



Module 10



INTERCULTURAL MATHEMATICS LEARNING OUTSIDE OF SCHOOL



This Module *outline* is based on the work within the project Intercultural learning in mathematics and science initial teacher education (IncluSMe). Coordination: Prof. Dr. Katja Maaß, International Centre for STEM Education (ICSE) at the University of Education Freiburg, Germany. Partners: University of Nicosia, Cyprus; University of Hradec Králové, Czech Republic; University of Jaen, Spain; National and Kapodistrian University of Athens, Greece; Vilnius University, Lithuania; University of Malta, Malta; Utrecht University, Netherlands; Norwegian University of Science and Technology, Norway; Jönköping University, Sweden; Constantine the Philosopher University, Slovakia.

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General overview and aim

„Let's create our common space, little piece of our common World, full of game and joy.“

This is the message of education program developed under the idea of intercultural mathematics education outside of school and entitled: **Architects**. The original target group of the program are pupils of 3rd – 9th grade at primary school who, in the role of architects, propose a new functional use of some concrete external area. They are focused on the area which is familiar for them and in which they have better experiences than adults. Thus their attention is aimed at the game and proposal of a new children playground.

The program Architects presents Cross-curricular learning which connects educational content of several teaching subjects especially mathematics, geography and computer science. Duration of the program is at least four standard lessons (four times 45 minutes is equal to 180 minutes), but there is possibility to realize it as a long-term pupil's project. Promotion and implementation of the program allows connection of several pedagogic approaches e.g. outdoor education, inquiry-based learning, project-based learning, role playing, use of ICT in education, adventure pedagogy principles and inclusive pedagogies principles.

Purpose of the Module 10: *Intercultural mathematics learning outside of school*, is to introduce the education program Architects to the students of teacher training studies (students of Initial Teachers Education (ITE)) as an alternative program for modern, active, multidisciplinary education. Through the individual activities students are gradually familiarized with a content of education program, methods and forms of learning used within the program as well as with the principles of the intercultural education and others above mentioned pedagogies.

This module is part of

- Mathematics and Science Subject dimension: intercultural perspectives on the school subjects themselves;
- Mathematics and Science Education dimension: pedagogical issues, in particular in respect to dealing with diversity in classrooms.



Relevant topics

Intercultural perspectives in math and science education. Cooperation of pupils and teachers in interdisciplinary education. Efficiency of ICT usage in relation with outdoor and adventure education, IBL pedagogies and inclusive pedagogies principles application.



Learning Outcomes

Through this module prospective teacher will:

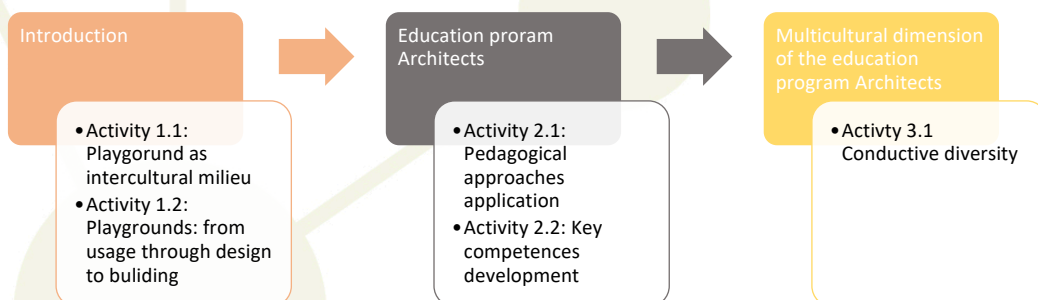
- get familiar in detail with the education program Architects and find out its benefits and hazards,
- connect intercultural learning to science and maths based on practical solution of problem situation,
- get familiar with principles of interdisciplinary education,
- connect the idea of IBL with realization of education through indoor as well as outdoor education,
- use ICT and online tool convenient for modernization and increasing efficiency of maths and science education,
- acquire skills to build a classroom atmosphere for team cooperation, communication and mutual respect of members of team with roots in different cultural background.



Flowchart and Module plan

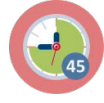
The module 10: *Intercultural mathematics learning outside of school*, involves three sections, which include lecture parts, group discussions, debates and student presentations. The structure is as follows:

- Introduction to education program Architects: 90 min
- Education program Architects under pedagogic supervision: 90 min
- Multicultural dimension of education program Architects: 45 min



I. Introduction to education program Architects

1.1. Playground as intercultural milieu



Duration: 45 minutes

Introductory activity is the entrance to the topic of children's play and playgrounds. The aim of the activity is to show the importance of children's play and playgrounds in global children's world, independently of a country, continent or culture in which children are growing up. The activity opens space for discussion with students about perception of common and different signs of various cultures in relation to design of children's playgrounds, their functions, social schemas of their realization and usage.

During the introductions activity students work in groups. The activity starts with warming up questions: Learning mathematics outside of school - what does it mean? What is your experience? Have you any experience with the outside of school learning? Which school subject? Was mathematics experienced during your previous outside of school learning activities? Is the playground the topic rich enough for looking for mathematics or making mathematics outside of school? How your childhood playground looked like? (etc...)

Each group has ICT device available to see movie entitled „East African Playgrounds - Why is the outdoor play important “. Movie is freely available on YouTube:

<https://www.youtube.com/watch?v=vTYPLY1dYYk&t=>

Task for groups is: carefully watch the movie and answer the following questions:

Why are children's playgrounds important? (expected answers: development of physical skills, physical exercise on the open fresh air, creativity when play with sand, communication with peers...).

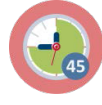
Which common features and which differences is possible to observe and notice, when European playgrounds and those in the south Africa (seen in the movie) are compared, (expected answers: common features: used by children, differences: different age structure of children on the playground, different playing elements, different material used for the elements building, number of playing children, safety requirements, ...).

Each group presents its answers, in the discussion the ITE students exchange their observations, opinions, ideas and responses on the questions posed above.

This activity contributes to the achievement of the following learning outcomes and the students in initial teachers' education will:

- connect intercultural learning to science and maths based on practical solution of a problem situation,
- get familiar with principles of interdisciplinary education,
- acquire skills to build a classroom atmosphere for team cooperation, communication and mutual respect of members of team with roots in different cultural background.

1.2 Playground from usage through design to building



Duration: 45 minutes

Activity is aimed at the introduction of the main idea and at the methodical process of the education program Architects. The result of the activity is the design of the playground which should be built on selected outdoor area.

Teacher (lecturer) describes in detail education program Architects to students, uses the presentation „Architects.pptx“. Teacher introduces the main idea of the program: proposal of children’s playground by students (pupils) of upper primary school. Teacher also introduces individual methodical steps, which are included in the presentation:

- **Setting of the task:** children’s playground design and discussion connected with experiences of students from various children’s playgrounds and their ideas on ideal children’s playground.
- **Selection of the external area and the space for children’s playground.** Proposal of children’s playground is linked with some real external area, exterior place where individual playing elements would be placed as well as the equipment for outdoor plays and activities. The area can be selected by teacher, by students or by some third person (head teacher of school, major of the town, ...).
- **Analysis of the external area.** This step is realized directly on the area where the playground is intended to build. In the terrain students recognize the geographical features of the area which could play important role in the playground proposal, in designing of individual zones and in selection of playing elements for playground (suitability of area, free space dimensions, green parts, slope and orientation of the area, existence of some old playing elements and their conditions, ...).
- **Definition of aims of proposal.** The aims of the playground proposal are strictly specified based on actual state of area considered for the playground building up. For instance the proposal of some brand of the new children’s playground, reparation or extending the playground, which exists,
- **Definition of the playground proposal criteria.** Each group of students defines its own criteria within which the group would adjust the own proposal. The criterion could be, for instance, unique appearance of the whole playground, multifunctionality of playing elements, low price, conformity with surrounding area, Each group of students presents and gives reasons for own proposal criteria.
- **Selection of potential playing elements.** Next step is the selection of playing elements which will create children’s playground and which will be placed on the selected area. Selection runs in two steps. Firstly, each student in the group selects his favourite playing elements which she/he would like to get involved into the proposal. Playing elements are selected from several available catalogues, Catalogues are in printed and online form. Consequently, each student presents the selection to the group. During short discussion within groups, students select set of elements which are considered in group playground proposal.
- **Location of playing elements and budget.** Location of playing elements on

selected area and the playground budget proposal requires use the off-line tool (applet) **Future map**. The tool allows setting of dimensions of proposed area, selection of playing elements, setting of dimensions of playing elements and creation of the proposal budget in the form of table. The total playground budget contains not only the total sum but also selected items of basic descriptive statistic which are calculated from playing elements used in the playground proposal so far.

- **Presentation of proposals.** After completing of proposals, each group presents its proposal. The groups do not present only final location of elements but also the playground proposal budget and criteria which they followed in their proposal as well as results of descriptive statistics (minimum and maximum price for playing elements, modus and median, ...).
- **Evaluation and feedback.** At the end, teacher (lecturer) evaluates work of individual groups. Evaluation from the site of students, peer-evaluation and self-evaluation, is also important. Evaluation should consider results of group work but also the style of the work in groups, total evaluation of the playground proposal, the whole program Architects evaluation,

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- get familiar in detail with the education program Architects and find out its benefits and hazards
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II. Education program Architects under pedagogical supervision

2.1. Pedagogical approaches application



Duration: 45 minutes

Activity is aimed at familiarizing of pedagogical approaches which are combined in education program Architects. Students investigate by their own creative work which pedagogical approaches are used in the program. They also find out the conditions of the program implementation and promotion and how to organize or optimize work of students with use of the discovered principles.

Students work in groups. The task within each group is to create conceptual map explaining the pedagogical approaches used in the education program Architects. For all groups, the basic common level of conceptual map is the title of education program Architects. Based on this common starting point, each group according to its own will chooses other levels which present educational approaches used in the program (e.g. work in groups, role playing, outdoor education, out of school education, IBL, ICT, cultural diversity, ...).

In the next level students can define conditions in which the concrete principles are realized and how to organize or optimize work of students with focus of the principles. For instance, in the case of outdoor education they can create the mind-map or conceptual map branches like: safety, orientation in space, physical activity (sport) in the fresh air, practical measurements, Another example for branching IBL: openness of education, scientific approach, practical character of tasks,...

Within the groups students can create their own system in conceptual map design. The result of the activity is presentation of conceptual map designed. Each group (one by one) presents one branch (one pedagogical approach) and the other groups can add notes (what they consider as an important to add) within common discussion of groups.

Based on facts presented, teacher together with students can create one final complex conceptual map which summarizes all ideas and remarks together.

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II. Education program Architects under pedagogical supervision

2.2 Key competences development



Duration: 45 minutes

Activity is aimed at familiarization with interdisciplinary character of the education program Architects. Through the creative activity students think about the content of the education program. Not only they define knowledge and its inter and multi-disciplinary character based on several teaching, school, subjects but students also develop soft and hard skills in teaching and learning (not only mathematics) activities outside of school.

Students work in groups. The aim of each group is to fill in a worksheet. This means to define which concrete knowledge and skills are developed in the area of mathematics and science in each methodical step of the program Architects. Students fill in only columns Math and Science. At the end of the activity, each group presents its notes and remarks to each methodical step of the education program Architects. Teacher summarizes results of individual groups and points out wide interdisciplinary character of the education program Architects with the special focus to mathematics and science knowledge.

Worksheet

	Methodical steps	Math knowledge, skills (Activity 2.2)	Science knowledge, skills (Activity 2.2)	Intercultural dimension (Activity 3.1)
1	Setting the task and discussion			
2	Selection of external area and its analysis			
3	Definition of aims and playground proposal criteria			
4	Playing elements selection			
5	Future playground map design			
6	Playground project budget proposal			

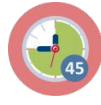
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III. Intercultural dimension of the education program Architects

3.1. Conductive diversity



Duration: 45 minutes

Short final activity shows how the intercultural approach can influence process of education program Architects and its results.

Students continue in group work and in filling the worksheet. Now they focus on the last column: Intercultural dimension. They try to describe how the intercultural approach would influence each methodical step of the education program Architects. Intercultural approach can be understood on two different levels. The first level presents the case when the education program is realized in multicultural environment (students come from different cultures e.g. gypsies or other national minorities, refugees etc.). The second level of the program presents the case when children's playground is planned for multicultural target group.

Final discussion

- How can a multicultural target group of children influence the process of planning and creating a playground?
- Which phases of the playground design and building will be most affected by the multicultural target group of children?
- How intercultural approaches involving designers (architects) from different cultures can influence a playground design?
- In which phase can intercultural approach be the most beneficial in the education program Architects implementation and why?

The conclusion of the final discussion should result in the idea that the multicultural dimension in creating a playground can bring different views, opinions and thoughts to make the outcome of the creative process more original, more valuable and more effective in relation to a multicultural group of children using the playground.

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Materials and resources



Presentation (pptx): Introduction to education program Architects



Worksheet: Development of key competences



off-line material, applet: Future map



Youtube video:

<https://www.youtube.com/watch?v=vTYPLY1dYYk&t=>



Granularity

The outdoor activity of designing and building of the playground in the real place (park, school yard...) is recommended. The planning of objects, playing elements and their distribution on the real geographical area can open more mathematics competences and knowledge during the outdoor practical activities and strengthen the real experience and adventure of students.

The real playground plan, map, design can follow the introduction activities and respect of the methodical process of the education program Architects is recommended.

The proposals of the playground on real external area are the additional aspects of the group work and prolong the time of the whole module of approx. 120 minutes. Students must observe, measure, estimate and select the appropriate external area and study catalogues with commercial playground elements, design the plan of the playground, prepare and present the presentation of the design.



References

Čeretková, S. et al., (2016). Materials for Teaching Together: Science and Mathematics Teachers collaborating for better results, (p. 133), Palacký University Olomouc, Olomouc.

Andresen, M. et al., (2016). Staircase to Even More Interesting Mathematics Teaching. 1. ed. - (p. 184) Nitra : UKF ISBN 978-80-558-0973-1.



Further readings

Department for Education and Skills (DfES). (2006). Learning Outside the Classroom MANIFESTO, DfES Publications, Nottingham, United Kingdom.

The guide for the outside the classroom learning activities. The basic principles of the outside of school activities introduction.

Cahyono, A. N., Ludwig, M. (2019). Teaching and Learning Mathematics around the City Supported by the Use of Digital Technology. *Eurasia Journal of Mathematics, Science and Technology Education*, 15(1), em1654. <https://doi.org/10.29333/ejmste/99514>

The study introduces the potential use of digital technology for supporting outdoor mathematics teaching and learning. A portal and a mobile app for mathematics trial program was created and is available on the project Erasmus+ webpage, which communicate in several languages and introduce readers and user to create mathematical tasks about outdoor real objects and solve the tasks during real mathematical trial in the outdoor milieu.

Gurjanow, I., Ludwig, M. & Zender, J. (2016). Why do in-service teachers and student teachers use MathCityMap and why don't - A short survey on acceptance and user behaviour of MathCityMap. Accepted to be presented at 10th Congress of European Research in Mathematics Education (CERME 10), Dublin (Ireland), 01-05 February 2017.

The study introduces the usage of digital tools during mathematical lessons outside the classroom.

COMPASS project materials available in several languages on the project webpage: compass-project.eu

The materials offer the teaching units focused to interdisciplinary mathematics and science education. Each unit topic is supported by worksheets and on-line applications. Most of units, or parts the unit consists of, is possible to adjust to out of school or outdoor activity.

Andersen, J. at all. (2010). *Bringing Mathematics to Earth*. Prvokruh, Olomouc, Czech republic. ISBN 978-80-901470-2-7

The book offers mathematics models, projects and problems based on the real life situations. Topics and activities for pupils are closely connected to outside of school and outdoor educational mathematics activities.

Georgiev, V., Ulovec, A., Mogensen, A., Mushkarov, O., Dimitrova, N., Sendova, E. (2008). *Meetings in Mathematics*. Demetera Publishing House, Sofia, Bulgaria. ISBN 978-954-9526-49-3

The book offers mathematics subject topics with tight connections to pedagogical and psychological strategies how to build mathematical competences together with cultivating soft skills (e.g. presentation and communication skills) and revealing the potential of students to be creative in mathematical context. The articles in the book can help teachers to identify mathematically gifted pupils in multicultural classrooms and broke the language barrier of students from different language origins.



Assessment

Pre-service teachers' (students in initial teachers' education, ITE) mathematical knowledge is not the dominant assessment issue. Their experience and skills for outdoor activity and reactions, attitudes and dispositions to the activities developed, along with the artefacts produced (real or virtual playground) can be used as the basis to evaluate to what extent they have achieved the expected learning outcomes. The following assessment criteria can be applied:

- They positively engage in activities intended at promoting empathy and mutual appreciation in the class group.
- They actively listen to partners and show respect for others' personal opinions.
- They evaluate arguments in a consistent way according to different criteria.
- They re-think previous statements after exploration and discussion.
- They identify appropriate features of outside of school mathematics activities to enhance mathematics education in their future classrooms, linking mathematics learning and socio-cultural aspects of outside of school activities suitable for the certain age of their students.
- They select suitable videos, recent news and events to introduce outside of school mathematics activities to show, how mathematics knowledge is important for real life in different cultures.
- They display different perspectives and interest groups in the developed design of the outside playground.
- They prepare appropriate questions to guide students' exploration and discussion of the selected outside of school mathematics activity.
- They identify key curricular elements that can be addressed through outside of school mathematics activity.
- They formulate consistent learning outcomes for the outside of school mathematics activity.
- They define appropriate assessment criteria for the outside of school mathematics activity.
- They critically discuss and review the design of outside of school mathematics activities.