Symposium: Informatics in Primary Education: Approaches, Current Issues and Lessons Learnt

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1 Introduction

Implementing Informatics since primary stage of the formal education in one way or another is highly topical these years. Some countries have already embarked on this journey and are gathering their first experience. Others are currently initiating a similar transformation, and some other countries are currently discussing such a transformation at the political and expert levels and looking for appropriate strategies to embrace it. This challenging early state process has many facets and alternative realisation possibilities. It is precisely because of the diversity of these states of development, it is necessary and productive to exchange experiences, discuss strategies, successes and challenges, and inform each other about ongoing early research projects and their findings.

This context is characterised not only by the diversity in the approaches, but use of terms, and the diversity of educational systems as well. For the purposes of this symposium, primary education will be understood in the sense of the UNESCO ISCED classification as a level of formal school education: (1) with the entrance age usually between 5 to 7, typically lasting until age 10 to 12, (2) focusing on providing pupils with fundamental skills and establishing their solid foundation for learning, (3) often with one generalist teacher responsible for a group of pupils and facilitating most of the learning process (sometimes with some other teachers for certain specialised subjects).

The variety of the issue of implementing Informatics education is also illustrated by the glossary used to name it (Informatics, Computing, Computer Science to name most common ones), and also the multitude of approaches to its implementation. Practically always, however, a great objective of the effort in behind is to initiate *compulsory and systematic development of computational thinking (CT for short) already at primary level*. In the recent JRC EC study [1] three different approaches to integration of statutory curricula to develop CT skills are indicated: (i) as a cross-curricular theme, when basic Informatics concepts are addressed in all subjects, (ii) as a separate subject, (iii) subsumed in another subject, e.g., Mathematics (sometimes explicitly focusing on programming) or Technology.

In this symposium, we will examine some recent developments in those efforts. We will address various aspects, including curricula, teachers professional development, Informatics concepts and CT skills, related educational research activities and other topics of interest. We want to share what are the issues encountered and lessons we have learnt in various countries. Our ultimate goal is to provide some new perspectives on current challenges. More specifically we plan to focus on the following questions:

- Approaches: There are different approaches taken by various countries/initiatives. In your contribution, which approach has been adopted?
- Challenges: In the process, many different challenges arise. In your case and experience, what are the issues you have to tackle? What are the strategies you have considered or are considering applying?
- Lessons learnt: What have you already learnt in the process, what are the methods or designs you have applied, what are the findings within this context? Here we provide opportunity to share what has already been learnt in the process in a standard academic research sense.

The symposium will comprise a series of twelve short contributions arranged in three clusters – according to three (hardly separable) leading questions of the symposium – with opportunities for discussion at the end of each cluster.

The first cluster of six papers focus on recently implemented or planned to implement Informatics in primary education national policies, strategies, future teachers and in-service teachers education, curricula, etc., in different countries.

Next group of three papers report on countries with certain (yet very young) history of having informatics already implemented, analysing early experience, evaluating it, improving or modifying the strategy. The third of these contribution addresses not yet well-established issue of digital accessibility.

The remaining three papers look ahead to what lessons we have learnt so far, including some early findings of various research projects and initiatives.

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Broadening Participation of Elementary School Teachers and Students Through Curriculum Integration and Statewide Collaboration

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The Broadening Participation in CT project developed, tested, and disseminated high-quality, rigorous modules integrating computational thinking (CT) with mathematics and science content to improve Computer Science (CS) education and increased students' access to activities that build computational thinking skills. The project provided capacity building technical assistance and support to first through sixth grade classroom teachers and resources to guide implementation[1] [1].

This effort helped teachers implement the Massachusetts Digital Literacy/Computer Science Standards within the context of compulsory education, broadening the access to CS education within the state. As a state driven by a high-tech economy, building foundational CS skills within compulsory education is seen as a long-term investment in the state's human capital.

In addition to the challenge of building capacity of compulsory education teachers to integrate Computer Science and computational thinking into their curricula we found that many grade 1-6 educators needed support to strengthen their science instruction. Many educators had misconceptions related to science concepts as well as limited science content knowledge and pedagogical support. As a result, the project team focused first on professional development to strengthen teachers' science knowledge and pedagogy, and then focused on developing strong science modules that integrated computational thinking and finally enhancing these with web-based instructional supports.

Important findings indicate that non-Computer Science teachers, with appropriate resources and support are able to strengthen their pedagogical content knowledge while introducing computational thinking into compulsory curricula and helping their students develop foundational skills, knowledge and attributes needed to begin a pathway to CS and CS-enabled careers.

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Informatics curriculum in primary schools in Lithuania

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In 2019, the Ministry of Education, Science and Sport of Lithuania developed new guidelines for pre-school, primary, basic and secondary education (www.mokykla2030.lt). In 2020, one hundred primary schools started to pilot the proposed Informatics curriculum. The pilot targets to develop learning resources and teacher training framework. The full-scale implementation commences in 2023.

The revised curriculum includes fundamental CS topics divided in four key areas with two cross-curricular topics:

- *Creation of digital content*. Essential skills of working with digital devices; managing textual, graphical, numeric, visual, audial information; information visualization and presentation; digital content creation.
- *Algorithms and programming*. Solving problems: algorithm, action control commands (sequencing, branching, looping), programming in a visual programming environment for children.
- *Data mining and information*. Working with data skills: problem analysis, data collection, sorting, search and data management, content quality evaluation.
- *Technological problem solving*. Essential technical and technological skills of working with digital devices: solving technical problems, evaluating and identifying suitable technologies for the selected problem, creative use of technologies.

Additionally, virtual communication and collaboration as well as to safe behaviour including ethics and copyright issues are covered by Informatics curriculum.

Several interesting observations on Informatics implementation in primary schools in Lithuania, also Slovakia and Norway, can be found in the report [1].

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Informatics in Teacher Education for Primary School Education

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In 2014, under the Government's Digital Education Strategy, the Ministry of Education, Youth and Sport of the Czech Republic (MoEYS) decided to revise the curriculum for primary, lower and upper secondary school education. One concrete result of the revision (which is still ongoing) is the replacement of the subject of 'ICT' by 'Informatics' with new educational content aimed at computational thinking (CT) development, and the introduction of digital competence as a key competence to be developed across all subjects at all levels of education. These changes are to be put into practice in pre-school, primary and secondary schools this academic year 92021/22), and no later than 1.9.2023 [1]. For Informatics Education, teachers can use a set of textbooks and teaching guidelines which were developed in a national project, 'PRIM' [2].

The Czech Republic has a long tradition of teacher education for primary school education provided at nine pedagogical faculties in the form of a five-year MA study programme. Faculties of Education have now to prepare primary education student teachers to develop pupils' CT in the 'new' distinct subject of ˈInformaticsˊ within four main topics: (1) data, information and modelling; (2) algorithmisation and programming; (3) information systems; (4) digital technology. Since primary school teachers usually teach all subjects in the primary education curriculum, some Informatics' concepts can begin to be built in other subjects (e.g., mathematics and languages).

At Charles University's Faculty of Education, primary education student teachers complete some studies through which their digital competences are developed and during which they master the use of digital technology in primary school education (interactive white boards, etc.). In order to be prepared for Informatics Education in primary education, two consecutive obligatory courses, 'Digital Technologies in Primary Education' and 'Didactics of Digital Technology' were included in the MA programme. The first is organized, for about 100 student teachers, as a set of interactive lectures focused on Seymour Papert's constructionist theory, key concepts, textbooks for Informatics, and examples of activities for CT development without using computers. The second, in a computer lab, is a set of practical exercises in robotics, programming in Scratch, etc.

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Comments on Informatics as a Subject in Austrian Primary Education

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The formal Austrian school system encompasses primary level (grades 1-4, age-groups 6/7-10), lower secondary level (grades 5 to 8), and upper secondary level (grades 9-12/13). Despite ambitious local, regional and national interventions, initiatives and projects, Informatics education in Austrian primary schools is (still) not widespread and sustainably rooted, and moreover, lacks cohesion, consistency and a sequenced structure. The reasons are manyfold and range from (mostly female) teachers' attitudes, lacking infrastructure and the absence of binding curricular requirements.

In contrast to (encouraging) recent developments with regard to lower secondary level in form of digital devices for all pupils and a new compulsory subject "Basic Digital Education", Informatics in primary education is still lagging behind, not at least also due to organisational issues and the lack of concerted political efforts. It will be interesting to observe how the new curriculum for all subjects which will come into force beginning with the schoolyear 2023/2024 will change the situation around Informatics in Austrians primary education within a foreseeable time in a nation-wide and sustainable manner. Till now this field is "rather a digital desert with growing oases" as a head of an educational institute expressed it allegorically. This applies to all digital aspects of most of the primary schools in general, and to Informatics education in special. The latter is broadly anchored in the new curriculum within some subjects as a "teaching principle" which is "to be obligatorily taken up in the lessons". Moreover, there is a comprehensive subject called "Sachkunde", with competence areas such as (social) sciences, history, geography and technology, where competencies "to program simple instructions" in grade 3 and "applying the automated processing, storage and communication of information" in grade 4 are explicitly stated. And last, "Basal experience with Robotics and coding of messages and microcomputers" are optional application areas within the newly designated subject "Technology and Design".

However, the above mentioned current digital desert is permeated by a network of flourishing oases, of which some are already dried up. But some [1] are in form of nationwide projects still alive, continued and extended. Currently, much expectations are placed in the project "digi.case" building on a ministerial project "Learning Thinking-Solving Problems" which will encompass concepts like unplugged activities, computational thinking, puzzles, Beaver tasks and apps for coding.

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About the ecosystem of Computer Science education in primary school – challenges in Bulgaria

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In the last years a lot of countries have started developing and implementing new curricula in their schools with focus on Informatics/Computer Science concepts, computational thinking, and algorithmic thinking. Compulsory or elective school subject Informatics or Computer Science (or similar) has been introduced in different school levels in different countries. Informatics education in Bulgaria started in the end of the 1960s years as elective courses in Mathematical high schools. As a compulsory subject it has been involved into school curricula from 1986/87 school year. During the years there were changes regarding the place of the subject in the school curriculum. In 2016 a new curriculum was introduced and a new subject "Computer Modelling" was involved for primary school students in 3rd and 4th grade (9- to 10-year-olds). As of 2021/22 school year topics related to programming are included in the new subject "Computer modelling and Information technology" for the students in 5th to 7th grade.

As every new entity the new school subject and curricula set challenges and problems in front of all stakeholders – teachers, parents, students, etc. Some of these challenges could be outlined as follows:

- Providing enough teachers with relevant competency to teach new subject.
- Identifying readiness and needs of teachers to effectively teach new subject.
- Choice of appropriate programming environment. For 3rd, 4th and 5th grade the syllabus requires block-based environment and in the 6th and 7th grade students should learn about script programming based on Python or Java Script.
- The syllabuses include a lot of abstract concepts like algorithm, loops, branching, variables, digital identity, subprograms, functions etc. These concepts must be precisely defined and at the same time to be presented in accessible manner for the 9- to 13-year-olds.
- Implementation of basic concepts in block programming environment and script programming environments in main topics of the syllabus requires usage of concepts that are part of mathematics curricula in next grades – negative numbers, coordinates, measurement of angles in degrees, random number, functions.
- Providing educational resources – textbooks, interactive learning materials etc.

Solutions of the challenges depend on different stakeholders: government pol-icy, universities and other institutions that provide teachers' training, publishers of textbooks, teachers. During the symposium the different issues of the ecosystem of Computer Science education in Bulgaria will be presented. Current syllabuses, national programs and initiatives for teacher training, educational institutions efforts, opinion of the teachers regarding new subjects and raised problems will be discussed. Also, some didactical issues that will help teachers to introduce abstract content for 9- to 12-year-olds will be presented.

Embedding Computational Thinking in Irish Primary Schools

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The Draft Primary Curriculum Framework (DPCF) developed by the National Council for Curriculum and Assessment (NCCA) in Ireland, released early in 2020 was planned to form the basis for extensive consultation to October 2020. The document was intended to encourage and support discussion and debate about a redeveloped curriculum for primary schools and the framework was to be finalised and published in early 2021 with the development of a specification for subject area by 2024. Of particular interest to this symposium is a new grouping of subjects, Mathematics, Science and Technology Education (including compu-tational thinking). Progress was hampered due to the global Covid pandemic.

A significant development in this DPCF is the inclusion of a set of core competences designed to be a central part in children's learning, which are to be em-bedded across all curriculum areas and subjects from junior infants to sixth class through the learning outcomes. Being a digital learner is one of these core com-petences. It is defined in the draft curriculum framework and a set of attributes are articulated which describe the learning and development opportunities which will be embedded in each of the curriculum areas and subjects in the curriculum framework for primary schools. These include (i) communicating and collaborat-ing with others through digital technologies, (ii) accessing, analysing and manag-ing content using digital technology (iii) enabling content creation, problem-solving and creativity using digital technology and (iv) interacting ethically and responsibly with digital technology (NCCA, 2020). T

The NCCA have been investigating possible approaches to the introduction and development of computational thinking in primary schools (NCCA, 2016, 2017; Millwood, 2018) but specifications have not been developed. The authors wrote the anchor paper for this core competence, aspects of which they will pre-sent as part of this symposium.

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Computing in English Primary Schools: a more coherent approach

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In 2014, England replaced information and communication technology (ICT) with a new subject, computing, in its national curriculum. The new subject included programming and other aspects of Computer Science alongside aspects of critical digital literacy such as online safety. Uniquely, the subject required primary school teachers to teach material few of them had learnt whilst in primary school themselves. Whilst much thought had been given to the content of the curriculum, details of implementation such as pedagogy, training, resources, assessment and incentives were largely seen as not the responsibility of central government. Sector led initiatives focussed on improving subject knowledge in relation to programming and computational thinking, and in facilitating peer to peer support through local hubs and 'master teachers. Commercial publishers released schemes of work for computing alongside lesson plans and other resources developed by teachers. Such initiatives were welcomed by many in schools. but lacked the coherence to effect the change needed at national scale.

It is thus unsurprising that by 2017 the state of English computing education was described as 'patchy and fragile'[2]. Substantial central government funding was secured to establish a National Centre for Computing Education (NCCE), tasked with supporting computing teachers' professional development, through face to face and online training. Other NCCE activities have included the development of a comprehensive scheme of work for primary computing, enhanced support for local communities of practice in computing through Computing At School, collaboration with the Oak National Academy to offer online learning for pupils during the periods of lockdown in response to the COVID-19 pandemic and an accreditation scheme for schools.

The transition from multiple grassroots implementations of England's computing curriculum to a more centralised approach drawing can be seen as necessary and largely effective. The very brief requirements of the curriculum have been expanded as a carefully sequenced syllabus, with high quality teaching resources and assessment materials. A set of pedagogic principles derived from research have been articulated and are evidenced in the lesson plans available. Many teachers have engaged with centrally designed professional development activities, and there is now a stronger sense of a national entitlement to a high-quality computing education in practice rather than merely by intention.

Challenges remain, including the need for computing to be given sufficient curriculum time and priority in all schools, the opportunities to interweave computing with other subjects studied in primary schools, and the desire to allow scope for both teachers' and pupils' experiment and creativity in primary computing.

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Informatics education in K-6 as an integration of concepts, methods, tools and pedagogical theories

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The present curriculum for Informatics as a compulsory subject for all four school levels in K-12 education in Poland has been introduced in 2017-2019. The grades 1to 3 are called the early-school education (E-SE). Some years ago, E-SE was called integrated education. Today, although the curriculum for E-SE consists of several "subjects" called educations, one teacher is responsible for a class of pupils and facilitates the learning process of all educations with some exceptions like foreign languages, and, unfortunately, Informatics. Teachers in E-SE are typically graduated from pedagogical faculties and trained in core subjects including only basics of ICT. In the last 3-5 years however there have been many initiatives sponsored by EU founds addressed to teachers (not only in E-SE) which aimed at teaching programming and robotics.

There are two main challenges which faces Informatics education in E-SE:

1. Preparation of teachers in E-SE to integrate Informatics with other educations,
2. How to implement the Informatics curriculum to be sure that pupils get skills and knowledge assigned to E-SE level of education which then is required at the next level of education – according to our approach of spiral development of skills, knowledge and competences through all years in K-12.

With regard to item 1, we have been very successful in convincing our Ministry of Education to finance in-service training for E-SE teachers and such courses for 120 hours are presently offered by 7 universities with CS and pedagogical faculties. The framework for this courses has been proposed by the authors of the curriculum. The main message to teachers at the course is: "you have to be prepared to integrate Informatics with other educations, no rescue from other teachers".

Regarding item 2, our main goal at the training is to show teachers how to plan and arrange activities for pupils to meet the curriculum requirements which refer to some concepts on logical, abstract and algorithmic thinking, algorithms and representation of information and also programming algorithms, organizing, searching and sharing information, utilizing computer applications. All problem situations should come from the environment of pupils. The teachers use various tools: physical objects, robots and their accessories, programming environments, etc.

We prepare teachers to use concept-oriented approach, e.g., pupils can sort: garbage (not only numbers), pictures on the floor, pictures which are to form an algorithm, numerical values; they can use robot for sorting or some applications, etc. In a series of Sudoku puzzles, pupils use abstraction, decomposition, algorithmic thinking and generalizations, not conscious that they are computationally thinking. We propose to start programming lessons with code.org and then move to Scratch and Blockly in robots. It is important to notice that all blocks contain text what helps students in moving to textual programming.

Accessibility Domino In The Informatics Education

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In the 21st century globalization and diversity in education community influence the process of education that face new challenges in digital skills and literacy. On the one hand, there is a need to equip teachers with global competency and digital skills to prepare pupils, students and would-be-teachers for global and digital workplace. Considering the digital learning environment in the 21st century, it should be noticed that this is a multilayer group in which both teachers and pupils must adapt to the dynamic and digital technologies.

According to The Digital Competence Framework for Citizen (DigComp) published in 2022, educators should be aware of digital accessibility, which means that they know how to create accessible digital content following official standards and guidelines e.g., Web Content Accessibility Guideline (WCAG) 2.1 and EN 301 549. The framework is well designed, however, there is a spectrum of required accessibility rules that have not been implemented in any university or college syllabi to educate Informatics teachers. As a result, educational programmes right from the start in primary schools do not include topics concerning digital skills and accessibility, which should be interrelated. What is more, the 21st-century globalization skills have changed and transformed. As a result, the roles of teachers, especially in Informatics education, must change so as to equip pupils with digital accessibility skills. Then, it should be noticed that the participants of the teaching-learning process face a range of barriers because of the lack of implementing accessibility in teacher education programs.

The whole teaching-learning process resembles domino with three elements. The first one refers to teachers who are aware of social competences, technological literacy and pupils diversity that is not limited to disabilities. Then, second element concerns pupils who participate in the process of education and should know how to implement digital accessibility in their daily activities via a spectrum of exercises covering good colour contrast, readable fonts or well-designed posters. Finally, a wide range of future employees who know how to create accessible digital content as their learning process (that begins in primary school) promotes responsible and global awareness. Unfortunately, this tripartite approach is limited to the notion of accessibility that is perceived as an issue referring only to disabilities. To sum up, the pedagogical framework should bridge from digital awareness to the notion of accessibility so as to effectively prepare learners for the global marketplace.

Elective Subject Computer Science in Primary School – the teachers' opinions

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In Slovenian primary school, the subject of Computer Science (CS) is still not part of the compulsory curriculum. However, since 2014 students have been able to take CS as an elective subject in grades 4-6.

Currently we are working on introduction of CS as a compulsory subject from kindergarten to the end of secondary education (ISCED0-3). Therefore, we are particularly interested in what are outcomes of the elective subject. Unfortunately, only the monitoring report for electives for the 2015/16 school year (published in 2018) [1] provides some data on the elective CS subject. This data shows that almost 100% of teachers participating in the survey agree that the definition of learning objectives and knowledge standards for CS subject are understandable, but only about 70% agree that they are achievable. Even fewer teachers (about 60%) agree that the subject is adequately integrated into the curriculum.

We are conducting a survey of teachers who act as mentors in two competitions, namely the Bebras Competition for Computational Thinking and the Pišek Competition for Block-Based Programming. We will report results on the following research questions. The first one is how participation in an elective CS affects success in the Bebras and Pišek competitions. Do the same students participate in both competitions? Are the same students successful in both competitions? The next research question is: Do teachers believe that choosing CS contribute to the development of students' computational thinking, as reflected in their success at the Bebras competition, and do students deepen their understanding of algorithms and programming, as reflected in their results at the Pišek competition?

In addition to these questions, we are interested also in what the teacher-mentors think about the elective subject of Computer Science, so that we can pre-pare practical teaching materials and activities for a compulsory subject in the future.

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Educational Robotics: A Lexical Analysis of Teachers' Resources

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In the recent years, several countries introduced Computational Thinking or Computer Science as a mandatory subject in primary education. Many activities are based on the use of tangible artifacts such as robots. According to the field experience of the authors, those robots are often presented during teacher education's workshops as mostly equivalents, or at least their specificities are only slightly described.

But we can identify two main differences between the most common types of robots: some of them rely only on sequential programming, i.e.: the program is defined as a sequence of ordered instructions having a beginning and an end (e.g.: Bee-Bot, Blue-Bot); some others may use a programming language leading on event-driven programming, associating events and actions to define their behaviour (e.g.: Thymio, Ozobot).

In one case or in the other, the activities based on those robots may be related to different Computer Science concepts: Algorithm, Sequence, Instruction, … in the one hand and Sensor, Event, Machine, … in the other hand.

The authors formulate the hypothesis that there is a dependency between the vocabulary used by teachers in the pedagogical resources they produce and the type of robot that those resources cover.

We brought together a corpus of 59 teaching resources authored by pre-service teachers from 3 different institutions in two French-speaking countries and 61 teaching resources in French from the web, those being authored by expert teachers or teams. All those 120 pedagogical resources were based on the use of educational robots to teach programming.

We categorized this corpus of 120 texts according to: authors category (Pre-service/Experts), type of robots (Bee-Bot, Blue-Bot, Ozobot or Thymio), country (France, Switzerland) that influences the national curriculum that was referred to. Three sets of terms have been extracted from the lexicon according to the following themes: Computer Science (CS), Pedagogy and Movement. We applied Correspondence Analyses on those sets of terms and analysed their dependencies with the source texts.

In this corpus, (1) experts' productions use more CS words and less Pedagogic words than pre-service teachers' ones; (2) Texts relying on sequential programming robots (Bee-Bot, Blue-Bot) tend to use more frequently Movement terms than event-driven robots (Ozobot, Thymio); (3) statistical analysis shows that robot types and CS (respectively Movement and Pedagogical) terms, are dependent for both author types (preservice, experts). Our communication will present in greater detail our research results.

Levels of Control in Primary Robotics

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For more than five years we have been intensively and purposefully developing educational content for Informatics as a subject in primary education (in our case, this means Years 1 to 4, ages 6 to 10) under the overall name *Computing with Emil*. One of the important motives why we are doing this is to develop a set of research instruments suitable for investigating the cognitive process of pupils in the early stages of their computational thinking (CT) development.

Part of the above project is also a thread devoted to educational robotics, which we have been doing since Year 1 in every year of our primary school. We use Blue-Bot programmable floor robots for this purpose. With the robots we also use blue plastic panels called TacTile Readers, which teams consisting of two to four pupils wirelessly connect to their robots and use small plastic command cards to control them.

One of the interesting research areas we explore in this context is the forms and levels of control of a virtual and tangible character (in our case, Emil on the screen, or Blue-Bot Ema, as we call our robot). In doing so, we draw on Blackwell [1], who believes that pupils *program things whenever they stop directly manipulate observable things but specify behaviour to occur at some future time*. Blackwell continues by pointing out two reasons why programming is hard: (a) loss of the benefits of direct manipulation and (b) introduction of notational elements to represent abstraction.

In our previous research on forms of control in Computing with Emil for Year 3 [2] we identified four levels of increasing cognitive demand, namely (i) *direct manipulation*, (ii) *indirect manipulation*, (iii) *direct control*, and (iv) *computational control*, i.e., programming. As a complementary second dimension to control, we also identified five levels of how the process itself can be represented. It may have (1) no representation, or be an (2) internal record, (3) external record, (4) internal plan, or (5) external plan – a program using certain notation, as common in programming.

In our current research within robotics thread of the Emil project we try to validate this two-dimensional structure. We explore the cognitive demands of different forms of control applied in Years 1 to 4. In the symposium we will present our findings, the most important probably being the following: If using the TacTile panel to control Ema from the very beginning (which in our case is Year 1 with pupils aged 6 to 7), the cognitive demands of the transition from *direct control* to *programming* are virtually non-existent. In the paper we will explain the reasons for this and present our pedagogy.

References

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Informatics in the Primary Social and Science Education

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The new core curriculum for the Primary Social and Science Education (PSSE, ger. *Sachunterricht*) in Germany addresses informatics competencies that have not yet been embedded in teacher education. Therefore, in various projects in German-speaking countries such an embedding is being tested and material for informatics in primary school is being developed.

The project *Informatics Education as a Perspective of Primary Social and Science Education* presented here is based on a cooperation between the Universities of Wuppertal, Duisburg-Essen and Münster. Students should acquire informatic-specific (didactic) knowledge and teaching methods in preparatory and accompanying seminars for their teaching internships during their studies. In this way, students gain an insight into informatic principles in the first phase of their education, which enables them to teach with and about digital media. In order to support the embedding of informatics education in the subject, the three mentioned universities in our project developed and evaluated materials, which are available as Open Educational Resources.

At the University of Duisburg-Essen, a learning unit about machine learning principles based on smartphone apps for the automatic identification of leaves has been developed and tested with two school classes. In addition to this material, guided interviews with teachers about the state of informatics in primary schools have been conducted at the University of Wuppertal. The material, the test results and the interview responses will be presented in this symposium. With this project, teacher students will not only gain insights into informatics competencies, but the students are also considered as multipliers for the teachers of their respective internship schools.