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The Use of Non-System Components of Construction Sets

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Abstract

The authors deal with an extension and modification of construction kits in order to create a simple tool for assessing the level of creativity according to the products made by pupils. The article describes a modified construction set – a creative set, divided into system and non-system parts. In the context of the product design, the use of non-system parts indicates the pupil's creativity performance. The creative set was tested out on a sample of 62 elementary school pupils. Subsequently, the authors put the products to analyse.

Keywords: construction set, creativity, functional creativity, technical education

Introduction

The most common outputs from the practical activities at the second stage of Czech elementary schools, 6th–9th class (ISCED 2), were introduced by Krátký in his collection of topics for activities in workshops. "This is a complete line of technically undemanding, but for kids quite interesting products, which bring them satisfaction from work and most of the time, even a less skilful children get nice results. The products are chosen to step by step develop pupils' manual skills, technical thinking and to lead them to use the proper operating procedures" (Krátký).

Krátký presents in his collection of topics several basic products for pupils from each year. Those differ especially in the difficulty of their operating procedures, amount of the tools used, the material or combination of materials. Nevertheless, the listed products miss some added value and on top of that do not reflect the technological progress of our civilisation. The character of products in the collection points out that it serves primarily to develop manual skills rather than to make space for own invention and creativity performance. Dostál (2016) reminds of so called technical literacy as the basic form of literacy for the 21st century. This literacy is mainly about technology and their control, evaluation and understanding. At the same time he refers to multidisciplinary approach to technology with focus not only on the development of manual skills but also on the development of thinking, emotions and creativity (Dostál, Prachagool, 2016).

Just the creativity is quite incorrectly but often considered as a component of art only. In fact, we are surrounded by creativity elements everywhere, every time, even in ordinary situations like cooking, housekeeping and maintenance, raising children or team sports. “Although creativity is a secret process, we can understand and influence it” (Petty, 2013).

Creativity is “psychic ability coming from cognitive and motivation processes, in which also inspiration, fantasy and intuition play important roles. It is manifested by finding such solutions which are not just the right ones but at the same time they are innovative, unusual, unexpected” (Průcha, Walterová, Mareš, 2003).

Kolář defines creativity as a “set of characters which allows creative activity, problems solving in a creative way. The current knowledge represents creativity as a complex phenomenon, which has its cognitive, affective, social and bio-physiological aspects” (Kolář and composite authors, 2012). Very interesting is the relation between the creativity itself and its manifestations. Creativity of an individual can be measured by a whole range of approved methods (Honzíková, 2015). However, it is more difficult to capture manifestations of creativity in a physical product, as a whole range of other factors affect the process such as the relationship creativity – innovation or creative product and its effectiveness, efficiency, etc. (Hallman, Wright, Conger, 2016).

Research Aim

The main aim of this sub-research is to prepare a tool for studying the level of creativity performance of elementary school children and verify it in practice. The initial assumption is that a creative individual makes a creative product. That means that creativity of the individual is somehow reflected in his activity (Kerr, 2009; Garcês, Pocinho, Jesus, Viseu, 2016).

The secondary aim is to study the use of system and non-system (added) components of a construction set and ways of their use.

Methodology and Research Tools

Technika (Technology), a Slovak text book for elementary schools from the publishing house Dr. Raabe, introduces a simple construction set. The construction set consists of simple basic parts which are connected with elastic eyelet rings. These basic parts (system parts) were supplemented by a set of non-system parts. Hodis, Hrbáček, Vybíral and Dosedla (2013) conducted a research and experimented with the products made from the construction kit. The products were made not according to any manual but according to own proposals by children. A Czech construction set Merkur was used, which is suitable to be complemented by other parts. Novák (2015) experimented with a German construction set UMT, which is a kind of construction system itself. The system is directly based on the possibility of supplementation by other components and the possibility to use simple machine methods. The experiments in lessons have confirmed modifiability and broad possibilities to monitor creative performance.

Considering the experience, a standard construction set (4 types) was supplemented by another 10 new parts. The use of these parts allows mapping any possible creative performance of an individual.

The results were processed by basic statistic tools, such as variance or variation coefficient (variability). The absolute numbers of parts were recorded and processed graphically. Subsequently, a qualitative analysis was executed for each product with the aim to identify the use of system and non-system components.

Tab. 1 Construction set components – numbers and names of parts

	Component:	No. of pieces:
System parts (basic)	Wooden ring	3 pcs
	Short wood dowel	5 pcs
	Long wood dowel	5 pcs
	Rubber ring diameter 1 cm	20 pcs
Non-system parts	Textile – 10 x 10 cm	1 pcs
	Plastic hook	2 pcs
	Metal spring	1 pcs
	Magnet	2 pcs
	Wooden wedge	1 pcs
	Wire	1 pcs
	Twine	1 pcs
	String	1 pcs
	Wooden wheel small – average	2 pcs
	Wooden wheel big with a hole	2 pcs

Research Group

The research was carried out at the second stage of an elementary school, namely in four different grades. There were 62 respondents – pupils in total.

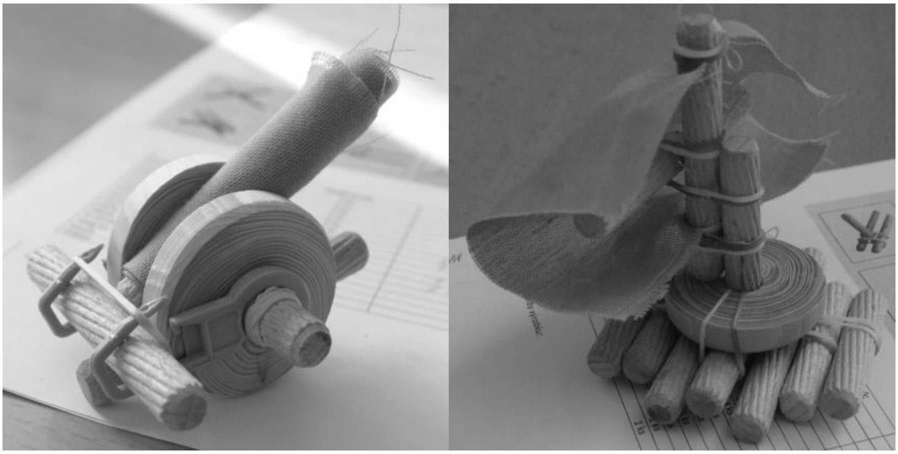
6th grade, 11–12 years, altogether 17 children.
7th grade, 12–13 years, altogether 15 children.
8th grade, 13–14 years, altogether 15 children.
9th grade, 14–15 years, altogether 15 children

Research Progress

Each pupil got a construction kit – a creative set according to the table no. 1. and a simple printed drawing for connecting the basic parts. Children had a chance to try out the connections prior building. All the research took one teaching lesson (45 minutes). Thus the pupils had for their own activity about 30 minutes available. The task was given in framework – using the added parts, build a toy.

After the product was made, it was photographed and analysed from the point of the use of each part.

Fig. 1. Creative set – construction set components



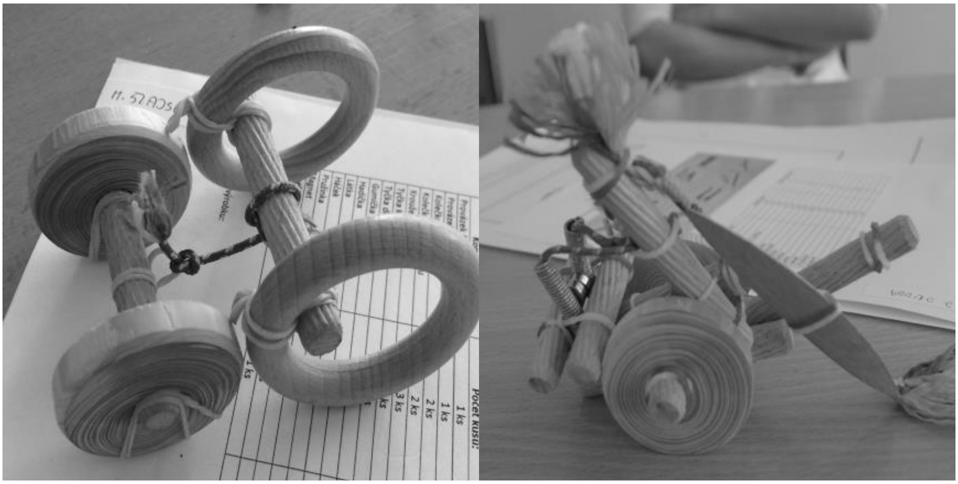


Fig. 2. Creative set – product demonstrations

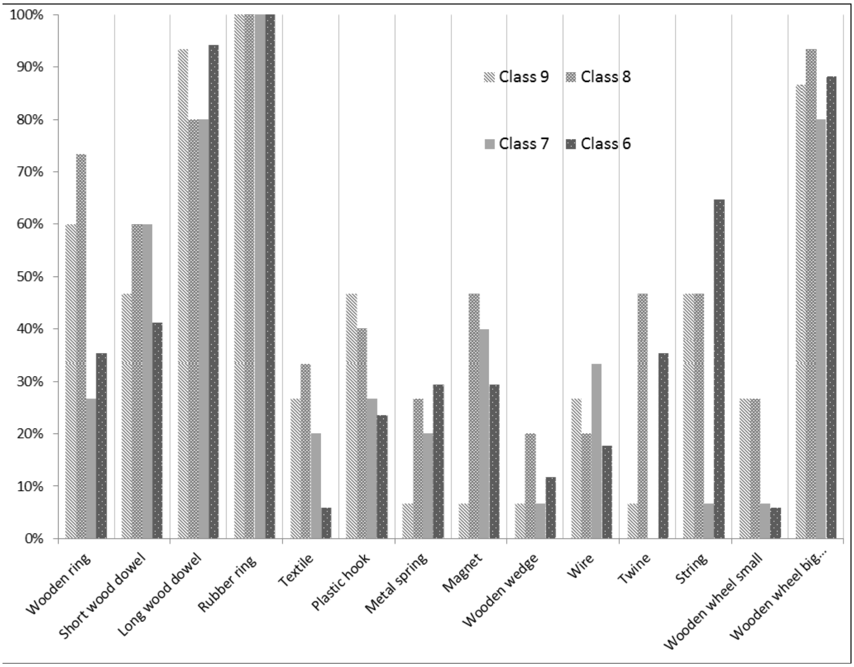
Results

We were interested especially in the use of individual parts of the kit. The graph 1 show percentages of the use of each item of the construction set with respect to individual grades. As expected, a rubber ring was used as a connection part in all cases.

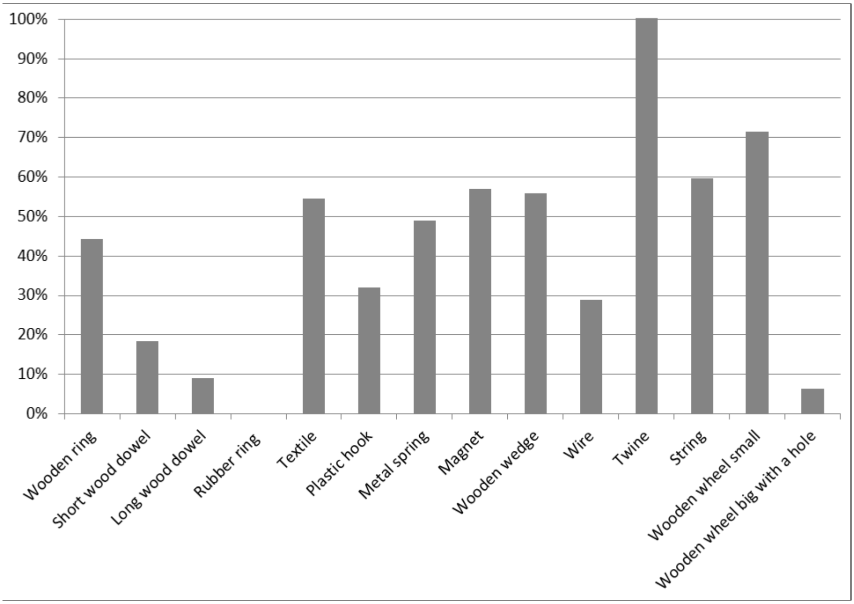
Also the other system components have a larger percentage of the use (a ring, a short and a long dowels). As you can see in the picture (Fig. 2), blocks and rings are used mostly as bearing construction elements. Actually the second largest percentage of the use was at a non-system part in the shape of a big wheel with a hole. The size of the wheel was so big that it was possible to put it on both of the blocks. In most cases, children used the ring as a wheel – a tyre. However, some of them used it even as a building element – a pedestal. On the contrary, a wheel with no hole was a really hard-to-be-used item for pupils. They used it mainly as a design element with no bigger construction sense. A thin string worked very well as a connecting item, while the thicker twine served more as a design item again.

The use of a wound wire – a spring and two magnets demonstrated really interesting options. The pupils, who used a ferromagnetic spring for their products, did so almost always in the combination with a magnet.

It is interesting that no pupil came up with an idea to deform or change some of the components. A deformation of a spring was possible or to tear apart and divide the piece of textile. Just a wire could be used after its deformation as a connecting element like a string.



Graph 1. Comparison of the use of components within the grades (100% means that the part was used by all respondents)



Graph 2. Component use variability within grades (variation coeficient in, %)

Let's have a look at variability of the items used within the individual grades (Graph no. 2). The variation coefficient clearly reflects which parts are easy-to--be-used and will often find their application in a product. A rubber ring was used in all cases, so its use variability is none. On the contrary, a thick twine was never used in the seventh grade, so when we compare it its variability is statistically maximal.

Discussion

The variability naturally divided the set of parts into the ones with easy use (system ones) and the ones with lower applicability (non-system ones). The original construction kit from the text book Technika by publishing house Dr. Raabe worked with four basic parts (a ring, a short dowel, a long dowel and a rubber ring). It came out that children are able to use also various types of hooks, deformed wire or a wheel with a hole in certain level (variability up to 30%). Regarding the wheel with a hole, we may say that it was the most common used part except the rubber rings. On top of that, the wheel had also a function, compared to the rubber ring which worked just like a construction item to connect other parts. Most of construction kits include parts in shape of a wheel with a hole. The item is mostly used as a wheel for a mean of transport, as the research confirms. If you take a wheel from a construction set, you would probably use it to build a mean of transport. Novák (2015) found out during his experiments with kids and kits that boys use wheels in their constructions more often than girls and most of the time, they build means of transport. On the other hand, girls put a wheel as a design part instead of its functional use. Our analysis of the children's products shows a similar trend. Boys make rather products picturing something from the real world with the use of the components which usually have a function (a cannon, a trolley etc.). Girls on the contrary choose abstract or less technical items (such as a figure, a centipede, decorations, jewels etc.).

It is more complicated to apply non-system components than the system ones. Assuming that a creative individual can see the use in some things which look useless at first, we may suppose that the amount and interconnection of the non-system parts in a construction solution may indicate the level of performed creativity. A question remains, whether e.g. an extreme solution in the form of illogical connection of non-system parts may be considered as an excellent performance of creativity (Treffinger, Young, Selby, Schepardson, 2002) or rather as its failure (Krotký, Simbartl, 2016).

Conclusion

The curriculum innovation in the educational area Man and the World of Work in the Czech Republic, following the new technologies, must be reflected even in new methods of evaluating children's performance. The product evaluation from both sides, the physical side with parameters (Draxal, 2016) and the creativity performance, will allow us, teachers, to stimulate a complex process of teaching a pupil.

„Teachers can provide students with not only summative assessments of their creativity, but also meaningful and actionable formative feedback, thus transferring to students a concrete understanding of what they need to do in order to be more creative“ (Cropley, Cropley, 2016).

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