Ways of Critical and Creative Thinking Development in Practical Training through Video-Study

Monika Valentová, Peter Brečka

Department of Technology and Information Technologies, Faculty of Education, Constantine the Philosopher University in Nitra, Dražovská cesta 4, 949 74 Nitra, Slovakia

Abstract **– Practical training is an integral part of training for any future profession. Improving and extending the practical training for future teachers, by strengthening the development of the required key competences oriented towards teachers´ critical and creative thinking, has been in the centre of attention in education in Slovakia. Future teachers enter the practice with many ideas on what is expected of good teaching to represent. However, their teaching style often lacks creativity, ability to assess or self-assess, as well as higher level of critical thinking when choosing appropriate methods and procedures. The objective of this article is to point out the application of observational video-studies, using the AAA method as a means of strengthening practical teacher preparation with emphasis on critical thinking development among educators in technical subjects. This paper is a follow-up to the previous study ´Implementation of Critical Thinking Strategies in School Subject Technology: A Preliminary Study´.**

Keywords **– video-study, AAA method, critical and creative thinking, technical education, teacher, pupil**

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Corresponding author: Peter Brečka ,
Department of Technology and Information Technologies, Faculty of Education, Constantine the Philosopher University in Nitra, Dražovská cesta 4, 949 74 Nitra, Slovakia.
Email: pbrecka@ukf.sk

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1. Introduction

Recently, the ability to think critically and creatively, has represented a key competence in almost all spheres of human life, including education. The two concepts of critical and creative thinking are closely related. While critical thinking is the prerequisite for reasoning, analysis reflected in research, using an interpreting information, creativity builds on these activities. A critically thinking person is a creative individual characterized by a quick flexible and divergent thinking. They most likely possess the ability to solve problems, transfer experience, knowledge and create something original, unique and useful. Both concepts have been amongst the main objectives of education in Slovakia, as it arises from the national educational program. The requirement of critical and creative thinking is emphasized mainly because of students´ repeated failures in international knowledge measurement OECD, PISA. The main reasons for these failures are:

- Insufficient pre-gradual training - recent extensive research in Slovakia has confirmed that the level of students´ higher cognitive skills is average, in assessments even below average [1];
- Disappointing results in teachers´ self-assessment, which show that teachers attach much more importance to the strategies for critical and creative thinking development in technical subjects compared to how often they apply them practically [2];

The above-mentioned factors are the main causes for this shift in university education regarding the future teachers'. This shift has put critical thinking on the forefront of future teachers' training, which combined with high-level didactic materials and practice will contribute to developing critical thinking in children and pupils [3].

One of the most relevant issues in pre-gradual students' training has been the development of their psycho-didactic competences in implementing

adaptive teaching practices and strategies with emphasis on building pupils´ knowledge. These are the strategies stimulating critical and creative thinking among pupils.

From this issue the main objective has arisen of APVV project, oriented towards identification of adaptive teaching strategies with application of cognitive oriented approach for developing critical and creative thinking of pupils, as well as further psycho-didactic topics and didactic strategies of particular areas, and their implementation in pre-gradual practical training of secondary level teachers through Centre of Practical Training [4]. Previously, this project examined the level of critical and creative thinking strategy implementation in technically oriented subjects. In the second phase, critical and creative thinking strategies for technical subjects were specified and based on the research results.

At present, the project is in the phase of creating methodological materials in the form of audio-visual didactic situations and strategies for teaching technically oriented subjects, supported by in-depth analysis - observational video study [5] using the AAA methodology.

2. Application of AAA Method in Video-Study Analysis

Lesson observation represents an integral part of training, as it offers the opportunity to assess, as well as, to improve teaching quality based on observation outcomes. The principle of video-study observation lies in the in-depth video footage analysis of a single or several educational situations. The results of several studies [6], [7], [8] show that video footage can be a particularly highly effective educational tool, thanks to which teachers can actively improve their learning styles, habits and self-reflection. Watching yourself or other teachers and reflecting on learning strategies has great potential to improve teaching efficiency, even in pre-gradual training.

We conducted our observational video-studies using the AAA methodology, which consists of three steps:

- Annotation- represents a brief description of the lesson or part of it, focused on the set objectives, topic, teacher and pupils´ activity content, continuity of the curriculum and applied teaching aids.
- Analysis- researches the teaching strategies applied by the teacher in order to achieve the set teaching goals, in our case with emphasis on developing critical thinking in pupils.
- Alternation- is a hypothetical suggestion aimed to improve, modify or change the learning situation associated with discussion [9].

We know from experience that students are more intuitive than deliberate and purposeful when planning teaching strategies. Applying strategies is the most effective when students are provided a model that they can critically assess or suggest their own alterations for improvement. Therefore, both practising teachers and future teachers, who have previously realised micro-outputs in their university or practical training, took part in the video-study.

Through these, students acquire knowledge of how to plan and apply individual strategies for critical thinking development in teaching technical subjects, but also how to practise critical thinking in self-reflection, and finally how to design and improve their lesson planning.

3. Critical Thinking Development Strategies

Strategies represent methodological approaches that the teacher selects in order to meet the educational objectives in compliance with pupils´ learning styles and general requirements [10]. These are observable and measurable sub-steps or processes which, in a well-thought-out arrangement, constitute the overall process - strategy [11]. From the perspective of future teachers, it is essential to know that such learning strategies can be effectively used in the given study fields and subjects [3]. The following strategies have been specified for the area of technically oriented subjects:

1. leading the students towards acquiring basic user skills in various fields of human activity,
2. using various teaching aids,
3. using various technical materials and equipment,
4. creating situations that induce the need for new designs, application of product creation processes in order to induce creativity,
5. inducing experimentation with ideas, materials, technology and equipment,
6. small group activity application,
7. developing the ability within pupils to take responsibility for individual or group project results,
8. informing pupils about current labour market requirements and recent technology development,
9. shaping the teaching content according to B. S. Bloom's taxonomy,
10. project teaching application,
11. problem solving application,
12. applying methods for developing creativity [2].

In the following part we present examples of observational video-studies with application of the AAA method from the implementation of selected teaching strategies in preschool education, as well as, lower secondary education in the subject of Technology.

4. Video-Study – Strategy for Observation, Investigation and Technical Material Application Development

Annotation

Educational activity was realized with pre-school and elementary pedagogy students from Constantine the Philosopher University in Nitra as a part of methodological exercise of practical education. The educational activity was represented by a simulation of a real methodological output for the area Humans and the World of Work in pre-school conditions. The content of the educational activity was carried out with the emphasis on performance standards arising from the educational area Humans and the World of Work and the Sub-area Materials and Technology in order to:

- study and assort selected waste materials,
- investigate the strength, flexibility, permeability and plasticity of plastics.

The motivational story narration, which the teachers (students) chose in the beginning of the lesson, aimed to arouse attention and interest. It created a pleasant atmosphere in the classroom and informed pupils about the topic. The story was about journey to school through a park with a lot of garbage thrown on the ground. The teachers collected and brought some of it to school and presented them to children. The presentation of the materials also actively involved the pupils, since they were asked to answer a couple of questions: "Do these materials belong to nature? Where do you throw them at home? Do you sort waste materials?" The objective of the following activity was to revise and, at the same time, verify the level of knowledge previously acquired by the pupils in the field of material sorting. Teachers made sure each pupil was involved and that all waste was sorted. Pupils and teachers checked the correct classification of the waste together during the narration:

"Four masters, little, kind, settled in our town. Each has a colour assigned according to what they collect. Help them children, they only want garbage! Things no longer work can be reused. Yellow - plastic: yellow sun, yellow gold, yellow bin for plastic sin. Green - glass: Container with green lid with bright glass is filled. Blue - paper: which container will hold the paper which is old? Blue is as the sky. Grey - metals: trash container is hiding old metals"

At the end of the activity the teachers commended the children for correct waste sorting.

The next activity was focused on the issue of plastic waste decomposition. The pupils had to guess the decomposition period of each material. After they answered, the teachers informed the children about the correctness or incorrectness of their estimations.

In a logical sequence, the pupils moved on to another activity, which was focused on learning about selected properties of plastics (strength, elasticity, flexibility, permeability, plasticity).

The teachers selected two pupils to verify strength. Each of them grasped one end of a plastic film bag and pulled it towards themselves. The pupils concluded that the plastics were tensile.

In order to demonstrate resilience, the teachers conducted an experiment with a plastic bottle and a plastic yoghurt cup. By gently squeezing it with their fingers, they pointed out the ability of this material to return to its original state and shape.

In order to observe flexibility of plastic materials, teachers used a plastic ruler. Each pupil had the opportunity to test the material by gently bending it.

An update of the curriculum content has been applied in this lesson, whilst verifying the plasticity of the materials. The teachers selected a pupil to stamp on a plastic bottle in order to push all the air out of it. They provided the pupils with further real-life examples and led them to think about why plastic bottles are compressed in this way, where we throw them in such form and so on.

Pupils checked the permeability of plastic materials with a plastic bottle filled with water. After simply manipulating the bottle (turning it upside down and sideways), the pupils described whether their hands became wet or not. The result they found was that plastics are impermeable.

Teachers also informed the pupils that plastic can be thermoformed. The pupils were immediately motivated for the next experiment. This activity was realised in three groups. Prior to the activity, teachers informed children about the importance of correct device handling. They also used an initial briefing to explain the procedures. Pupils´ task was to mould the plastic into a flower shape above a candle flame (Figure 1).

Figure 1. Moulding Plastic with Heat Application

During the activity, the teachers always paid attention to safety, which was very important in this case. The production process included heating in

order to mould the plastic bottle piece above a candle. This deformed the plastic into various interesting shapes. With a glue-gun, teachers glued various small items such as buttons, beads etc. onto the plastic flowers (Figure 2).

Figure 2. Result of Plastic Moulding

At the end of the activity, teachers verified the acquired information from the experiment by asking questions:

- What did we find out from heating the plastic?
- What happened to it?

The teachers concluded that plastics can indeed be thermoformed. Finally, the pupils were warned to never do this at home alone, only in the presence of adults. Teachers commended the pupils for their overall activity and work.

Analysis

The aim of the educational activity was to teach children to observe, sort waste materials and to study their properties (strength, flexibility, permeability, plasticity, etc.). The implemented teaching strategies were appropriate. Many activities were interesting, entertaining as well as informative, apart from the activity in which pupils were supposed to estimate the decomposition time of waste materials. This activity was inappropriate, considering the replies. These timeframes could be difficult to imagine for young pupils. Despite these activities, the whole educational activity dealt with the topic of waste materials, and the individual activities logically followed one another.

Teachers decided to use several methods (motivational narration, demonstration, debate, explanation, practical activities, commending, encouragement, updating the curriculum content, observation, etc.) and switched amongst various processes of work appropriately, which made teaching interesting and activating. Pre-school pupils are interested in activities by which they can try and experiment themselves. Therefore, we evaluate the selected educational activities as being appropriate, apart from the classification of waste accompanied by the poem. This activity was unnecessarily long, and pupils were inactive.

The main part of the educational activity was focused on investigating properties of plastic materials using simple scientific research methods. The teachers chose observation to acquire new knowledge and concepts. They involved children in activities as often as possible. Similarly, the acquisition of knowledge was not carried out by an explanation by the teachers. Instead, the pupils were led to describe what they saw and what was happening with the plastic, in order to formulate conclusions and generalizations. In this way, they became acquainted with the properties of plastics such as: strength, elasticity, flexibility, permeability, compression ductility and thermal ductility. In this context, teachers informed pupils of the importance of plastic sorting. From our perspective, it would be advisable to create more room for discussion on this subject in order to develop recycling competences, and fixate a positive attitude towards the environment.

In the final part, the teachers created a situation to help pupils understand the importance of secondary use of waste materials. In this activity they changed the shape and use of a plastic bottle. Through this activity, pupils could observe other interesting features of plastic materials, such as thermal ductility. However, it would not be appropriate and safe for children to carry out such activities themselves. We consider the activity interesting for demonstrating formability of the material, but from the point of thinking development, teachers could have dedicated more attention to creating a discussion about the assumptions and views on what happens to the material, how plastic changes, etc. We find the final evaluation and a summary of all findings positive. At the end, the teachers drew attention to the dangers of performing these activities at home without supervision. They commended them for their overall activity and work.

Alteration

The sub-area Materials and their properties is focused on learning about various natural and technical materials through various assembly and technological tasks. The task of the teacher is to create situations which enable pupils to think about natural materials as products of nature, and technical ones as a result of human activity. Debates, discussions, or other dialogical methods should also address the issue of plastic disposal (waste sorting, recycling, etc.).

Whilst teachers fulfilled the requirement to include debates and discussions in the activity, they did not develop them further. Often, they tried to speak for

pupils, indicate answers in questions, or frequently asked yes/no questions (e.g.: Does waste belong to nature? Do you leave waste in nature? Do you sort waste? Etc.), without additional development. We, therefore, recommend the inclusion of debates based on B.S. Bloom´s taxonomy. Open-ended questions can lead to higher cognitive responses than just yes or no.

Another positive aspect regarding the teachers' part was also the inclusion of activities focusing on close examination of technical material - plastic - in construction of a specific product. In addition, among the many characteristics of plastic, activities focused on observing their strength, elasticity, permeability and plasticity. By carefully selecting appropriate activities (apart from estimating the decomposition time of selected plastic items and shaping plastic above the candle), teachers led the pupils to observation, examination, formulation of conclusions, development of thinking and manual skills. The activities were mostly entertaining and of experiential nature with educational content. In these activities, however, the content of the curriculum was hardly updated. Teachers did not indicate to pupils where they could encounter these materials, or how they could be applied in practice, as they did in the case of plastic bottle compression.

From the perspective of health and safety education, which is an integral part of pre-school education, we suggest using various technical materials, tools, and equipment to ensure safe activity performance. Thus, to adapt the educational environment and enable the pupils to work with materials and equipment actively, and at the same time safely.

5. Video-Study – Strategy for Developing User Skills, Responsibility for Work Quality with Application of Technical Materials, Tools and Equipment

Annotation

The lesson took place in the 6th grade of the Radošina elementary school in the workshop. Only boys were present at the lesson. The content of the lesson was based on the educational area Humans and the World of Work, the sub-area Technical Materials and Their Processing Procedures. The aim of the lesson was to:

- distinguish basic types of plastic;
- perform a simple experiment to compare the selected property of the material;
- carry out selected working procedures for manual processing of plastic.

In the introduction part, the teacher informed the pupils about the aim of the lesson, which was to complete and process the product from the previous lesson (Figure 3), as well as experience working with thermoplastics and thermosetting polymer. She activated the pupils through a debate to find out their previously acquired knowledge about thermoplastics and thermosetting polymer. In the main part, which was of a practical nature, the pupils' task was to examine the bending of thermoplastic and thermosetting samples using a cooker. Based on this examination, the pupils had to complete the work they started in the previous lesson.

Figure 3. Examples of thermoplastic and thermosetting products

We can say that pupils had the necessary and safe equipment, and enough space to carry out the practical experiment. The activity consisted of operations such as measuring, sawing, grinding, drilling and thermoforming plastic. The teacher guided pupils' activities, supervised their individual work and ensured the work is safe. Practical task was more time consuming. As the teacher mentioned in the beginning of the lesson, the pupils did not manage to finish their work. She informed them that the work is to be finished next time, and asked them to clean and order their workplace and their surroundings. She thanked them for the work and finished the lesson.

Analysis

The objectives of the lesson for pupils were to:

- be able to distinguish between thermoplastics and thermosetting polymer,
- examine the thermoforming of plastic,
- develop the skills of manual processing of plastics.

In order to meet the above objectives, the teacher created a lesson of a practical nature consisting of an introductory and exposition part. Even though her voice was rather authoritative, there was a pleasant

atmosphere in the classroom, and the pupils seemed relaxed while working.

At the beginning of the lesson there was no motivational part. The teacher solely informed the class about the tasks they will try to do during the lesson, namely:

- Finish and process the product they began working on in the previous lesson. The teacher also mentioned that the task will take some time and thus the product may not be finished by the end of this lesson either;
- Test whether they are working with a thermoplastic or a thermosetting material.

Note: It would be preferable to use the following plastic distinction:

- Thermoplastic - become thermoformable when we apply heat. They harden after cooling. The process is repeatable.
- Thermosets – (thermosetting plastic) - become temporarily deformable after application of heat. After cooling, they lose their plasticity. Further heating does not change their shape.
- Elastomers - (rubber) are characterized by exceptional elasticity and low hardness [12].

Following this information, the teacher tried to revise knowledge acquired from the previous lesson. Through questions, she tried to determine the level of analysis from the pupils, whether they could assess the difference between a thermoplastic and a thermosetting material. She corrected and supplemented pupils' answers until they concluded that thermoplastics can be bent using a heat source, e.g. a cooker. No explanations were made regarding thermosetting materials. The teacher did not develop the debate further, but rather focused on repeating the lesson objectives multiple times. During the lesson, the teacher gave pupils very little space to speak, but rather used monologue.

She reiterated what their second task would be, i.e. to verify whether they were working with thermoplastic or thermosetting material and selected the procedures accordingly. Pupils working with thermoplastic material, had to bend the plastic until they reached a shoehorn shape. Pupils working with thermosetting plastics, had to reach the shape of a hanger, one part of which consisted of a thermoplastic material. The teacher suitably supported this interpretation with concrete product demonstration.

Prior to the activity, the teacher provided correct terminology, defined the procedures and provided various advices to pupils. She included initial briefing, during which she explained clearly and comprehensibly to the pupils what tools they would be using to make changes to the products.

The teacher smoothly proceeded to the second task which was the plastic type examination. She used plastic samples which she did not name. Then she selected two pupils and explained them how to go about the task. To ensure safe work, she chose to bend the plastic over the cooker. Pupils´ task was to use the ticks for heating the plastics over the cooker and see if they could be bent afterwards. (Figure 4).

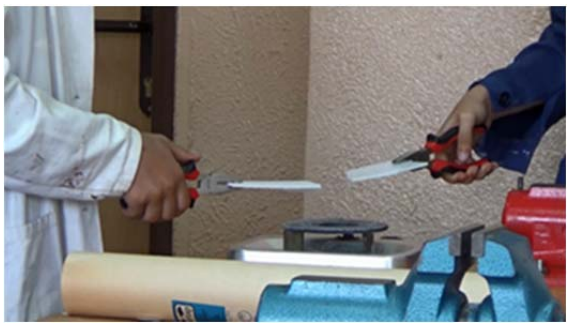

Figure 4. Observing the Features of Thermoplastic and Thermosetting Materials above the Cooker

The teacher did not verify whether the students had been listening to her and remembered what to do. This is one of the reasons why one of the pupils decided to bend the plastic sample freely outside the cooker, for which the teacher reprehended him with a slightly raised voice. She often forgot to use the correct terminology when repeating how pupils should proceed. Instead of verifying that students understand the assignment and know how to proceed, she repeated it several times, which seemed tiring. In the meantime, she called on the other pupils to start working on the completion of the work from previous lesson. The activity was interesting, however ineffective for several reasons:

- The assignment implied that once pupils found out what plastic they were working with, they would choose the following procedures accordingly. The activity, therefore, should have been included in the previous lesson or at the beginning of the current lesson, wherein the teacher would randomly distribute plastic samples to the pupils who would heat them up over the cooker, in order to determine whether it was a thermoplastic or a thermosetting material. They should have proceeded on what is based on these findings. In this case, it was unnecessary, as the pupils had already developed the products.
- The teacher did not evaluate the activity at all. Other pupils did not get to know the result of bending plastics.

As soon as the selected pupils who heated the plastic samples above the cooker were finished, they joined the others and continued working on the shoehorn. During this activity the teacher approached the pupils individually, guided their work and in case

of improper handling, corrected them and demonstrated correct handling.

After completing the first part of the task (cutting out the shape and drilling the edges), the teacher interrupted the activity to make sure that the pupils listen to her. She verbally explained the other working methods (clamping, drilling a hole for hanging of the shoehorn and cleaning it with a warding file), (Figures 5 and 6).

Figure 5. and 6. Workshop Production Using Thermoplastic and Thermosetting Materials

Pupils, who managed to work the product according to the assignment, could proceed by thermoforming the product to the desired shape. In this part, again, the teacher chose a narrative to teach pupils how to work on shaping effectively and safely.

Figure 7. Using the Flexibility of Plastic in Production

The only negative in this section was that the teacher led pupils to mould plastic without protective gloves, which could have resulted in burns (Figure 7). As the teacher mentioned in the demonstration, she did not use gloves in order to keep the product free of imprints. However, there are several types of gloves that could have been used in order not to harm the result quality. Due to limited duration of the lesson, the teacher was forced to interrupt the pupils' activity. She summarized the activities by awaiting them next lesson and urged them to clean and organize the tools according to the lists they received. However, she did not evaluate pupils' activities. At the end she just stated that the lesson was over, thanked the pupils for their activity and reminded them to wash their hands after work.

Alteration

The subject content of Technology represents an integral part of the educational process because it complements general education with an important component necessary for an individual to find employment on the labour market. Through this subject, pupils can develop their thinking and skills needed to be able to practice different professions in the future. Therefore, it is desirable to create educational process in the spirit of developing user's skills when working with technical materials, tools and equipment.

An important prerequisite for training and skill improvement is sufficient time and space, as well as the materials and tools necessary to perform the activity. On these depends the quality of the management within the educational process, as well as the ability to implement suitable teaching strategies. Methods of motivation and demonstration are also an integral part of the training and skill improvement. Through these the teacher motivates pupils and presents methods, for proper handling or workflow. We therefore recommend:

- Inclusion of motivational elements in the introductory part of the lesson. Due to little time available (as practical part requires more time), debate/discussion seems to be the most effective motivation method. Instead of a monologue, the teacher could have students actively participate in the discussion, pointing out the relation of the acquired knowledge, skills and the professions in which these skills are needed. Through discussion, the teacher could have ascertained not only whether the pupils remember the difference between a thermoplastic and a thermosetting plastic, but also whether they could explain the comparison, apply this knowledge, and propose new methods to investigate properties, etc.;
- Demonstration of suitable technical practices. Continuous instructions, selected by the teacher to inform pupils about the work could be supported by a concrete demonstration of the correct tool handling. The teacher could have continually encouraged pupils to try it for themselves under her supervision, in order to receive feedback on how well pupils handle these activities, and how well they understood her instructions;
- Inclusion of dialogue methods. Practical part was an essential part of the lesson. The activity was focused on product design according to a model. Nevertheless, several dialogical methods could have been used to create a space for the pupils to express themselves, for example at the end of the lesson;
- Inclusion of the final evaluation. The final part of the lesson usually focuses on assessment and evaluation of final products, towards which pupils have been working and overall evaluation of pupils' work. The objective of the evaluation

is to compare the achieved results with the specified requirements. In this case, it could have been a model product that pupils were supposed to work on. Since the pupils failed to complete the activity in time, it was not possible to carry out such an assessment. The teacher, however, could have provided a short summary of the task, what they learned from it, what they were doing right, and what they were having trouble with. Further objective is also to point out what the pupils were doing wrong, in order to make sure they had not acquired the wrong skills. Encouragement is also an important prerequisite – pupils need to be shown how they can improve these shortcomings which motivate them for further practical work. In relation to the development of critical thinking, we are trying to develop self-esteem habits in pupils. Pupils´ self-assessment not only helps in developing and promoting their opinion, it also acts as a feedback for teachers which helps them with their self-assessment, and contributes to more effective preparation for next lesson as well.

6. Conclusion

The objective of this contribution was to point out the available means to improve future teachers´ practical pre-gradual training by the means of a video-study and application of the AAA method.

As regards contents, we focused on the implementation of teaching strategies in technically oriented subjects, thanks to which students acquire a real idea of how to implement observation strategy, exploration with application of various technical materials, strategies for developing user skills, and responsibility for quality of work when working with various materials and equipment.

For future teachers, strategy selection and planning is not an easy process. Strategies need to be picked out carefully in order to comply with the teaching objectives, complex personality development, as well as the specifics of technical subjects and general requirements of the modern age.

By applying selected video-study analyses we wish to provide the students with a means of professional development, development of critical thinking in implementing teaching strategies with emphasis on critical and creative thinking development in children and pupils, as well as the ability to think critically in the area of self-evaluation.

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