Primary Education Student Teachers‘ Perceptions of Computational Thinking through Bebras tasks

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1 INTRODUCTION

in accordance with the DigComp concept

MoEYS Czech Republic

Government's Digital Education Strategy (2014)

Education Policy Strategy until 2030+ (2020)

Two projects for all nine faculties of education (2016-2020)

PRIM (computational thinking) – curriculum „Informatics and ICT“

- pre-school, primary, lower and upper seconday school level

DG (digital literacy) - digital literacy across curriculum

Informatics - the framework of expected learning outputs for:

- **Data, information and modeling**
- **Algorithmisation and programming**
- **Information systems**
- **Computer and its control**

Curriculum revision

RVP (FEP = Framework Educational Program) – since 2005, compulsory „ICT“

RVP revisions (in 2021):

- new educational field of "Informatics and ICT" (instead of „ICT“)
- Digital competency as the 7th key competency

2 INFORMATICS IN CURRICULUM IN THE CZECH REPUBLIC

What is ready for schools and teachers?

New revised Framework Educational Program (RVP):

Informatics
(expected learning outcomes + key themas):

I. Data, information and modelling
II. Algorithms and programming
III. Information systems
IV. Digital technology

Model School Educational Programs (ŠVP):

1. **ŠVP Carefully forward**
2. **ŠVP Fearlessly forward**
3. **ŠVP Progressively forward**
4. **ŠVP Creatively forward**

2 INFORMATICS IN CURRICULUM IN THE CZECH REPUBLIC

What is ready for schools and teachers?

Changes for pre-school, primary and secondary education:

12+2 textbooks

Since October 2017, 14 textbooks and teaching guidelines have been produced

for teaching Informatics as a new subject in primary and secondary schools curriculum,

for computational thinking development in all levels of education (including pre-school education).

A unified didactic approach to the elaboration of all these textbooks based on constructionist idea (*learning-by-making)*.

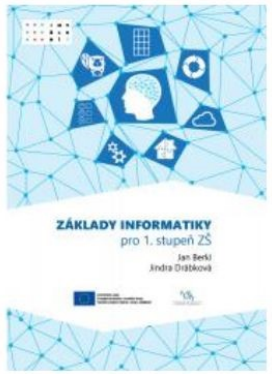
Pupils can learn by experimenting (tinkering) and inquiring activities during solving interesting problems or their own ideas. Each textbook basically consists of two parts:

one intended for pupils (*learning material*)

and the second one aimed to teachers (*teaching guidelines*)

2 INFORMATICS IN CURRICULUM IN THE CZECH REPUBLIC

What is ready for **Primary Education**?

Algorithms and programming			Informatics		Robotics	+	Informatics
							
Algoritmizace s využitím robotických hraček pro děti do 8 let	Výlety šaška Tomáše - algoritmizace pro malé děti	Základy programování ve Scratch pro 5. ročník základní školy	Základy informatiky pro 1. stupeň ZŠ	Práce s daty pro 5. až 7. ročník základní školy	Robotika s LEGO WeDo pro 1. stupeň základní školy		Informatika s Emilem 3
ISCED 0, 1	ISCED 0, 1	ISCED 1	ISCED 1	ISCED 1, 2	ISCED 1		Ivan Kalaš, Andrej Blaho Milan Moravčík

Textbooks correspond to the expected learning outcomes of the revised curriculum („Informatics and ICT“)

3 COMPUTING IN STUDY PROGRAMS FOR TEACHER EDUCATION AT THE FACULTY OF EDUCATION (CUNI)

Changes in pregradual (pre-service) teacher education:

- Bc / MA degree study programs in Teaching Informatics (new accreditations)
- Implementation Digital Literacy cross all field didactics (cross curriculum: in languages, Arts, Chemistry, etc.)
- Bc / MA degree study programs for Pre-School Education /Kindergarten
- MA degree study program in Teaching in Primary School Education (new accreditation)

3 COMPUTING IN STUDY PROGRAMS FOR TEACHER EDUCATION AT THE FACULTY OF EDUCATION (CUNI)

MA degree „Teacher Training for Primary Schools“ (5-years study):

in Year 2 – two compulsory courses

Winter Semester	Digital Technologies in Primary Education	1 credit	1 teacher	Full-time 100 students	Interactive lectures (12 hours)
	Digital Technologies in Primary Education	1 credit	1 teacher	Part-time 45 students	Interactive lectures (12 hours)
Summer Semester	Didactics of IT	2 credits	5 teachers	Full-time 100 students	Practical workshops in groups
	Didactics of IT	2 credits	5 teachers	Part-time 45 students	Practical workshops in groups

4 THE STUDY

The course „Digital Technologies in Primary Education“

The final assignment for student teachers: to choose and solve one activity

Activity 1	*Activity 2*	*Activity 3*	*Activity 4*
Code.org	Bebras contest tasks (MINI category)	Informatics Textbooks for Primary Education	Hello Ruby (books written by Linda Liukas)

Step 1	**Step 2**	**Step 3**	**Step 4**
To choose a year of Bebras con-test	To assess Bebras tasks and to decide which of them are easy/ difficult	To justify the opinion as to why the Bebras task is easy/ difficult	To design a teaching situation for three selected Bebras tasks as CSUnplugged activities (didactics approach, teaching aid, worksheet, etc.)

4 THE STUDY

Sample of participants: n = 66

136	Number of 2nd year student teachers who attended the course (71,7% full-time and 28,3% part-time). • During their study at lower or upper secondary school, they did not have a computer science (CS) or computing subject, only the 'ICT' subject (which was in schools unfortunately called 'Informatics'). • A few student teachers had participated in the Informatics Bebras contest while pupils at lower or upper secondary school. • Several of them (mainly part-time student teachers) work in primary schools and teach the subject 'ICT' to children. In the course, 'Digital Technologies in Primary Education', which introduced them to the topics and requirements for the new school subject 'Informatics', they found many interesting examples and ideas for working with pupils in primary education.
116	Number of student teachers who chose the Activity 2 (to analyse Bebras tasks)
66	Number of student teachers who analysed Bebras tasks for year 2019.

4 THE STUDY

Research Design and Methodology:

Data were collected through student teachers’ written texts in which they

- assessed the Bebras tasks for the year 2019
- explained why they assumed the difficulty level of particular tasks.

+ information resulting from a design of teaching procedure for selected three Bebras tasks (see Step 4)

In the case of student teachers, it is not a matter of agreeing on the difficulties with the Bebras tasks' authors.

Their view of the task level difficulty reflects student teachers' subjective feelings, which is mixed with their own experience, as they struggled with solving the task.

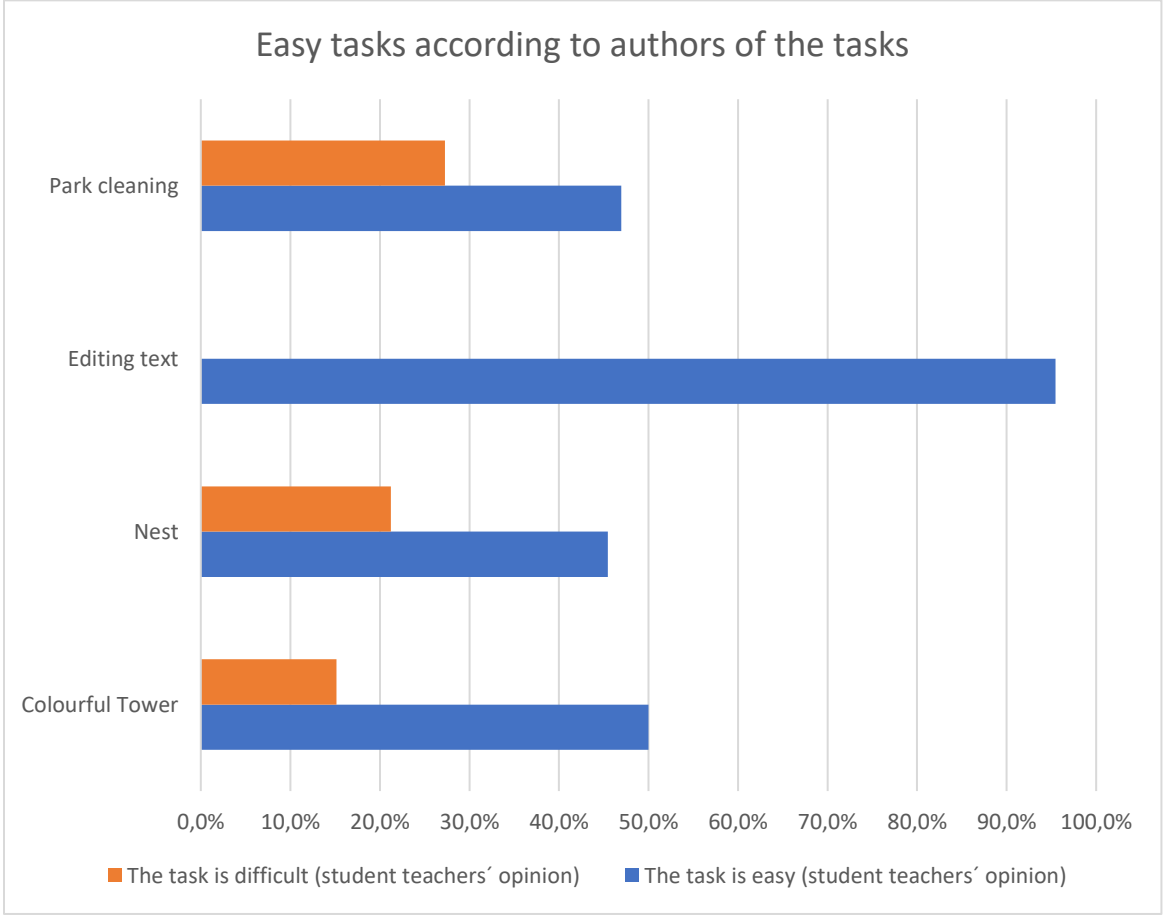
The Bebras task analysis is a way how to teach student teachers to think about pupil's thinking computationally.

4 THE STUDY

Bebras tasks that authors find easy are also considered easy by most student teachers.

- **Editing text:** According to the student teachers, it is evident this task is easy. However: primary school pupils do not work very often with a text editor.
- **Park cleaning:** Student teachers consider orientation in the area of the lawn + estimating distances to be problematic.

  „The robot works according to the following program: As long as there is an object on the lawn, drive to the nearest object, pick it up and load it.“



Easy tasks according to authors of the tasks

4 THE STUDY

Park cleaning

Po koncertě zůstala v parku spousta odpadků a robotický odpadkový koš má za úkol je sesbírat.

Robot pracuje podle následujícího programu:

```
Dokud je na trávníku nějaký předmět,
dojeď k nejbližšímu předmětu,
zvedni jej a nalož.
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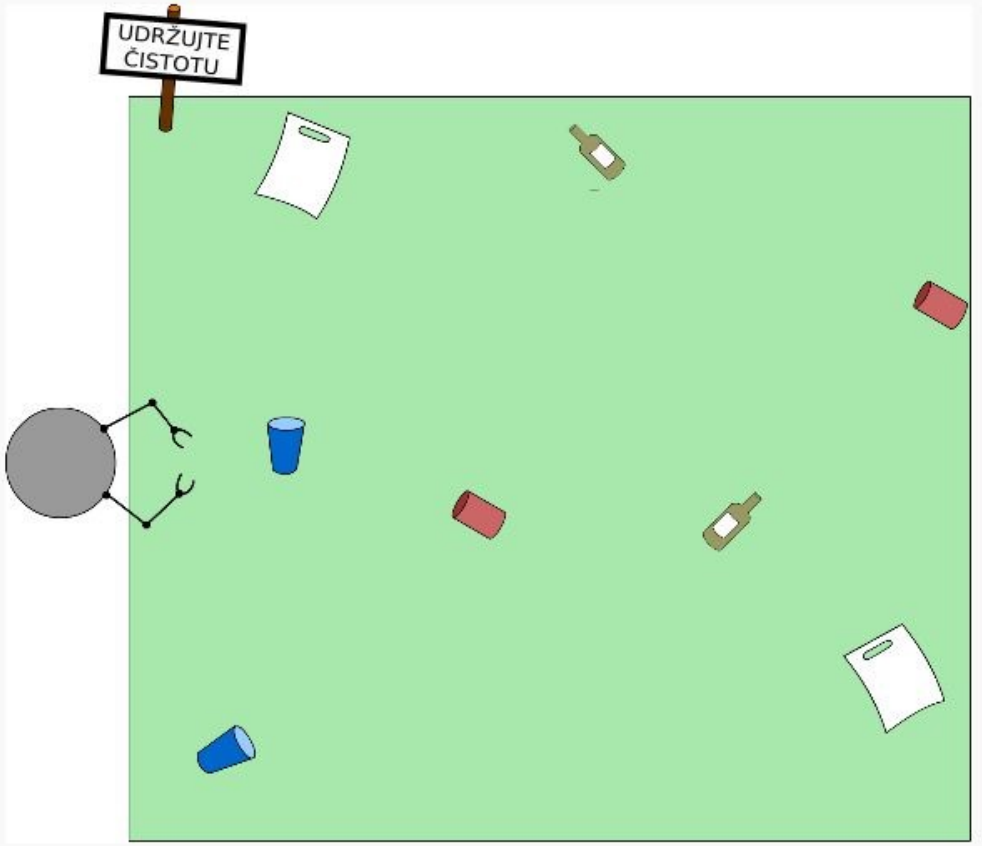
Který z předmětů robot naloží jako poslední?



Editing text

Zdůvodnění správné odpovědi

Správnou odpověď můžeš vidět vpravo.

Je vidět, že změny přibývají odshora. Při první úpravě Radim text zvětšil.
Následně změnil tvar písma, pak změnil barvu na zelenou a nakonec přidal podtržení.

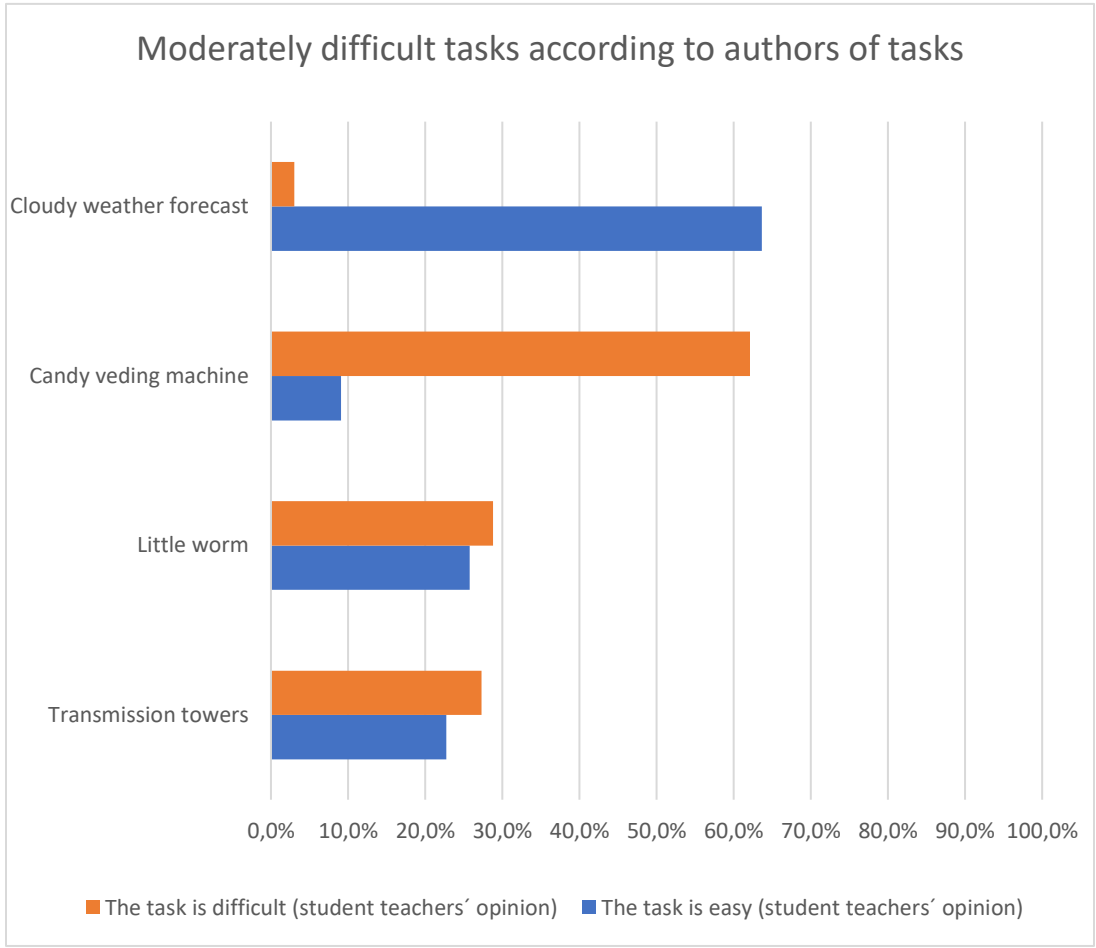
Vánoce	Toto je původní text
Vánoce	Změna velikosti
Vánoce	Změna písma
Vánoce	Změna barvy
Vánoce	Přidání podtržení

Moderately difficult tasks according to authors of the tasks

4 THE STUDY

Moderately difficult Bebras tasks student teachers evaluate differently.

- **Cloudy weather forecast**: According to the student teachers, this task is easy, because it is enough to concentrate and visually compare the shapes
- **Candy veding machine**: Student teachers consider this task to be purely mathematical, according to them it is difficult because pupils will not find a strategy for how to proceed.

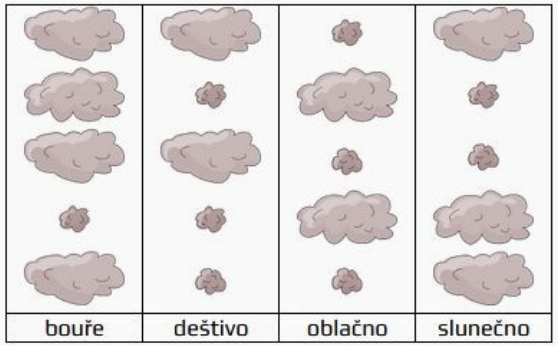


Moderately difficult tasks according to authors of the tasks

4 THE STUDY

Cloudy weather forecast

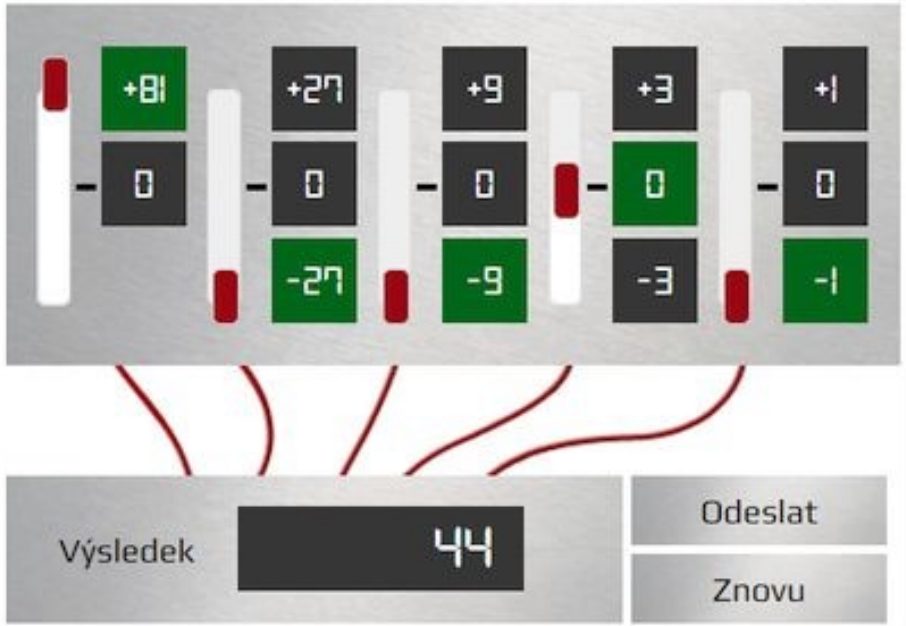
Šaman kmene Dakotů každý večer z vrcholu kopce Wetterberg vysílá pro své soukmenovce svoji předpověď počasí na následující den. Používá k tomu obláčkové zprávy - pět obláčků, velkých nebo malých, vypouštěných za sebou. Určitá uspořádání obláčků pak znamenají, jaké počasí předpovídá:



Dnes ovšem fouká silný vítr, takže ti, kteří předpověď sledovali, mohli rozeznat pouze dva z pěti obláčků (obrázek vlevo). Ostatní byly rozfoukané tak, že se nedalo poznat, jestli jsou velké nebo malé.

Jaké počasí vlastně šaman na zítra předpověděl?

Candy veding machine



+ 81 − 27 − 9 + 0 − 1 = 44.

4 THE STUDY

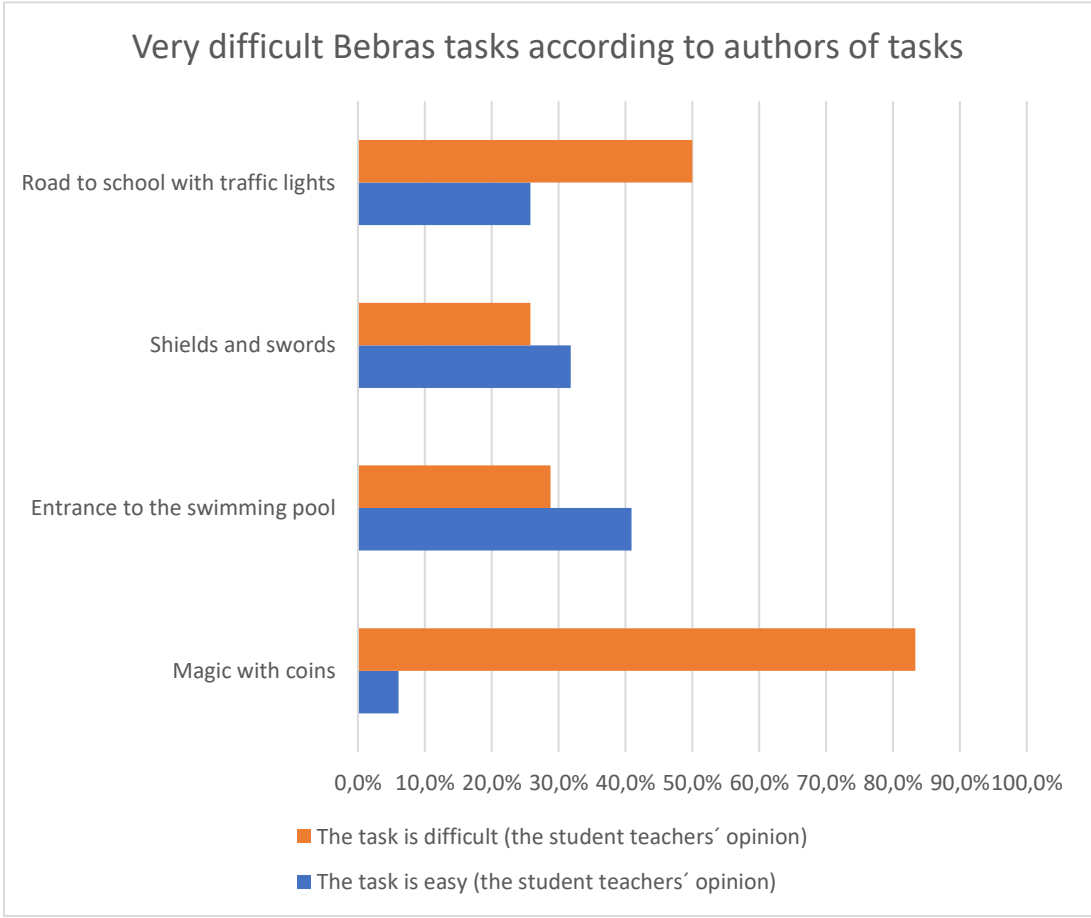
Very difficult Bebras tasks student teachers evaluate differently. Tasks that authors find very difficult are considered easy by most student teachers.

- **Shields and swords**:

  „Drag to place masters of historical fencing to apply: Each sword points to one of the masters. The master must defend himself against each sword with his shield.“

- **Entrance to the swimming pool**:

  „Children from the age of 8 are allowed to enter the swimming pool or they must be accompanied by someone who is 10 years of age or older.“



Very difficult tasks according to authors of the tasks

4 THE STUDY

Entrance to the swimming pool

Je léto. Doma je čím dál větší a větší horko. Petra (12 let) a její mladší bratr Franta (6 let) mají chuť se osvěžit v nedalekém koupališti.

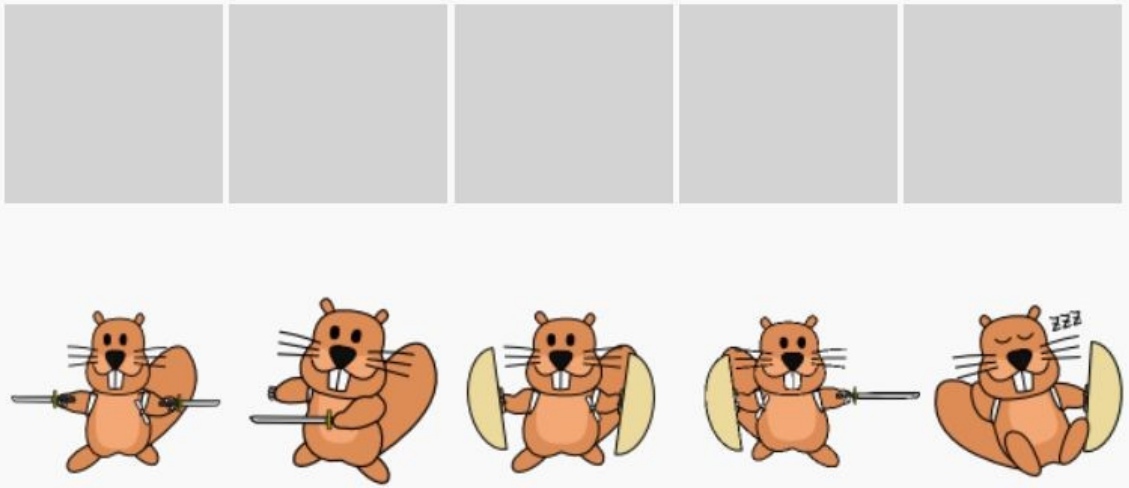
U vchodu do koupaliště Petra čte na ceduli, že vstup je dovolen dětem od 8 let nebo musí být doprovázeny někým, komu je 10 let a více.

Komu je dovoleno jít na koupaliště?

Shields and swords

Taháním umísti mistry historického šermu, aby platilo:

- Každý meč ukazuje na jednoho z mistrů.
- Proti každému meči se musí mistr bránit štítem.



5 DISCUSSION

Some student teachers compared the Bebras tasks with mathematical ones used in other contests for primary school pupils (Kangaroo, Mathematical Olympiad, etc.)

They found the Bebras tasks more interesting and engaging. They appreciated the fact that the Bebras tasks usually include a picture or an interactive function, so the control of the task could be user-friendly for pupils. Student teachers also valued a theme or story of Bebras tasks – these tasks reflect pupils' lives, interests and experiences that can be fun.

The student teachers pointed out that a significant condition for the successful solution of each task is the ability to read the assignment carefully and to concentrate on its reading with understanding.

From a didactical point of view, reading and visual literacy, logical thinking and numeracy are very important for solving Bebras tasks.

The student teachers appreciated very much the opportunity they had about how a pupil could think over and if pupils are capable of solving each Bebras task.

They considered that to be a great challenge in their professional development to becoming a primary school teacher.

6 CONCLUSIONS

Using qualitative methods, based on analysis of the Bebras tasks among 116 primary education student teachers, it was found that

- for better understanding of CT, student teachers are required to have sufficient Informatics knowledge to be able to think computationally and understand the informatics contexts of Bebras tasks.

Primary education student teachers did not have sufficient pre-knowledge on

- (i) what Informatics is,
- (ii) how computers work,
- (iii) algorithms,
- (iv) programming, and knowledge in mathematics, but (and at the same time) they would be required as teachers to develop CT of their pupils

The study's findings indicate that due to their lack of fundamental knowledge in informatics student teachers did not differentiate greatly between CT and mathematical thinking.

6 CONCLUSIONS

Informatics in primary education, including CT development, requires not only logical thinking, reading literacy and counting abilities, but also a good level of abstract thinking, which is still developing in primary school pupils, however, it turns out that, similarly to mathematical thinking.

Teaching using puzzles, quizzes and games can support and develop understanding and learning algorithms which has been successful in studying other computing disciplines [4]. The majority of the Bebras tasks have a such character.

The primary education student teachers do not yet have an idea of what it means to think computationally. It will be necessary to focus on this in the subject ‘Digital Technologies in Primary Education’ first, and only then to address teaching issues of how to teach pupils computational thinking. This finding fully corresponds to the recommendations of Yadav et al. [19], that

> “teacher educators need first to develop pre-service teachers' knowledge and skills on how to think computationally and then how to teach their students to think computationally. It is thus imperative for pre-service teachers to understand computational thinking in the context of the subject area which they will be teaching. This requires them to have deep understanding of their own discipline and knowledge of how computational thinking concepts relate to what students are learning in the classroom.”

6 CONCLUSIONS

From the analysis of Bebras tasks, after completing the course ‘Digital Technologies in Primary Education’, primary school student teachers did not show convincingly that they know what computing and computational thinking are. Can a student teacher without any CS education assess the difficulty of informatics tasks for primary school pupils at all?

> Some authors point out that it is not possible to develop student teachers’ pedagogical skills to develop CT of their pupils when they do not have sufficient knowledge in CS. Student teachers´ teaching competency to develop pupils’ CT cannot be based only on some examples of educational programming platforms or educational robotics exercises but should be combined with an intro-duction into fundamental CS concepts and procedures.

In primary school teacher education, it is necessary to pay great attention to the evaluation of informatics tasks for pupils, so that they can "grasp" the informatics content of assessed task. The student teachers in this study evaluated the Bebras tasks rather as interesting tasks (such as quizzes or games); they did not have enough insight from CS to notice what and why it may be difficult for pupils working on Beaver tasks. They assessed difficulty mainly according to their ability to solve the task. They applied a certain "automated" (stereotypical) thinking procedure for solving problematic tasks which could be a barrier to gain insight into completing the task.

For primary education student teachers to really develop CT correctly, they need to have a grounding in CS, otherwise “there is a real danger that Computational Thinking becomes a label for a set of enjoyable time-filling activities with little coherence and a lack of continuity and progression” [11, p. 14]. To ensure the development of CT in primary schools, initial teacher education, cannot concentrate only on pedagogical issues of pupils' CT development, but must also include informatics.

Thank you for your attention!

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Ideas for teaching approches: aids