From Digital Competence to Informatics Education – Structuring a Wide Field

Peter Micheuz, peter.micheuz@uni-klu.ac.at
University of Klagenfurt, Software Engineering and Soft Computing, Didactics of Informatics, Universitätsstraße 65 – 67, 9020 Klagenfurt, Austria

Abstract
In Austria, a major school reform of the final exam (Matura) will be put into action in 2015. All subjects, Informatics included, will be affected. Its underlying philosophy is a strong competence orientation. This short paper discusses the current state of a coherent and comprehensive framework for Informatics education, building on a similar model for digital competence at lower secondary level. Finally, one sample task will be presented to illustrate how a concrete task can match an abstract model.

Keywords
reference framework, informatics education, competence orientation, curriculum, secondary education

INTRODUCTION
Since the late 1980s, Informatics, ICT and Digital Media education at the lower and upper secondary levels in Austrian schools for general education have shown a very inconsistent picture. This paper outlines a comprehensive and coherent framework of Informatics, IT and digital literacy education for Austrian students at secondary level. Accordingly, Austria is in line with some other countries and organizations which endeavour to foster and implement ICT and Informatics (computer science) in general schools (Unesco, 2002, ACM, 2010). Currently, some major school reforms deal with a rigorous outcome orientation in form of clear expectations about results of formal learning. Competence is the prevalent term in this context, addressing the students’ applicability of knowledge and skills. Competences include skills, knowledge and motivation to cope with new situations (Weinert, 2001). According to the American Heritage Dictionary, competence means “the state or quality of being adequately or well qualified respectively a specific range of skills, knowledge, or ability.” The level of a competence is measured by completing tasks and solving problems.

A VIABLE DISTINCTION – CS (Informatics), IT and DL
In contrast to traditional subjects such as German, English, Mathematics and Natural Sciences with elaborated curricula for each age-group, computing at schools has still to fix the problem of an unclear terminology. Prominent organizations of UK, including the Royal Society, agreed on four main fields describing computing at schools with a clear distinction and sound definitions (UK, 2012).

Herein “Computer Science (CS) is the study of the foundational principles and practices of computation and computational thinking, and their application in the design and development of computer systems”, whereas “Information Technology (IT) deals with the creative and productive use and application of computer systems,
including considerations of e-safety, privacy, ethics, and intellectual property." Both, Computer Science and Information Technology, are disciplines that should be encountered by pupils from early stages onwards.

Digital literacy, abbreviated deliberately in small letters “dl”, is defined as the “ability to use computer systems confidently and effectively, including basic keyboard skills and experienced mastering of standard software and navigating and harnessing the internet.” Digital Literacy is a cultural technique and a must for persons to function in a digital society. It is the foundation of Digital Competence. These aspects have been considered in developing comprehensive competence models in a wide field.

**THE AUSTRIAN APPROACH**

The Austrian school system encompasses elementary (grades 1 to 4), lower secondary (grades 5 to 8), and upper secondary level (grades 9 to 12/13). The first competence model presented in this paper refers to pupils aged 14 years at the end of lower secondary level. After more than twenty years, the vision is a national agreement on clear and binding objectives within a sound and acceptable framework of ICT/Informatics in general education.

**A Framework for Digital Competence for Lower Secondary Level**

Not least triggered by the Digital Agenda (DA, 2008), a framework for “Digital Competence” has been developed by an Austrian task force, consisting of representatives of informatics didactics, school boards, and teachers as well.

<table>
<thead>
<tr>
<th>Content</th>
<th>Level of Competence</th>
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<tbody>
<tr>
<td>Information Technology, Human and Society</td>
<td></td>
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<tr>
<td>Impact of IT in Society</td>
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<tr>
<td>Responsibility in Using IT</td>
<td></td>
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<tr>
<td>Privacy and Data Security</td>
<td></td>
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<tr>
<td>Development and Vocational Perspectives</td>
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<tr>
<td>Informatics Systems</td>
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<td>Technical components and their use</td>
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<tr>
<td>Design and Use of Personal Information Systems</td>
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<td>Data Exchange in Networks</td>
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<td>Human-Machine Interface</td>
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<tr>
<td>Software Applications</td>
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<tr>
<td>Documentation, Publication and Presentation</td>
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<tr>
<td>Calculation and Visualization</td>
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<td>Search, Selection and organization of Information</td>
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<td>Communication and Cooperation</td>
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<td>Informatics Concepts</td>
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<td>Representation of Information</td>
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<td>Structuring of Data</td>
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<td>Automation of Instructions</td>
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<td>Coordination and Controlling of Processes</td>
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Table 1. Model for Digital Competence and Basic Informatics Education in Austria’s Lower Secondary Level

After two years of occasional meetings and reviewing regional, national and international curricula and frameworks, an Austrian task force decided to develop a new balanced competence model and framework as a compromise of informatics and media education. It can be considered to be equivalent with the Austrian concept of educational standards for traditional subjects at the lower secondary level. Finally, it can serve as a solid fundament and preliminary stage for further Informatics and ICT teaching at the upper secondary level.

Based on this competence model and classification scheme for “Digital Competence” for lower secondary level (Micheuz, 2011), prototypical tasks have been developed and are currently evaluated at particular schools. The challenges of a suc-
cessful integration of ICT in existing subjects and/or the implementation of an obligatory new (interdisciplinary) subject IT/Informatics are still to be met.

The Competence Model for Informatics at Upper Secondary Level

In contrast to vocational schools with the focus on Applied Informatics, secondary academic schools (Gymnasium) impart a broad general education at pre-university level. In these schools the subject Informatics is obligatory in grade 9 and elective in the grades 10-12. Due to a major reform on the school leaving certification process (Matura) in 2015, there is a need for an educational guide providing recommendations for the structure and implementation of competence oriented final exams for Informatics.

Unlike the vague existing curriculum for Informatics, the competence model gives a clear and comprehensive picture of the subject Informatics at upper secondary level. It has been developed by a ministerial working group in 2011. The degree of structural similarity of both competence models in Table 1 and Table 2 is high and intended. It consists of four main categories, each divided into four widely independent areas. Currently 80 (rather abstract) learning objectives in form of “I can ...” statements describe the competences in more detail. The requirements are laid down in so called descriptors.

COMPETENCES IN CONTEXT

Competence models play a well-defined and central role in the spectrum from abstract objectives to their implementation, leading to intended learning activities and students’ outcomes. Typically, they are deduced from a core curriculum, and thus form the basis for so called educational standards. However, a competence oriented approach, aiming at concrete learning outcomes has to be substantiated by appropriate and corresponding tasks. That is exactly what educational standards are about: Clear educational objectives based on competence models, illustrated by appropriate tasks and problems, accompanied and evaluated by assignments.
Austrian educational competence models are based on two dimensions, contents and activities. Obviously, contents are represented by strands and nouns in Table 2. Activities are expressed through verbs and resemble Bloom's Taxonomy (Bloom, 1956), distinguishing clearly between lower and upper cognitive levels.

### Table 3: Cognitive Levels and Associated Verbs

<table>
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<tr>
<th>Lower Cognitive Skills</th>
<th>Knowing (Remembering Information): Define, identify, list, match,…</th>
<th>Applying (Using tool knowledge in concrete situations): Modify, chart, use, calculate,…</th>
<th>Reflecting (Thinking of activities): Analyse, plan, organize,…</th>
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Both competence models have an abstraction level which guarantee longevity and sustainability.

**Sample Blueprint of a Competence Oriented Task**

The screenshot of a so-called "URL shortener" of a well-known US company can serve as a possible starting point for competence oriented questions and tasks, covering almost all cognitive dimensions of the competence model.

- Knowing and Understanding (reproduction, knowledge)
- Applying and Designing (transfer, action)
- Reflecting and Evaluating (reflection, metacognition)
Here is a feasible set of questions and tasks, representing concrete and verifiable objectives, containing some verbs of Table 3 and which can be easily mapped to particular content areas in the competence model.

- Explain the acronym and concept of URLs.
- Describe which country is represented by the top level domain "gl".
- Explain the administration of the internet and to whom it belongs.
- Give reasons why the link "goo.gl" works without the prefix "http://".
- Analyze the website in Fig. 2 and describe the language behind it.
- List some elements of this language and demonstrate its effects.
- Explain the acronym HTML and argue why it is not a programming language.
- Explain why, after entering the long URL to be shortened, a so-called "Captcha" has to be solved.
- Explain the acronym “Captcha” and why it has to do much with the well known theoretical computer scientist Alan Turing.
- Implement a slimmed website which, after entering a long URL, yields a random string.

This sample of a complex task covers already a wide range of competences in form of knowledge and skills. Each question respectively task represents an operational learning objective and varies in difficulty, complexity and intellectual demand. Thus, every question and task can be mapped to the competence model. The development and collection of good competence-oriented task will be the next steps to put the competence model into action.

CONCLUSION

In theory, this Austrian approach implies a smooth and balanced way from digital literacy and basic Informatics education to a comprehensive competence model for Informatics education at secondary level. These competence models for general education have been overdue. They provide a coherent and complete picture of a wide field and can lay the foundation for an improved Informatics education in Austrian general schools, doubtlessly a big challenge in a wide and dynamic field.

REFERENCES
Biography

Peter Micheuz is since 1979 an Austrian teacher for Mathematics, Physics and Informatics at the Alpen-Adria-Gymnasium Völkermarkt and since 2000 in charge of teachers’ education for Informatics at the Alpen-Adria-University Klagenfurt. As generalist and digital immigrant he publishes in the domains of Informatics education and E-Learning.

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