The Teaching-Learning-Lab
Digital Literacy and Computational Thinking for Everyone

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Keywords: Teaching, Learning, Computational Thinking, Digital Literacy.

Abstract: As advancement of the already successful Informatics Lab in 2016 a Teaching-Learning-Lab (TLL) was implemented with the main aim of supporting all teacher education departments of our university to teach and practice digital literacy and computational thinking as "fundamental skill for everyone" (Wing, 2006) in different ways. Our support is based on three pillars: equipment, know-how and research. Scientists, (future) teachers and students can use the rooms (creative, experimental and observation lab), the technical equipment and instructional technology for planning, designing, holding and/or observing and analyzing teaching units. We offer workshops for digital literacy and computational thinking in and for different subjects. Our main research focuses on the connection of computational thinking to other disciplines and its impact on problem solving and text comprehension. Furthermore, the Teaching-Learning-Lab offers research possibilities for scientists and students in different areas concerning teaching and learning. We enhance cooperation between schools and university and give support in finding research questions for master or PhD-theses in didactics, conducting teaching experiments. The paper describes challenges and opportunities of the Teaching-Learning-Lab in fostering the digital literacy competences and computational thinking of the target groups.

1 INTRODUCTION

In 2006 Jeannette Wing postulated that computational thinking (CT) should be „a fundamental skill for everyone, not just for computer scientists" (Wing, 2006). She describes computational thinking as a complex skill, which is fundamental to manage future life's challenges. It's a way to think in different levels of abstraction, for which theories and tools from computer science can be used helpfully. Computational thinking includes problem-solving skills, which are needed in any domain and therefore should be trained as well as possible in primary and secondary education. Within these 11 years, many positive developments can be determined. For example, the importance of computational thinking is fixed in the curriculum since 2014 for K-12 schools in England (Wing, 2016). Unfortunately, public schools do not always cover this demand adequately in Austria. The government responds to this lack lately. In January 2017 the Austrian Federal Ministry of Education presented the digitizing strategy with the aim of fostering the digital literacy starting at primary school level.

An extra-curricular initiative with the same aim is the Informatics Lab, which is part of the Regional Educational Competence Centre (RECC) of Informatics at the Alpen-Adria-University Klagenfurt. It aims at implementing computational thinking as a general (learning and problem solving) skill by addressing children and their parents as well as teachers and teacher educators of all subjects. The main concern is to show, that computer science concepts and techniques (e.g. modeling with UML-diagrams) understood as higher order thinking skills, can be useful and motivating tools for teaching and learning in different subjects. Wing (2016) postulates that a main research question is to find out what computer science theories should be taught, at which age and how. In the Informatics-Lab we have positive experiences with teaching the concept of modeling and transferring it to different subjects (Sabitzer and Pasterk, 2015). The main focus in the Informatics-Lab is on creating teaching and learning materials to foster computational thinking skills in children. One special aspect is that we create materials, which are independent of a computer,

Demarle-Meusel, H., Sabitzer, B. and Sylle, J.
The Teaching-Learning-Lab - Digital Literacy and Computational Thinking for Everyone.
DOI: 10.5220/0006367001660170
In *Proceedings of the 9th International Conference on Computer Supported Education (CSEDU 2017) - Volume 2*, pages 166-170
ISBN: 978-989-758-240-0

following in part the ideas of CS Unplugged (Bell, 2011)

To get a more widespread effect and focus on additional target groups, the Informatics-Lab was extended to a Teaching-Learning-Lab (TLL) for students and teacher educators as well as teachers. Learning-Labs are characterized by presenting a setting, in which persons are able to work on practical problems. Ideally in groups of two or three persons problems were discussed and possible solutions were developed. After this process, proposed solutions can be evaluated based on assessment criteria (Flechsig, 1979). Repenning's (2015) understanding of computational thinking based on the assumption of Wing (2016) focused on the same trisections: 1. Formulating the problem 2. Representation of a solution and 3. Implementation and evaluation of the solution. In the setting presented by the TLL, the learner takes an active role, according to the principle of participation and designs his/her own learning process (Pallasch and Reimers, 1990). The learning opportunities in the TLL are consistent with the concept of CT.

Our main research focuses on how to create a setting, which is fruitful to disseminate the idea of computational thinking as a fundamental skill. It is intended that the setting of the TLL is able to foster the ability of computational thinking in different target groups. In the following sections, the development of the TLL and its offers are described. Furthermore, we discuss the challenges we are facing with and the opportunities we see for the future.

2 THE TEACHING-LEARNING-LAB

The Teaching-Learning Lab is initiated and managed by the School of Education, a division within the Alpen-Adria-University Klagenfurt that is devoted to the field of teacher education, located in the Lakeside Science & Technology Park.

The TLL is dedicated to supporting and strengthening the teaching community of our University providing academic researchers, teachers, students and pupils with unique opportunities to create learning environments using the power of knowledge and the promise of education. It offers a variety of resources and services on teaching and learning ranging from group events (e.g. workshops, learning communities, teaching demonstrations) to personalized approaches to teaching and learning enhancement (e.g. classroom observations, books and other resources on teaching).

2.1 The Contents

2.1.1 Teaching and Learning

The TLL provides support for continuous innovation in and enhancement of teaching and learning. This includes workshops, meetings and conversations on a variety of teaching and learning topics. Each appointment offers the opportunity to discuss and share experiences on current issues in teaching and learning with focused support around topics such as teaching and learning techniques and common pedagogical challenges. The TLL also provides opportunity and support to engage deeply in collaborative discussions about enhancing teaching and learning. Participants are invited to meet regularly throughout the academic year to explore a specific area of interest with the opportunity to develop professional knowledge and skills through activities such as workshops, discussions and readings. Furthermore, all participants can benefit from our pool of ideas, expertise and materials for their own teaching or learning as well as for research in all related fields.

2.1.2 Learning Technologies

The TLL provides computing and multimedia resources to meet a wide variety of technology needs. The setting allows testing the usability of multiple products including 3D printing, image processing (e.g., Photoshop), web design and other software designed to meet the needs for technology-enhanced space for individual and group learning and teaching.

Laptops and tablets enable visitors to connect, collaborate, and interact individually or collectively.

The TLL is also equipped with a digital SMART Board, which can be used for a variety of applications.

There are also workarounds that enable visitors to record audio and video for peer and self-assessments. Educators can use the audio and video equipment to hone their instructional delivery by recording themselves and analyzing their own performances as they view the reactions of participants. Not only can content be captured and reviewed, there is also the possibility of live-streaming interacttive audio and video presentations, lectures and meetings to individuals or groups with the option to view content live in a room, adjacent to the main

room, to provide helpful feedback in the development and evaluation process.

2.1.3 Developing and Disseminating

The TLL works with participants to develop "reusable educational material" and the broader field of education, including teaching cases, simulations, assessments, activities and other assets.

As a unit within the Alpen-Adria-University Klagenfurt, the TLL establishes and maintains collaborative relationships with other departments of the University, including the departments of teacher education, as well as with schools and other educational institutions. The TLL also provides a forum for testing and can be used for many different research purposes assisting with focus groups, comprised of pupils and their teachers from primary and secondary schools.

2.2 Resources Available

The TLL is an active learning and research space that is designed to support, develop and evaluate innovative and effective approaches to teaching and learning providing academic researchers, teachers, students and pupils with unique opportunities to explore active learning pedagogies. The Teaching-Learning-Lab includes several independent labs:

The InformaticsLab is an open lab for children between four and fifteen years enabling them to get in touch with technology and to explore the basic principles and concepts of computer science and digital literacy in a playful and exciting way.

The CreativeLab is a facility for teaching, research and creative collaboration, which offers hardware (set up for use), a specialist library (the collection currently includes popular didactics books, books on computer science, textbooks, teaching resources, journals, current periodical titles) and an interactive SMART Board.

The TeachingLab is a large multipurpose classroom equipped with video and audio technology (with potential for audio-video-based teaching observations) supporting seminars, lectures, meetings and presentations

The LivingLab is fully equipped small apartment, a platform that encourages application of knowledge to the real-world context implementing different smart technologies and models. It further offers the possibility to do research on informal learning or behavioral studies.

The ControlRoom is an area equipped with computers and designated for the monitoring and operation of the entire technical infrastructure to ensure that the most appropriate technology is specified for each individual project. It allows participants to observe, record and analyze e.g. lessons with school classes in order to improve their own teaching.

2.3 Target Groups

Current teachers and new graduates

The TLL is deeply involved in supporting current teachers and new graduates entering the teaching profession. Lab classrooms provide the context to experience in-depth, sustained professional growth within a collaborative learning community with a variety of instructional materials (videos, simulations, worksheets etc.) and technology to support the teaching process.

Academic professionals

The Labs provide an authentic opportunity for academics and researchers to see ideas in practice with the possibility to share knowledge with other participants and benefit from opportunities to self-assess, self-monitoring and peer review to make judgments about their teaching receiving feedback from others.

Students

The TLL allows students to hone in on their areas of study while being presented with the opportunity to use all available resources. The Lab also offers interesting and challenging semester and master projects for students providing help in finding and adjusting research questions.

Students are welcome to brainstorm with other participants and get academic support and additional input on teaching and learning with variety of technologies to support teaching, learning, and assessment. Especially teacher students are welcome to give lessons to or get involved in projects with our partner schools in order to get more practice before entering their school life.

Pupils

Pupils can take advantage of the wealth of academic support and resources provided. They can also take the opportunity of internships with the Science and Technology Park being a perfect location to host collaborative research and diploma projects. Furthermore, they can discover computer science concepts, train their digital competences and learn to apply technology and some useful computer science techniques (e.g. modeling) in order to sup-

port their own learning (see also section 3.2 CT for everyone).

3 CHALLENGES AND OPPORTUNITIES

The lately implemented Teaching-Learning-Lab has great potential in fostering computational thinking and digital literacy within teachers, students and pupils. Achieving this objective involves handling some challenges we are facing. On the other hand, these challenges are great opportunities in order to advance the research in computational thinking (CT).

3.1 Assessment of CT

Assessment of CT often goes hand in hand with analyzing programming capabilities (Werner et al., 2012; Fields et al., 2012; Han Koh et al., 2010). A significant challenge in research is to design an assessment tool for CT, because we are teaching this way to think and handle problems often without using technology equipment like programming software. A main research question will focus on developing an assessment tool to map CT processes regardless of programming software. Our main research will focus on the transferring process of patterns underlying computational thinking. Our opinion is that if people are able to use e.g. the concept of modeling adapted for their specific problem or the whole subject, they implemented this way of thinking in their everyday life.

In our research we will support this transfer process in different ways. The first step is that they will get used to the concepts and way of use of computational thinking. Materials and tasks will be presented and are ready to use. In a second step, they will be strengthened in using and transferring their knowledge, in finding solutions for problems they are facing, e.g. “how can I implement this didactical method within my lesson?” One possible way we see is in the process of transfer knowledge into different subjects. If teachers, students or pupils are able to use a certain tool or method to get to a solution in their own created question/problem – we get to know, if the way to solve a problem focuses on computational thinking. For this we have to operationalize the main components of CT. Different authors focus on different core components constituting computational thinking. Wing (2008) highlighted abstraction as prominent component. The abstraction process is about to differentiate important from unimportant content, or simplifying from the concrete to the general (Barr and Stephenson, 2011). Whereas Barr and Stephenson (2011) name nine main components of CT. Yadav et al. (2017) define Computational Thinking as problem-solving skill set – problem decomposition, algorithmic thinking, abstraction and automation. The assessment of CT will be based on different theories to create a set of indicators measuring the level of CT.

3.2 CT for Everyone

The TLL focuses on different disciplines. An important issue is to get persons from outside the field in touch with CT. But how can we support people to really understand the concept rather than just using a tool? An ineffective way is to teach them to the test. A big challenge is to impart this way of thinking, the way to solve problems. Teachers, especially from primary schools, have lacking confidence teaching computer science. To take this doubt, aspects of CT are connected with their subjects. Teachers and students find out, which benefit they have from using CT. Because of this experience the inhibition threshold can be lowered. The following figure shows an example of introducing modeling in primary education. In this case we use an entity-relationship diagram, which usually visualizes the structure of a database. Figure 1 demonstrates that entity-relationship diagrams can also be used in language lessons as a tool for planning and constructing new stories or for summarizing a given text.

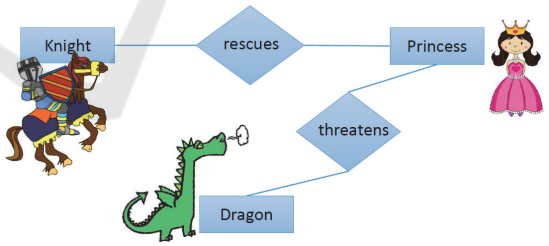

Figure 1: Entity-Relationship diagram “Fairy tale”.

3.3 Implement CT into University Didactics

To get a widespread and long-term effect implementing CT in teacher education as well as in the Austrian school system, the setting of the TLL holds great potential. As described above, the TLL focuses on different target groups: teachers, university professors, students and pupils. CT should be a permanent part of the teacher education and training. A big challenge is to implement this setting

into the common university didactics. Different offers will force this process, e.g. offering training in digital literacy and CT for students. In the next years we will face the challenge to foster CT in the context of university didactics beginning with the concept of modeling where we have already some positive results.

4 CONCLUSIONS

Within this setting, the Teaching-Learning-Lab of the School of Education has the possibility to enhance the digital literacy efforts of the Austrian government. The strategy will be implemented in the next years in the Austrian school system. There will be a need to educate teachers and students in the field of digital literacy. The TLL will focus on imparting knowledge concerning digital competences; our demands go far beyond that. As RECC (Regional Educational Competence Centre) we focus on computational thinking not only for persons who are connected to informatics, but for every subject. Our aim is to promote the postulate of Wing (2006) that computational thinking is a fundamental skill for everyone and our opinion is that the TTL is a promising setting.

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