







Module 10 | Technological, pedagogical and instructional design aspects of teaching CT

Module *outline* is based on the work within the project “Future Teachers Education: Computational Thinking and STEAM” (TeaEdu4CT). Coordination: Prof. Valentina Dagienė, Vilnius University, Lithuania. Partners: Vienna University of Technology (Austria), CARDET (Cyprus), Tallinn University (Estonia), University of Turku (Finland), Paderborn University (Germany), CESIE (Italy), Radboud University (Netherlands), KTH Royal Institute of Technology (Sweden), Ankara University (Turkey). The project has received co-funding by the Erasmus+ Programme KA2.

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General overview and aim

When future teachers have developed their Computational Thinking competence, they also need to know how to apply it in everyday teaching by designing relevant lesson plans, learning tasks, learning resources and assessment. This module focuses on practical aspects of instructional design guidelines and digital tools that can help teachers to integrate Computational Thinking into everyday learning and teaching activities in any subject area. The module is based on agile instructional design framework SAM (Allen, 2014) and task-centered instructional strategy (Merrill, 2002). A set of free digital authoring tools will be introduced and put into practice during the practical and collaborative instructional design activities that will take place during the module.

This module aims at development of practical instructional design skills of future teachers to prepare them for designing relevant learning activities, resources and assessments that support the development of Computational Thinking competence among students.



Target group and prerequisites

Explain to whom this module is designed. Describe prerequisites.

This module is designed for future teachers in any subject area and education levels (from preschool to upper-secondary). The students who take this module are expected to be acquainted with key concepts and issues of teaching Computational Thinking (Module 1: General introduction to CT) as well as one module related to their subject area or target education level (e.g. in case of future language teachers, Module 7: CT for languages, arts and humanities).

This module is meant to be taught collaboratively to future teachers from various subject areas, so they could explore through collaboration the different perspectives on CT. The participants would benefit from completing also Module 8 (Educational environments for CT) and Module 9 (Using constructivism, and project and challenge driven pedagogy for learning CT) prior to this module.

Keywords

first principles of learning; instructional design; agile design; design iterations; task-centered instructional strategy; authoring tools; assessment strategies.

This module is directly contributing to the development of future teachers' digital competence, especially the following sub-competences according to DigCompEdu:

- 1.2. Professional collaboration
- 2.1. Selecting digital resources
- 2.2. Modifying digital resources
- 2.3. Managing and protecting digital resources
- 3.1. Teaching in technology-rich environment
- 3.3. Collaborative learning
- 4.1. Assessment strategies



Learning Outcomes (LOs) and Assessment Methods

After successful completion of this module, the participants will be able:

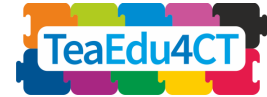
- apply agile instructional design methods on designing CT-related learning activities and resources;
- collaborate with future teachers from other subject areas to design for learning CT
- justify their design decisions with arguments drawn from constructivist learning theories, SAM instructional design framework, first principles of learning and task-centered instructional framework
- define the CT-related learning outcomes in accordance with selected framework (e.g. Bloom's or Merrill's taxonomy);
- use various authoring tools to create learning resources relevant to instructional design decisions;
- design assessment activities and criteria to evaluate formation of students' CT competences;
- explain and apply ethical and legal requirements in designing learning resources and assessments related to CT.

Learning Outcomes	Assessment Methods
1. To apply agile instructional design methods on designing CT-related learning activities and resources	Formative assessment by instructor during the project phases
2. To collaborate with future teachers from other subject areas to design for learning CT	Self-assessment with rubric prior to project presentation
3. To justify their design decisions with arguments drawn from constructivist learning theories, SAM instructional design framework, first principles of learning and task-centered instructional framework	Self-assessment with rubric prior to project presentation
4. To define the CT-related learning outcomes in accordance with selected framework (e.g. Bloom's or Merrill's taxonomy);	Formative assessment by instructor during the project phases
5. To apply various authoring tools to create learning resources relevant to instructional design decisions	Self-assessment with rubric prior to project presentation
6. To design assessment activities and criteria to evaluate formation of students' CT competences	Formative assessment by instructor during the project phases
7. To explain and apply ethical and legal requirements in designing learning resources and assessments related to CT.	Written report



Module plan and didactical approaches

This section will include an explicit text with a brief description about general module plan. Recommendation: use flowchart.



The module includes four face-to-face units (each with duration of 4 hrs) and 12 hrs of independent online learning activities. Each unit contains 2-3 tasks, at least one of these tasks is collaborative. Some tasks will be finished after the session as a homework assignment. The face to face sessions include lectures, practical activities and group discussions.

Unit 10.1: Technology toolbox for designing digital learning resources for CT

- Introduction to the course and the topic: 60 min
- Practical examples and tasks: 180 min
 - Activity 1.1: Overview of authoring tools
 - Activity 1.2: Authoring and embedding interactive exercises

Homework:

- Activity 1.3: Integrating created learning resources into a short unit in an online course within a Learning Management System (Google Classroom, Moodle, Canvas, Schoology etc)

Unit 10.2: Pedagogy and Instructional Design for teaching CT

- Introductory reading and video (prior to the contact session)
- Practical examples and exercises:
 - Activity 2.1: Discussion on First Principles of Instruction
 - Activity 2.2: Defining the learning goals and outcomes

Homework:

- Group activity 2.3: Design the mockup of the course structure

Unit 10.3: Applying task-centered instructional strategy in teaching CT

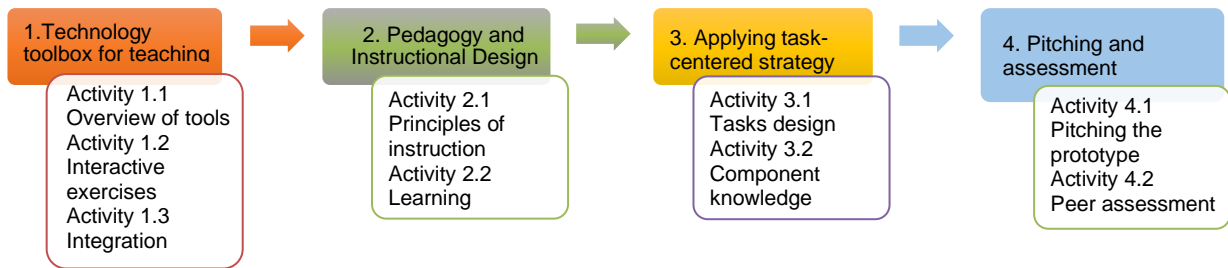
- Introductory reading and video (prior to the contact session)
- Practical examples and exercises: 180 min
 - Activity 3.1: Identify the progression of tasks
 - Activity 3.2: Specify component knowledge and skills

Homework:

- Group activity 3.3: Design a prototype using task-centered strategy

Unit 10.4: Pitching the prototype and peer-assessment

- Explaining the rules for pitching and assessment, demo: 30 min
- Pitching of prototypes: 210 min
 - Activity 4.1: Pitching the prototype by each group
 - Activity 4.2: Peer assessment and feedback



Units and activities

Unit 1. Technology toolbox for designing for learning CT

Activity 1.1. Overview of authoring tools

Aim of the Activity: In this activity, we introduce to future teachers some of the tools, that can be used for designing digital learning resources and experiences on CT related topics, such as content authoring tools, video-conferencing tools, simple educational coding environments, algorithm visualisation tools etc. In this activity, the future teachers will learn how to choose, combine and integrate various tools.

Keywords

Content authoring tools, learning management system, coding, algorithm, programming



Presentation: Technology Toolbox for Designing Learning CT

This presentation provides students some insight about various content authoring tools that can be used for teaching about CT.



Discussion: Content authoring tools

What are content authoring tools and why to use these in teaching CT? How to choose appropriate content authoring tool for your audience (possibilities & limitations)? What kind of content authoring tools could be used for teaching a specific CT topic to a specific target group?



Video Analysis: Comparing Different Content Authoring Tools

Watch the video to get some insight about different content authoring tools.

<https://youtu.be/811IXk3jPDY>

During this video students will get some insight about possibilities that can be provided by different contemporary content authoring tools.



Discussion: Creating Interactive Exercises

What kind of interactive exercises are useful for teaching CT for different age groups? What are the best free online tools to create such exercises? What do we have to pay attention to while authoring and remixing interactive exercises (licenses, embedding options, storing and analysing student responses etc)?

Activity 1.2. Designing interactive exercises



Collaborative Work: Choosing and making use of a content authoring tools

Based on the discussion, video analysis and readings, for revealing the differences between different content authoring tools, choose one. Define one CT topic that you'd like to teach to a specific age group within 30 - 90 minutes, think through the structure of the unit and related online learning resource.

Educational Content Online: 10 Tips on How to Write for Your Education Website

<https://techbear.com/educational-content-online-10-tips-on-how-to-write-for-your-education-website/>



Collaborative Work: Creating Interactive Exercises for chosen topic

Each group member should create one of the listed interactive exercises using H5P (interactive video, multiple choice, find the hotspots) for teaching CT skills within the topic and subject you have chosen for your group.

Activity 1.3. Homework assignment - integration



Collaborative Work: Integrating a collection of online resources into a teaching unit on a Learning Management System

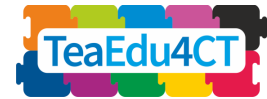
Integrate the set of learning resources your group has created into a coherent teaching unit using an online learning platform (eg. Google Classroom).



Learning resources

E-Learning and Authoring Tools: At a Glance

https://www.researchgate.net/publication/280234116_ELearning_and_Authoring_Tools_At_a_Glance



15 sources of digital content for your classroom

<https://www.thetechedvocate.org/15-sources-digital-content-classroom/>

The Niche Expert: How a Teacher Can Become a Content Creator in Education

<https://www.clearvoice.com/blog/niche-expert-teachers-becoming-educational-content-creators/>

Interactive content (H5P): <https://guides.masslibsystem.org/h5p>

Parson's problems: <https://js-parsons.github.io>

Organize Content Effectively to Maximize Student Learning

[https://www.shiftelearning.com/blog/choosing-an-organization-strategy-elearningSTEM vs STEAM](https://www.shiftelearning.com/blog/choosing-an-organization-strategy-elearningSTEM-vs-STEAM)

H5P tutorials for authors <https://h5p.org/documentation/for-authors/tutorials>

Teacher's Guide for Google Classroom

https://s3.amazonaws.com/scschoollfiles/546/teachers_guide_to_google_classroom.pdf

Unit 2. Pedagogy and Instructional Design for teaching CT

Activity 2.1. Discussion on First Principles of Instruction



Presentation: Introduction to Instructional Design

This presentation provides students some insight about Instructional Design, focusing particularly on Merrill's task-centred instructional design approach.



Discussion: Merrill's First Principles of Instruction

Preparation for discussion: read the Merrill's paper on First Principles of Learning.

Discussion in small groups: What are the guiding principles for designing effective, efficient and engaging instruction? How are Merrill's First Principles similar and different from other pedagogical/didactical principles and frameworks?

Activity 2.2. Defining the learning goals and outcomes



Presentation: defining the learning outcomes

This presentation provides students some insight about composing the learning outcomes in accordance with Merrill's task-centred instructional design approach.



Individual task: Define the learning goal and learning outcomes

Select a target group for teaching CT (age range, background, prior experience), then define 1-2 instructional goals and 3-4 learning outcomes for one introductory lesson (45-50 min) on the topic of algorithm.

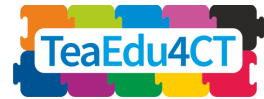
Share your results with another student for peer assessment, then discuss the feedback with him/her.

Activity 2.3. Design the mockup of the course structure



Group task: Design the mockup of the course structure

Select a target group for teaching CT (age range, background, prior experience), then design a mockup of the course structure: topics, units. Assign to each group member one unit from this course, define learning outcomes for these selected units



Learning resources

Merrill's First Principles of Instruction

<https://mdavidmerrill.files.wordpress.com/2019/04/firstprinciplesbymerrill.pdf>

Video on First Principles

<https://youtu.be/Xr5YNctHi7k>

Merrill's Task-Centered Instructional Strategy

<https://files.eric.ed.gov/fulltext/EJ826059.pdf>

Merrill's Component Display Theory

<https://www.instructionaldesign.org/theories/component-display/>

Unit 3. Applying task-centred instructional strategy in teaching CT

Unit 10.3: Applying task-centered instructional strategy in teaching CT

- Introductory reading and video (prior to the contact session)
- Practical examples and exercises: 180 min
 - Activity 3.1: Identify the progression of tasks
 - Activity 3.2: Specify component knowledge and skills

Homework:

- Group activity 3.3: Design a prototype using task-centered strategy

Activity 3.1. Identify the progression of tasks



Presentation: Task-centered instructional strategy

This presentation Merrill's task-centered instructional design approach, focusing on providing real-life context and difficulty/progression regarding instructional tasks.



Individual task: Identify the progression of learning tasks

Read the Merrill's paper on Task-Centered Instructional Strategy, pay attention to examples provided in text. Use these examples to come up with at least three real-life cases (Whole Tasks) for your course. What are the simplest versions of the task at hand? How to proceed to the next level of complexity and, eventually, to the target level of performance expected from this target group?

Activity 3.2. Specify component knowledge and skills



Pair task: Specify component knowledge and skills

Read about the Merrill's Component Display theory and define the component knowledge and skills for your course. What are the facts, concepts, procedures and rules related to identified learning tasks? How to how to define the components for each the target level of performance expected from this target group?

Share your results with another student for peer assessment, then discuss the feedback with him/her.

Activity 3.3. Design a prototype using task-centered strategy



Small group task: Compose a strategy of a lesson

What are the TELL, SHOW, ASK and DO elements of your instructional strategy? How these are sequenced and assigned to individual learners, pairs, small groups? What learning resources (e.g. videos, texts, interactive exercises created with H5P or Parson's) are linked to these elements? Use LePlanner.net to design an instructional strategy for one lesson in your course. Based on this strategy, create a prototype using some authoring tools from Technology Toolbox introduced in Unit 1.

Demo scenario in LePlanner.net: A Flipped Classroom scenario on how to collect inquiry data with Google Forms <https://beta.leplanner.net/#/scenario/56deca3e0fd9a2313cfe34e2>



Learning resources

Task-Centered Instructional Strategy by M.D.Merrill

<https://files.eric.ed.gov/fulltext/EJ826059.pdf>

First Principles of Instruction by M.D.Merrill

<https://mdavidmerrill.files.wordpress.com/2019/04/firstprinciplesbymerrill.pdf>

Unit 4. Pitching the prototype and peer-assessment

Unit 10.4: Pitching the prototype and peer-assessment

- Explaining the rules for pitching and assessment, demo: 30 min
- Pitching of prototypes: 210 min
 - Activity 4.1: Pitching the prototype by each group
 - Activity 4.2: Peer assessment and feedback

Activity 4.1. Pitching the prototype by each group



Video tutorial and discussion

Tutorial: How to pitch your idea https://youtu.be/XWRtG_PDRik

Another tutorial: <https://www.youtube.com/watch?v=Njh3rKoGKBo>

Examples of good pitching: <https://youtu.be/X1M2LcL5Oo4>



Whole class discussion

Brainstorm to define the criteria (assessment rubric) for peer-assessment of the pitch. Don't forget to include the alignment with First Principles of Instruction.

A guiding example:

<https://prod-media.coolaustralia.org/wp-content/uploads/2017/04/06190746/Pitch-Assessment-Rubric.pdf>



Small group task: Prepare to pitch your prototype

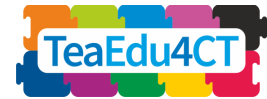
Design a presentation and prepare the group talk to pitch your prototype in 3 minutes. Rehearse it at least twice. When ready, present it live in the classroom. Optional: prepare and upload a video recording of your pitch.

Activity 4.2. Peer assessment and feedback



Small group task: Peer-assessment

Use the assessment rubric created in Activity 4.1 to peer-assess the prototypes and pitches made by other groups.



Whole class discussion

Engage the whole class in discussion to give feedback to the course, use Padlet, Tricider or Mural to document and summarise the discussion. Recommendation: keep in mind the First Principles of Instruction while discussing the pedagogical aspects.



Implementation ideas

This module can be integrated with Modules 5-9.