Introduction to Programming using Ozobots in an Economics Major CS-Class

Michaela Müller-Unterweger, Marc Berges
Computer Science Education, Friedrich-Alexander-Universität Erlangen-Nürnberg

Requirements for the learning unit
- Motivation of non-major CS students for CS
- Economic focus required by the curriculum
- Required topics: concept of algorithm, control structures, program structuring, algorithms for solving manageable problems

Ideas / Structure
- Real-world context with economic focus
- Use of physical devices
- Pair programming
- PRIMM approach
- Creative session at the end

Ozobots
- Small educational robot
- Suitable for all age groups
- Programmable by drawing colors and lines or by block-based programming (Ozoblockly)
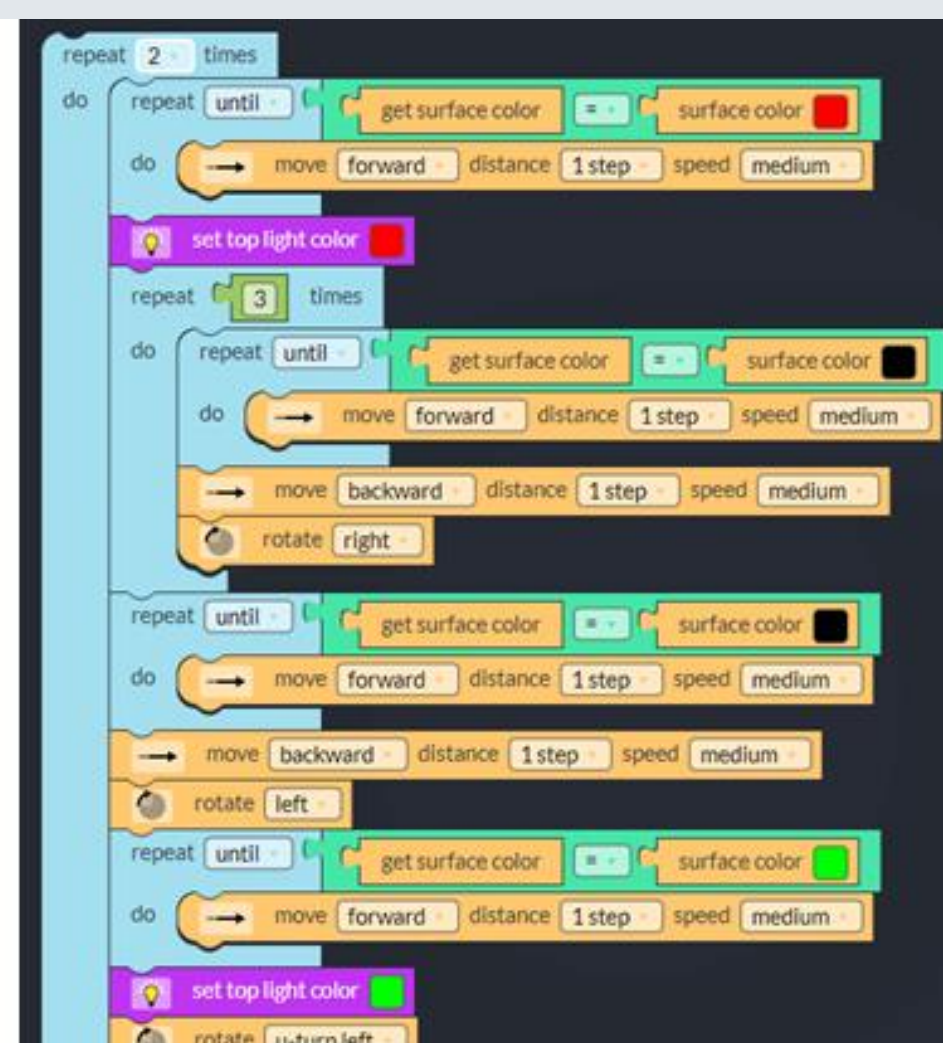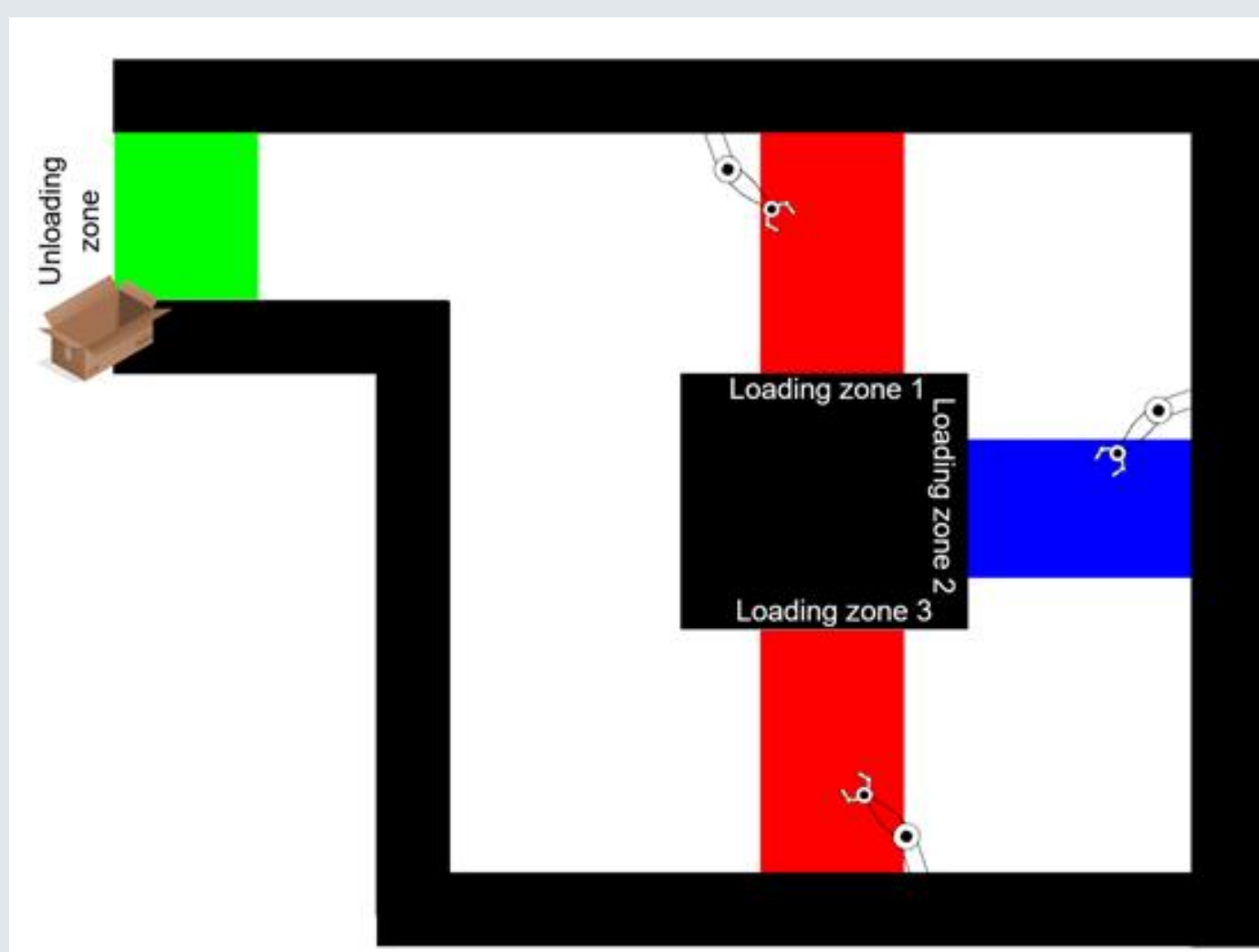
Learning unit

Introduction and first steps
- Definition of an algorithm
- Initial experience in programming Ozobots (environment, flashing the program to the Ozobot, using color sensors)
- Programming a simple sequence
- Task: *Program a simple sequence so the Ozobot permanently shuttles between green (unloading) zone and red (loading) zone changing the color of the LED accordingly.*

Conditional Statement
- Task: *Steer the Ozobot through the new warehouse from the green unloading zone to the red loading zone.*
- Formulation of an algorithm in natural language
- Discussion that a simple sequence is insufficient
- Introduction of the conditional statement
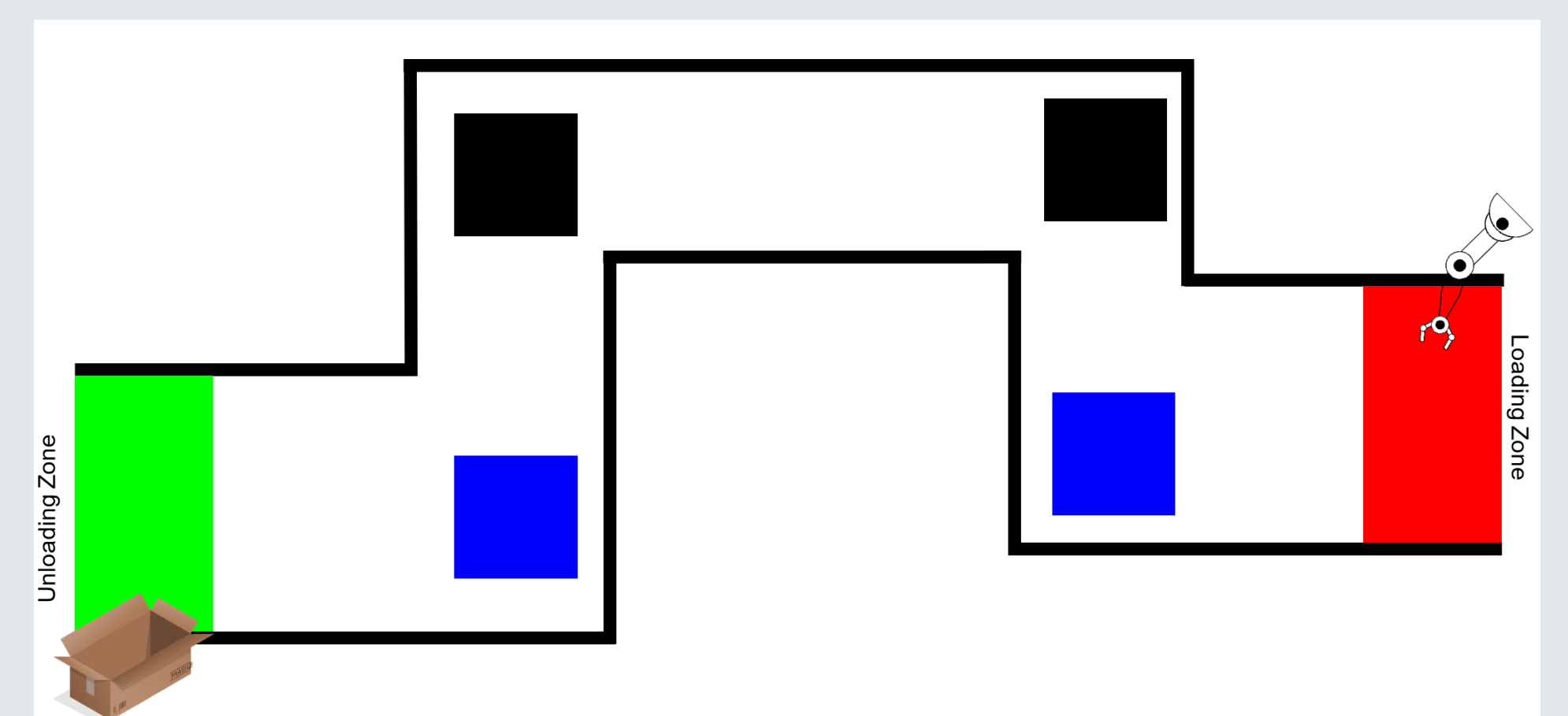- Implementation of the program

Conditional Loop and Fixed Loop
- Task: *Analyze the program. Describe the route of the Ozobot in your own words. Check the solution transferring the program to the Ozobot.*
- Analyses of a given program
- Compare conditional statement and conditional loop
- Finish the program for all loading zones
- Discussion of economic aspects for chaotic vs ordered organizational systems in warehouses


Practice session
- Task (i.e.): *Complete the following tasks:*
  a) *The robot has to pick up two heavy items from loading zone 3. It can only travel counter-clockwise and transport only one package at a time.*
  b) *The robot has to pick up several packages from loading zone 2 and 3. It can only travel clockwise.*
  c) *Create your own scenario in the warehouse. Switch your scenario with another group and solve their task.*
- Implement and test the programs using different control structures

Creative Session
- Task: *Create your own scenario in an economic contest using a robot. Use your knowledge about algorithms and control structures.*
- Enrichment of content within a creative framework

## Evaluation and Participants
- Pre-/post-Test with 9 test items based on Bastian and Mühling (2022)
- Three student groups (15 to 17 years): two non-major CS-Classes (test group using Ozobots, control group using Scratch), one major CS-Class (using textual programming)
- Test group showed improvements in all items (except I5), control groups showed improvement in less items
- Test group demonstrated most significant improvement in four out of nine items (I2, I3, I7, I9), all dealing with the programming concept of a fixed loop
- Test group performed significantly better in all complex items than non-major control group
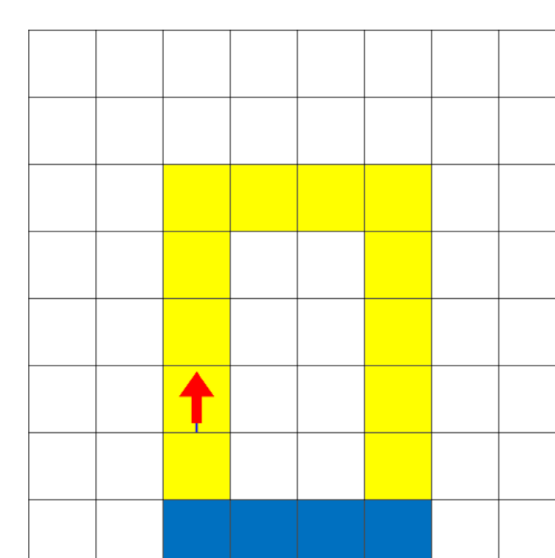
Item I5
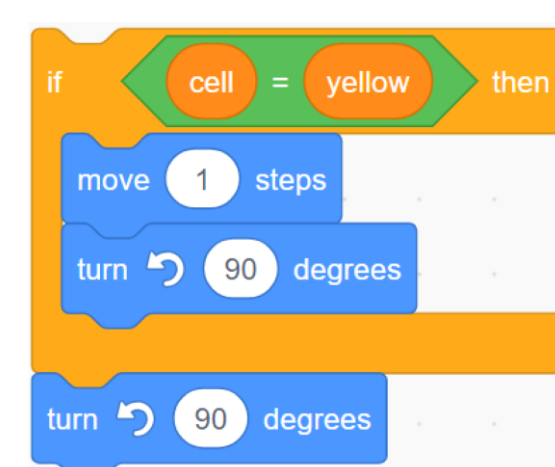
Item I7
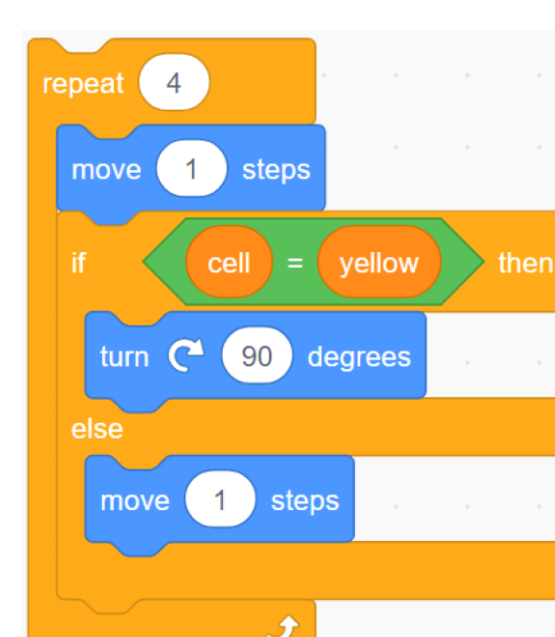
Conclusion
- High motivation of test group to tackle the subject matter
- Real-world context matching the educational focus (economics, business administration)
- Test group was better able to comprehend and process complex contexts than the non-major CS control group
- A comparison of the results with those of the major CS class reveals that the test group could not match the performance of the major CS class in nearly all items

→ **Using Ozobots improves the learning outcome but does not close the gap between non-major and major CS-learners. Nevertheless the students show better results than the 2nd non-major group.**

Further ideas
Use of 3D instead of 2D plans
Additional scenarios
Use in a storytelling approach

Link to Pre-/Posttest and Poster sources

{michaela.mueller-unterweger, marc.berges}@fau.de