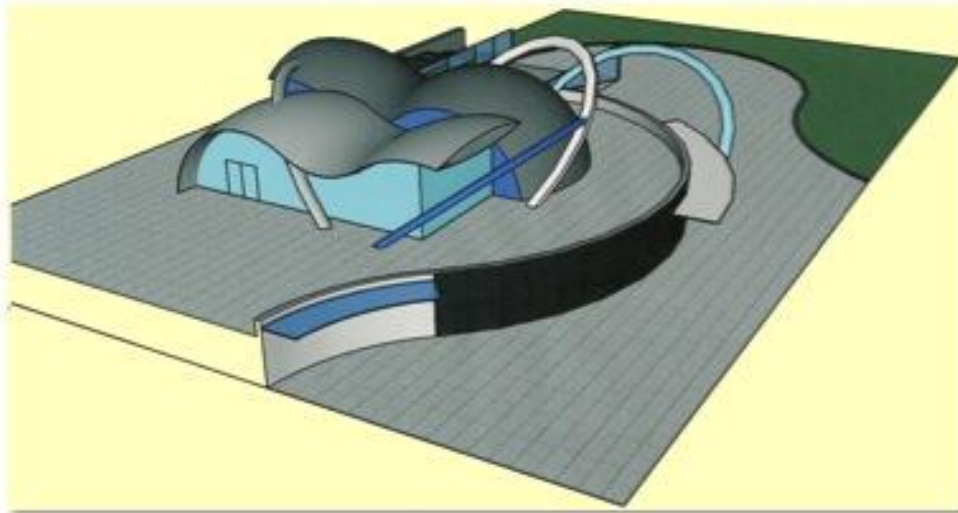


Image 13. Design of building design by student F.M.

In the video (<http://vimeo.com/5487550>) I can see evidence that students were free and independent while they worked on their products during the Technical Education lesson. For instance, most of them were focused on their work and they did not ask me for any help. While they created pincers it was possible to hear background music, modest murmur, giggling and noise of sharpening materials. All of that indicated a teaching atmosphere in which students were free to talk, move and express themselves creatively. Their interests expanded over the planned contents of Technical Education classes. Some students started to get involved with Technical Education contents in their free time, for example, student F.M. who started to design various objects of buildings on the Google Sketch Up with the intention to make models for them and to apply them for the technical education exhibition (Image 13). I.M. got interested in car models and we often talk about their making outside the class. M.G. started to build constructions. Some girls also showed more interest in technical education, for example Ž.H.

This process helped me to question my own role as a teacher and what was expected of me. From the traditional lecturing and the making of identical practical works, I directed my teaching towards students' needs and interests freeing their creative potentials. In this way I also freed my potentials for the creative planning of the teaching process. After this experience, there have not been identical students' work during lessons, and I continue to encourage my students to create their own original designer works. My relationship with students also changed and is now based on making agreement.

I felt odd during some classes because I had to do almost nothing, except to photograph or to videotape. Now I am convinced that it was the best evidence that the action research approach was working.

4.6. Problems which we faced

The first problem noticed during the research was the schedule of technical education lessons, which were held every second week lasting one block-lesson (90 minutes). Due to this schedule only six block-lessons were planned (23rd January, 6th and 20th February, 6th and 20th March and 3rd April 2009). The two-weeks-gap between Technical Education lessons was too long which I tried to compensate with class teacher's lessons (this occurred twice during the research). It was necessary to find the right balance for students of their involvement in my research and providing some other contents from the given curriculum during the class teacher's lesson. Using the class teacher's lessons wasn't the best solution. A better solution would have been to enhance the communication between students and teachers on the open designer forum.

The second problem I'd like to emphasise was about the peer-evaluation and self-evaluation process. Students had previously been taught to evaluate their final work and give a correct answer. They didn't manage well with the observing and evaluating a creative process, which led to diverse solutions and they didn't have experience of evaluating original ideas. Students didn't know how to evaluate the process and they weren't critical in evaluating other works. It might also be that they are of an age where it is important to them to stay in friendly relations with peers and not to appear critical.

The third problem was the behaviour of some students. Two students understood the term freedom to mean there were no limits and they could behave in anyway they wanted. Those students weren't easy to handle during lessons, but there were moments when they took part and then I'd be happy because I thought they were interested in the activity, but the very next lesson they disproved my hope. They disturbed the whole class. However, it was interesting that it didn't bother the other students, who were deeply involved in their own activities, too much.

5. Interpretation

In Croatian pedagogical literature the educational process structure is described in different ways. Poljak's (1980, p. 53) articulates the five stage process that takes place in most Croatian schools: 1) preparation, 2) working on a new educational content, 3) practicing, 4) repetition and 5) assessing. In such an approach to teaching emphasis is put upon the role of teacher and a student's responsibility is reduced to participation in pre-prepared activities. Although students are expected to be active learners they are not allowed to decide about aims, methods and contents of their education. Through conducting this action research study it appeared that this does not enable creative lessons to be provided because only the teacher is in a position to decide what will happen in the lessons. I found that teachers and students working together through an educational process structure, which contains three stages: *agreement, realization and evaluation* (Bognar & Matijević, 2002, p. 203), was a much better solution. This shift did not mean just using different terms for the same teaching processes. It represented a completely different approach to teaching, which was more student-centred. Although this didactic approach still is not dominant in Croatian schools it was influential in the project in which we participated.

5.1. Agreement

Hart (1992, p. 8) gives eight stages of student involvement, which is represented in Image 14. The students' participation in our schools usually exists in the first three stages, which shows their non-participation, that is students are manipulated, students are used as decoration or they symbolically participate (Staničić, 2006, p. 326). In our case, students are consulted and informed about the plan. The decision about the introduction of the action research plan didn't include the conscious need to include the students in the planning process. Such an approach was mostly influenced by the previous teaching process structure where teachers usually do the planning. However, by introducing my plan to students I, as teacher, opened the path to agreement. When students rejected some planned activities I offered the possibility of "brain-writing" where they could show what they agree with in the plan, what they would like to add, and what they would like to exclude from the plan. Instead of imposing the teacher's plan, students were offered an agreement.



Adapted by Adam Fletcher from Hart, R. (1994). *Children's Participation: From Tokenism to Citizenship*. New York: UNICEF.

Image 14. The ladder of student involvement in school (Fletcher, 2005)

Students were able to freely expose and exchange their ideas by eliminating the time limit from the agreement stage. We supposed that students, who were allowed to create and learn in their own way and who had psychological freedom (Rogers, 1961, p. 358), would be more ready to express their creativity. Thus, the stimulation of students' creativity required a different structure of the educational process. In other words the educational process should be a mutual activity of students and teachers. The mutual activity supposes an agreement between participants.

The agreement is the first stage of the educational process, which enables the enquiring students' educational needs to be planned and prepared for. "The content and activities are partly defined by the curriculum, but in the agreement stage they are made more concrete and are transformed due to the interests and needs of the participants in the educational process" (Bognar & Matijević, 2002, p. 203). The agreement is an important precondition of the students' real involvement in learning which is the intention of the teaching process. According to Hart (1992, p. 8) at the higher stages of students' involvement the agreement is presumed between children and adults and in our case students and teachers.

Besides that, the active role of all participants, including students, is presumed in action research too (Bognar, 2006, p. 182). Including students in the action research planning we contribute to its democratisation. We avoided treating students as objects for research, but as autonomous and creative agents, "who participate actively in making their own histories and conditions of life, able to be more effective in making their histories and conditions of life by knowing what they are doing, and collaboratively constructing their collective history and conditions of life." We encouraged students "to work together as knowing subjects and agents of change and improvement" (McTaggart, 1996, p. 39). This could include the creation of their own living educational theories (Whitehead, 1989; Huxtable, 2011) as they explain their own learning as interdependent yet autonomous and creative agents in becoming action researchers in their own learning (Bognar & Zovko, 2008).

5.2. Realisation

Realisation is the teaching process phase which continues from the agreement. It presents the middle stage in which the educational aims are realised (Bognar and Matijević, 2002, pp. 208-216). This stage should also be focused on students' individual capabilities. Activities agreed on in the previous stage are owned by the students and then become the activity carrier at this stage. The teacher's role was to coordinate and to help.

In addition, this stage represented the creativity process which should enable students to create ideas and products. According to Wallas (in Ozimec, 2006) the creation process consist of several recognizable phases:

1. preparation
2. incubation or the internal maturing of solutions
3. illumination or inspiration
4. examination or verification

In this action research each phase of creative process could be recognised in the realization phase.

The preparation phase is the beginning of the creative cycle (Ozimec, 2006, p. 330). In our case students were supposed to invent (design) the original pincer. According to Dryden and Vos (2001, p. 191) for creative problem solving to happen we have to surpass the usual ways of thinking, that is, open new ways and discover new relations. Creative techniques were used in order to enable students to think about their future product – the pincer, i.e. helped them to create ideas. The techniques were used for the stimulation and the

development of students' creative potentials and they were used as individual methods of creative thinking.

Students were asked to generate as many as possible uses for a pincer with the aim of enabling them to notice and formulate the problem and to search for solutions. The next technique, which was used to prepare students for the problem solving, was the technique of *six universal questions*. Students tried to clear up the problem which they wanted to solve by answering the questions what? where? when? who? why? and how? Although it seemed that the techniques didn't give the final results – creative ideas of pincers, they contributed to a “free idea associating” which students subconsciously combined ideas during the incubation phase in order to solve the problem. It seems that the creative techniques we utilised in this research contributed to at least two recommendations for developing creativity in children: “1) Foster an environment in which a child feels safe and comfortable to express ideas that are unconventional... 2) Encourage independence in problem solving, keeping in mind the principles of optimal challenge and frustration” (Russ and Fiorelli, 2010, p. 245).

After the intensive search for the problem's solution comes the *incubation phase*. In this phase the active search for the problem's solution stops which in the creative process indicates an interruption of external activities and the activities transfer to the internal plan (Ozimec, 2006, p. 331) while the unconscious processes continue. Čudina-Obradović (1991, p. 58) emphasizes that in the incubation phase the domination of the brain's left side stops¹⁷ and intuitive assumptions, which were generated during the preparation, freely combine with each other, that is the brain's right side task¹⁸.

In this case, students stopped dealing with the problem consciously and tried to find subconsciously a solution to the problem when the technical education block-lesson ended. Some students sometimes needed to share their possible solution of the problem with the teacher without having technical education classes. It is important to point out that teacher's availability and her openness to students' ideas were necessary to satisfy students' needs. Therefore, it is not correct to envisage an incubation phase as merely intuitive and unconscious process. Actually, in our case it was the evolution of slow hunches. Johnson (2010, p. 75) emphasises that for developing those hunches in productive solutions it is important to provide a supporting social environment – a creative network.

The question is how to push your brain toward those more creative networks. The answer, as it happens, is delightfully fractal: to make your mind more innovative, you have to place it inside environments that share that same network signature: networks of ideas or people that mimic the neural networks of a mind exploring the boundaries of the adjacent possible. Certain environments enhance the brain's natural capacity to make new links of association. (Johnson, 2010, p. 47)

Through discussions with each other and with the teacher, students were enabled to gradually move from the incubation phase to the illumination phase. *The illumination phase* is the phase where “the whole problem is revealed and the final solution is found” (Ozimec, 2006,

¹⁷ The brain's left side is specialized for a logical, successive work on information and it deals with verbal, analytic and abstract material. (Čudina-Obradović, 1991, p. 54)

¹⁸ The brain's right side synthetically works on information, non linear, whole, working on different kinds of information at the same time. (Čudina-Obradović, 1991, p. 54)

p. 333). A lot of people call it the fruit-bearing moment and it represents the total effort used in the problem solving. Students reached their fruit-bearing moment when they made the pincer's schemes which were unique original solutions (Image 5, Image 11). However, it is not good to expect that those students' products will show "high creativity", "to have certain characteristics, such as innovation/novelty, excellence, recognition by the field within which it takes place and a break with past understandings or perspectives" (Craft, 2001, p. 46). Craft argues for "little c creativity" which involves innovation and development. She believes that little c creativity "can be fostered, indeed that children need to be initiated into it, and thus that there is an important role for education to play here" (Craft, 2001, p. 59). Our action research provided opportunity to students to express their creative potentials and to create for innovative products, which for some may lead to the high creativity in technology design.

Verification phase or examination phase is the last phase of the creative work cycle. The solution's real value and viability are examined in this phase. It is important to give the students the opportunity to elaborate their ideas, i.e. to examine the solutions. Students were enabled to make their activity lists in the form of a mind map for this purpose. They should have predicted the activities (operations) to be done to reach a creative product using their activity lists. Creating the activity list students examined their solutions, thought about them in a critical – logical manner and when needed further worked on them. Students started to draw their future products and all the activities predicted by the activity list only after the examination. According to Torrance (as cited in D. Cropley & A. Cropley, 2010, p. 311) this represents the *communication of results*, i.e. expressing the creative results in an understandable form.

Students came up with a creative product at the end of the creative process. To reach a creative result according to Torrance (in Čudina-Obradović, 1991, p. 58) four elements are necessary:

1. *knowledge* (necessary for Wallas' preparation phase or Torrance's problem acknowledgement and information assortment)
2. *divergent thinking* (necessary for the set up of the hypothesis about possible solutions)
3. *critical – logical thinking* (necessary for the examination and the rejecting of incorrect hypothesis)
4. *communication skills* (necessary for the creative result presenting and explaining).

In traditional teaching the convergent way of thinking dominates. However, using creative techniques students' thoughts are directed to various possible solutions (divergent thinking). If we want to enable the student's creativity it's necessary to organise the lessons in a way which enables divergent and lateral thinking¹⁹ too. In our case students individually created their pincers. This was the reason why all the creative techniques during lessons are used individually. However, Srića (1994, p. 39) thinks that the most creative ideas result from different human interaction forms and that ideas of others can be used as an instigative "trigger". So, whilst it would be desirable to combine individual and group creative techniques in lessons this was not done in our action research.

¹⁹ "Divergent thinking is interested in multiple possibilities, just like lateral thinking, but this is only one aspect of lateral thinking... The term 'lateral thinking' is reserved for the specific techniques and tools that are put forward as a systematic way of getting new ideas and new concepts." (de Bono, 1992, pp. 55-56)

Traditional lessons don't allow students to question the truth of offered contents. It doesn't allow them to suggest different solutions but they have to repeat everything that is told to them. Otherwise, going in a different direction could disturb the teaching process. Having fun during lesson is often not part of the teachers' repertoire. Teachers can be "worried" about using creative techniques that can produce original ideas they can't recognise. The same happened for me (Sanja) in this research as I wrote in my research diary: "Honestly, the children wrote all kinds of stuff, maybe they did not take it seriously, so I am a bit disappointed" (S. Vidović, research diary, 23rd January 2009).

Teachers, who are focused on the official curriculum in their teaching process, expect the students to give one correct answer. They may not be comfortable with students giving alternative answers and as a result may give up trying to enable students' creativity. However, it is important to know that all people, including students, at the beginning use already existing solutions or analogies while solving a problem (Ozimec, 2006, p. 329). So the students' inability to manage these techniques is a product of prior teaching. A question also comes up: who is more unable to manage? We can say that the inability to manage refers equally to students and teachers. The teachers weren't educated for creative work lessons in their primary education. Teachers often emphasize that students are not serious while doing the activities. Maybe the problem is that teachers don't assume creative activities are serious teaching activities, but see them as temporary additions to teaching. That's why it is important to educate teachers about the value of creativity as a human phenomenon:

At some level, education is a zero sum game; there are only so many hours in the day, so many things that can be included in the curriculum, so many ways a teacher can expend energy and focus attention. Time spent on topic or skill X means time not spent on topic or skill Y. This brings us to the compelling simple question: *Would we value educational creativity if we knew how to do it?* (J. K. Smith & L. F. Smith, 2010, p. 262)

Unfortunately, even when individual teachers understand the social and individual value of creativity they do not encourage it in their classrooms if it is not appreciated within a particular school culture and in a wider social community. Therefore, the place of creativity in educational settings is not only a private affair of a particular teacher, but it should be recognised at the level of the educational system. However, it would be wrong to say that teachers should wait until the system is changed. It is much better that they, along with academics, initiate projects as we did and to create authentic changes that are not merely applying "pre-packaged answers produced by government agencies, academics and various enterprises." Since "packages too easily become formulaic in their application and the essence of what was important educationally can be missed, lost or at worst destroyed, in the process" (Huxtable, 2012). Although single small grass-root project cannot change the system, a series of small changes/projects could contribute significant changes as it happened in the project Creativity|WORKS:

This project has enabled and facilitated a vast range of small changes to occur for a wide and varied number of people from different circumstances and backgrounds. Collectively these changes have produced positive ripples of influence in complex ecologies of informal learning environments. A series of small changes have occurred with individuals leading to larger significant and life changing experiences. In the ripples of affect and effect the participatory social engaged arts projects within Creativity|WORKS send out their own ripples of influence on individuals, groups and communities. (Henon, 2009).

5.3. Evaluation

According to Bognar (Bognar & Matijević, 2002, p. 217-225) evaluation can be external and internal. In a didactical sense internal evaluation is seen as more important and this is used to evaluate the realisation of goals. The educational process is evaluated by its participants – teachers and students. It is important to enable students to be able to self-evaluate, especially in terms of explanations of their own learning (Bognar and Zovko, 2008).

In the phase of realization students had the opportunity to monitor the realisation of individual goals. They monitored their own processes of creating ideas from the preparation phase of the creative process. Students evaluated their ideas, rejected them and/or created new ones while they were looking for the solutions of the problem. After reaching the problem's final solution and predicting activities on the activity list which lead them to the creative product, students observed the realization of their activities and when needed corrected them (self-evaluation). As students took responsibility in the realization phase for the creative product's making, the self-evaluation was necessary. Of course I, as the teacher, helped them with individual guidance.

Students could also use their portfolios for the formative evaluation. They put their works inside the portfolio during the realisation phase. Although the portfolios were always available to them we didn't notice that they used the portfolios too much to observe their own improvement during the realisation phase. If we wanted to enable students to observe their own learning and/or creative process it would be preferable to introduce them to the meaning and role of portfolios in the formative evaluation:

Perhaps the best reason to use formative assessment in the classroom is to involve students in their own assessment process. In a classroom where formative assessment is present, the learning cycle is transparent to students. Teachers explicitly share and refer back to learning goals and success criteria, and students think metacognitively about their learning—there is no mystery. Students are in a partnership with teachers with regard to their learning. With this partnership comes shared motivation and responsibility for what transpires during a lesson. (Pernisi, 2011, p. 179)

In addition to portfolios, regular teacher's feedbacks were very important for encouraging the creativity of our students. We noticed that students liked to talk with each other and with the teacher about their ongoing efforts to create pincers. It appeared that informal chats at school hallways during short breaks between lessons were a very important way of communicating with the teacher. It seems that such an informal way of communication better fits into creative processes than formal communication, which occurs during lessons. This required Sanja to change her teacher's role, from transmitting knowledge to active listening to students' creative ideas. Therefore, to encourage students' creativity it is much more important that the teacher is ready to listen to them and to provide positive, balanced feedbacks and opportunities to revisit ideas (Beghetto, 2013) on various occasions, particularly informal ones, than to teach them how to do something. Beghetto (as cited in Runco, 2007) discovered that "of all the variables included in the model, students' reports of teachers providing feedback on their creativity (that is teachers telling them that they were creative) served as the strongest unique predictor of students' creative self-efficacy" (p. 192). Beghetto (2013) suggests how this feedback might look in the classroom:

Provide the kind of evaluative feedback that not only attempts to build students' confidence in their ideas, but also helps students develop the self and contextual knowledge necessary to know when and how their ideas fit given the academic learning constraints, conventions, and standards of the particular activity or task. This involves providing students with multiple opportunities to revisit or resubmit their ideas in relation to the academic subject matter being taught (e.g., establishing a virtual or actual "idea dropbox" to allow students to elaborate on or resubmit ideas; using a portion of the chalkboard as an "idea parking lot" for ideas that are not fully developed but can be revisited, and a class notebook that includes an "idea garden" for new ideas and even an "idea grave yard" for ideas that have been put to rest in light of subsequent learning and insights). (Beghetto, 2013, p. 12)

The summative evaluation took place at the end of the teaching process. Students used it to see if they reached the set up goal and how they reached it. They should have evaluated the product's making process based on mutual grading criteria which were set up in advance. They graded each element according to elaborated stages (Image 10). Students agreed upon an analytical grading model²⁰. In this case, students evaluated the following elements through five levels expressed by Smiles: effort input, creativity, neatness, preciseness, originality, presentation and adaptability. Using "Smiles" for each evaluation element was similar to the traditional grades from one to five, which they turned to at the end. Matijević (2004, p. 67) points out that children come to school unburdened with grades, but they learn through the school system that their behaviours are stimulated with visible marks (school grades), which also happened in our case. However, creative work doesn't tolerate traditional grading (numbers or something else). It should enable each student's improvement according to their needs on the way to self-actualization. In this process of self-actualization students' works would be evaluated in relation to themselves, meaning that students' judgments would be their own most important criteria. One self-evaluating possibility is a students' map (portfolio).

Students noticed the disadvantages in the agreed way of evaluation by themselves. Being used to the evaluation of the final result, they didn't manage the evaluation of the process which led them to their product. Besides that, the traditional teaching practice often insists on one correct answer. Apart from that, more products (pincers) came up in this research for which students didn't have evaluating models to use. The students' inability to manage with evaluation is mostly the result of the fact that self-evaluation is often neglected in the teaching process. So, students should be offered lessons which would enable them to do something and (self)evaluate it at the same time. As long as the summative evaluation prevails at schools the extrinsic motivation of students will be preferred. In order to develop the intrinsic motivation with students, it is necessary to pay more attention to the evaluation of the learning and/or creating process itself. The evaluation and the self-evaluation of students' creativity in the educational process is definitely an area which has to be better explored. This should be possible as our action research continues.

²⁰ "Analytical grading is a grading model which is based on the analytical estimation of more variables in an educational curriculum. Assessor tries to select more variables (goals) trying to estimate each" (Matijević, 2004, p. 14).

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