# Tasks in Science Instruction and Textbooks in the Czech Republic: A Comparative Review of Research Methods

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One of the currently most monitored characteristics of instruction in the Czech Republic is its quality. Therefore instruction puts emphasis on the development of key competencies. Pupils are strongly expected to transfer the acquired knowledge and skills to various situations, especially to situations which they can encounter in real life. The aim of the poster is to review the methods used in research on tasks in primary and lower secondary Science instruction (which in the Czech context consists of biology, geography, physics, and chemistry) realized in the Czech Republic during last 25 years to present and to summarize selected results.

## Theoretical Background

### Key Competencies

Key competencies have been included in the Czech curricula (as well as in other countries) since 2005 as one of new general aims of education. Weinert (2001, p. 53) sees key competencies as „complex systems of knowledge, beliefs, and action tendencies, that are constructed from well-organized domain-specific expertise, basic skills, generalized attitudes, and converging cognitive styles". Appropriate tasks can be considered as the core activity for developing key competencies in instruction.

### Tasks, questions and their cognitive level

Doyle (1983, p. 161) understands academic tasks as „the products that students are expected to produce, the operations that students are expected to use to generate those products, and the resources available to students while they are generating the products". Tasks are mostly assigned in the form of teacher's question.

We define a teacher question in the classroom settings as an instructional stimulus that conveys the content elements the pupils are to learn and directions regarding what they are to do and how they are to do it (c. f. Cotton, 1988). The mostly used task and question classification systems are based on the type of cognitive process required to answer (Gall, 1970). According to Wine (1979, p. 14), lower cognitive questions are those which „ask the student merely to recall verbatim or in his/her own words material previously read or taught by the teacher". Wine (ibid.) defined higher cognitive questions as those which „ask the student to mentally manipulate bits of information previously learned to create an answer or to support an answer with logically reasoned evidence". We suppose that especially demanding tasks can support higher cognitive processes necessary for developing key competencies.

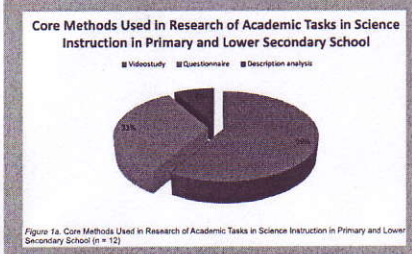


*Figure 1a.* Core Methods Used in Research of Academic Tasks in Science Instruction in Primary and Lower Secondary School (n = 12)

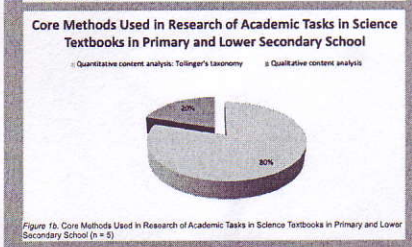


*Figure 1b.* Core Methods Used in Research of Academic Tasks in Science Textbooks in Primary and Lower Secondary School (n = 5)

## Methodology

In order to find relevant studies for our review, we searched the ANL database (a database of articles from Czech newspapers and periodicals) of the National Library of the Czech Republic and relevant monographs. Using keywords "task", "learning task", "analysis", "analyse", "research" and "competence", we found in total 2453 potentially relevant studies that included the keyword(s) in the title or abstract. We excluded the studies that were not empirical, published in a peer reviewed journal or did not pertain to Science instruction (2431 in total). Full texts of 22 studies were then reviewed; 13 of them were excluded thereafter as they did not include any relevant information (n = 9) or their field of study was too marginal (n = 4). As a result, 9 of published studies were included in the analysis as well as 8 other studies that were not included in the database (as they were published in monographs) but were considered relevant.

The relevant studies were reviewed comparatively. We analysed research methods and selected results from the perspective of the cognitive level of tasks and questions. We divided the task and question analysis into two parts, depending on the source of tasks or questions: (a) studies analysing Science instruction and (b) studies

**Table 1**
Analysis of the Research Methodologies of Tasks in Science Instruction and Science Textbooks for Primary and Lower Secondary School

| Author (project) | Research methodology |
|---|---|
| **(a) Analysis of Instruction** | |
| **Pstružinová** (1992) | A descriptive analysis of the pedagogical-psychological aspects and frequency of questions that teacher asks |
| **TIMSS 1999** (Roth et al., 2006) | Video study, questionnaire for pupils, parents, teachers and national research coordinator |
| **Brtnová & Čepičková** (2005) | Questionnaires using unfinished sentences and observation sheets with five grades scales |
| **TIMSS 2007** (Martin, Mullis, & Foy, 2008) | Didactic test, pupils', teachers', school principals' and national research coordinators' questionnaire |
| **Vaculová** (2008) | Didactic test, video study – video analysis |
| **Vaculová, Trna & Janík** (2008) | Video study – video analysis of the function of task in the process of Physics instruction |
| **Hübelová** (2009) | Video study – video analysis of the role of didactic media and aids, organisational forms and phases of the instruction |
| **Knecht et al.** (2010) | Video-study, microanalysis |
| **TIMSS 2011** (Martin, Mullis, Foy, & Stanco, 2012) | Didactic test, questionnaire for pupils, parents, teachers and national research coordinator |
| **PISA 2012** (OECD, 2014) | Didactic test and pupil's and school principals' questionnaire |
| **Janík et al.** (2013) | 3A methodology (qualitative analysis based on video-study – annotation, analysis, alteration) |
| **Lokajíčková** (2013) | Video study – video analysis from the perspective of cognitive level of tasks, participants and processes |
| **(b) Analysis of textbooks** | |
| **Wahla** (1976) | Quantitative content analysis according to Tollinger's taxonomy[1] (frequency, formulation, operation and sequence analysis) |
| **Vránová** (2005) | Cognitive level analysis according to Tollinger's taxonomy |
| **Čížková & Lustigová** (2009) | Cognitive level analysis according to Tollinger's taxonomy |
| **Knecht & Lokajíčková** (2013) | Content analysis comparing the requirements for expected outcomes of operations |
| **Šimík** (2013) | Descriptive analysis according to Tollinger's taxonomy |

[1] Tollinger's taxonomy divides 27 types of tasks into 5 categories according to the cognitive level – tasks requiring:
1. memory reproduction of knowledge, 2. simple mental operations with knowledge, 3. complex mental operations with knowledge, 4. communication of knowledge and 5. creative thinking.

## Findings & Conclusions

- There is an obvious lack of empirical research dealing with academic task in the 90's. It could be interpreted that reasons are connected to the consequences of social-political changes following the Velvet revolution.
- During the examined period there is an obvious move from quantitative descriptive research to qualitative analyses.
- Analysis of particular teaching situations are more frequent than analysis of whole lessons. Video-studies are becoming a more and more frequent tool for investigating instruction (see the Figure 1a).
- Research on cognitive level of tasks and questions still being uses categorical systems based on the Tollinger's taxonomy of educational objectives in the cognitive domain (a Czech alternative to Bloom's taxonomy) which has undoubtedly been the most influential in research on questioning in the Czech Republic in the last 25 years (see the Figure 1b).
- Quite a lot of information about using tasks in the Czech Science instruction comes from international comparative studies TIMSS and PISA.
- Result suggest that teachers prefer questions with lower cognitive level as they expect these to result in quick and correct answers from pupils. This does not seem to have changed in the last 25 years. This, however, can be interpreted as rather negative as the development of key competencies requires tasks based on higher cognitive processes.

It appears that there have been no essential changes in the types of questions teachers pose in Czech Science instruction. Instruction is highly social-culturally dependent and this may be the reason why we did not find any changes in the cognitive level of researched tasks (questions) despite the new concept of competencies which has been introduced into the Czech curricula.

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Poster was supported by the scholarship fund of the Faculty of Education, Masaryk University and by project GA ČR GPP407/12/P059 Příležitosti k rozvíjení kompetence k řešení problémů v učebnicích a ve výuce.

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