IncluSMe

Intercultural learning in Science and Mathematics initial teacher education

Module 8

THE RELEVANCE OF LANGUAGE FOR MATHEMATICS EDUCATION

Co-funded by the Erasmus+ Programme of the European Union

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Intercultural learning in Science and Mathematics initial teacher education

This module 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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ICSE International Centre for STEM Education

Pädagogische Hochschule Freiburg
Université des Sciences de l'Education · University of Education

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General overview and aims

In this module student-teachers in ITE (initial teacher education) at lower secondary level are introduced to relevance of language in mathematics education and it provides them with background and tools to teach mathematics in a language-oriented (or language-sensitive) way.

Background

For students of all backgrounds (both mono-lingual and multilingual students) it is important to develop the subject-specific (academic) language of mathematics. This language is needed for conceptual understanding and 'meaning-making' in mathematics. The development of subject-specific language can be facilitated by adopting a language-sensitive approach to mathematics. Although multilingual students will encounter other and maybe more problems than monolingual students, this approach is aimed to benefit all students in developing their mathematical proficiency.

Aim

The aim of this module is twofold:

1. To make student- teachers aware of the relevance of language for learning (and teaching) mathematics.
2. To provide them with background theory, resources, skills and tools to support their student's development of relevant academic language, and thus equip them to enhance mathematics learning in classrooms where students' levels and background in academic language proficiency may differ.

This module is part of:

- Mathematics and Science Subject dimension: (inter)cultural perspectives on the subjects themselves;

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Relevant topics

In this module, the following topics will be addressed:

- The distinction between 'everyday' language, general academic language and the specific language of mathematics;
- Some background and characteristics of language-sensitive mathematics teaching;
- The relevance of interaction, contexts and language-support for the learning of (the language of) mathematics;
- Tools to analyse teaching materials and classroom interaction (scaffolding) on the use and support of language in mathematics teaching;
- Tools and activities to support future teachers in designing language sensitive lessons and activities

Learning Outcomes

Through this module prospective teacher will be able to:

- Understand difficulties student face with language in mathematics (especially multilingual students).
- Become aware of the role and relevance of language in mathematics education (everyday language, general school language and subject-specific language of mathematics).
- Develop knowledge about the approach of language-sensitive mathematics teaching and its tools.
- Analyze language in classroom materials and teaching practice.
- Learn to value the role of various representations and visualizations as a bridge for understanding and developing linguistic skills in mathematics education.
- Learn to know and use scaffolding strategies to support students in language-sensitive mathematics lessons.
- Design classroom activities that support students' language proficiency as well as their mathematical understanding.

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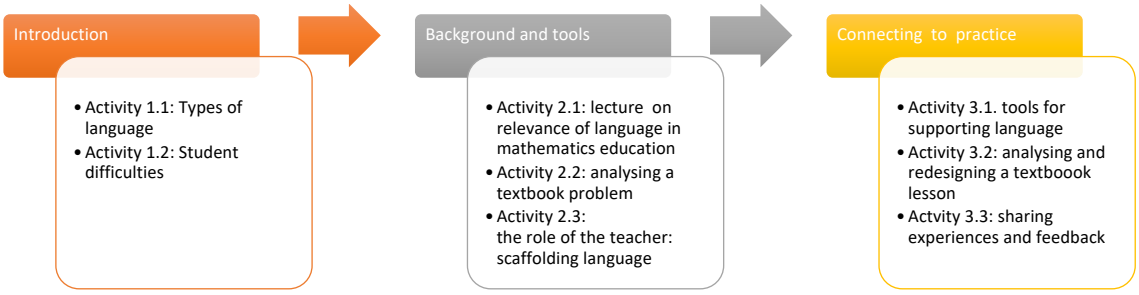
Flowchart and Module plan

This module involves three sections, all structured into several activities, including interactive presentations, (small) group discussions and student presentations. The structure is as follows:

- Introduction into the topic – 2 activities (60 minutes)
- Background and tools – 3 activities (90 minutes)
- Connection to practice – 3 activities (120 minutes)



The activities can be distributed over 3 sessions of 60-120 minutes with 90 minutes of homework as follows:

- Session 1 – activities 1.1, 1.2, 2.1 + 30 minutes homework reading
- Session 2 – activities 2.2, 2.3, 3.1 (and 3.2) + 60 minutes homework designing
  Session 3 – activity 3.3

Depending on your local situation you may want to adjust this.

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I. Introduction into the topic: The relevance of language for mathematics education

1.1 Types of language

Duration: 30 minutes

This is a "warming-up" activity. The intention is for pre-service teachers to become aware of how - in subject specific (mathematical) language - some words from daily language are given a new meaning. In small groups they study a collection of words from STEM-subjects (see worksheet for activity 1.1) and discuss the differences in meaning these words have in daily language as compared to the meaning in mathematics. They illustrate these differences in meaning by making sentences (typical expressions) using these terms. They use the question on the worksheet to discuss what this means for their students (what difficulties will they face?) and for their teaching. The findings of the small groups will be shared in a whole class discussion.

This activity contributes to the achievement of the following learning outcomes:

- Understand difficulties student face with language in mathematics (especially multilingual students)
- Become aware of the role and relevance of language in mathematics education (everyday language, general school language and subject-specific language of mathematics)

I. Introduction into the topic: The relevance of language for mathematics education

1.2 Student difficulties – an example

Duration: 30 minutes

In this activity pre-service teachers study an example (transcript) of a student solving a task and facing language difficulties he himself is not aware of.

Student-teachers are first presented with the mathematical task (see part 1 of activity 1.2 on the worksheet) and solve this themselves. Next, they think of difficulties related to language aspects this task may present to students (grade 6-7). This can be done either in small groups or with the whole group.

Then they read the transcript of a student explaining how he solved the task (see part 2 of activity 1.2 on the worksheet), and they discuss the language abilities as well as the language problems of this student. Below some background information is given on the transcript.

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1. The excerpt is part of Dutch research (van den Boer, 2003) into the problems second generation immigrant students (in multicultural schools) encounter in mathematics education and the factors that cause these problems.
2. The student is a boy (aged 12) born in the Netherlands of Moroccan parents
3. It is a dialogue between a Student and a Teacher-researcher. The student has read the task aloud and solved it and now explains what he did.

The pre-service teachers connect this example to their own teaching: do they recognize the example? Can they give similar examples from their teaching? They relate this to what they discussed in activity 1.1

This activity contributes to the achievement of the following learning outcomes:

- Understand difficulties student face with language in mathematics (especially multilingual students)
- Become aware of the role and relevance of language in mathematics education (everyday language, general school language and subject-specific language of mathematics)

II. Background: language and mathematics education

2.1 Lecture on the relevance of language in mathematics education

Duration: 30 minutes

The educator presents theory about language in mathematics and language-sensitive mathematics teaching (see separate ppt). This presentation includes the following topics:

- Why language is crucial for (mathematics) learning
- The distinction between daily language, general academic language (school language) and subject specific academic language and difficulties students may have with each
- Characteristics of the language of mathematics and the importance of subject-specific language objectives
- How teachers stimulate students to speak and write (language production) for the learning of mathematics
- Scaffolding language
- Tools to support language development
- Optional: discussion on statements, such as:
    - All teachers are language-teachers
    - Restricted talk becomes restricted learning (Barwell)

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Homework

The re-service teachers may be asked to read an article on language-sensitive mathematics education as homework. Suggested article is from the proceedings of CERME 4 (Bosch, 2006) p.1215-1225

> van Eerde, D. & Hajer, M. (2005). *Language sensitive mathematics teaching in a multicultural classroom. How students' talking and writing can enlighten hidden problems.*
>
> http://www.mathematik.uni-dortmund.de/~erme/CERME4/CERME4_WG10.pdf

You can replace this by an article in your own language. It is important that the article you chose contains classroom examples or has direct practical value for teaching. You could present the following home-work task to your students:

> Write a paragraph of about 300-500 words based on this article in which you make clear how you could make your own mathematics lessons more language-sensitive.

This activity contributes to the achievement of the following learning outcomes:

- Become aware of the role and relevance of language in mathematics education (everyday language, general school language and subject-specific language of mathematics)
- Develop knowledge about the approach of language-sensitive mathematics teaching and its tools

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II. Background: language and mathematics education

2.2 Analysing a textbook problem

Duration: 30 minutes

The pre-service teachers analyse a textbook problem to identify the types of language used in this problem and predict difficulties students may face when working on this problem.
The exemplary problem (see worksheet for activity 2.2) is set in the everyday context of doing the laundry. Preservice teachers, in pairs, analyse the problem guided by the following questions:

1. **What kind of language is used in the problem of the washing powder? Identify daily language, mathematical language (words) and symbols and general academic language.**
2. **Consider the problem (language and picture) through the eyes of a student: what might be difficult for the students?**

Discuss in the whole group the types of language the pairs have identified as well as the problems they expect their students may have. Do they expect different types of problems for first and second language learners?

You may replace this textbook problem by a similar one. It is important that the problem you select is set in a familiar context, that all three types of language are used in the problem and that the mathematics that the pupils need for solving the problem is not too complex.

This part contributes to the achievement of the following learning outcomes:

- Understand difficulties student face with language in mathematics (especially multilingual students).
- Become aware of the role and relevance of language in mathematics education (everyday language, general school language and subject-specific language of mathematics).
- Analyze language in classroom materials and teaching practice.

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II. Background: language and mathematics education

2.3 The role of the teacher: scaffolding language

Duration: 30 minutes

The intention of this activity is twofold, first o present pre-service teachers with examples of a teacher scaffolding language and second to present them with tools to scaffold students' language in classroom interaction.

In the first part of the activity pre-service teachers read a dialogue (part 1 of activity 2.3 on the worksheet) and discuss in pairs strategies the teacher uses to scaffold students' language.

Next pre-service teachers read a text in which seven scaffolding strategies are presented and explained. For each strategy one example is provided (see part 2 of activity 2.3 on the worksheet). You can either discuss these with the whole group or you may have student-teachers do this in pairs. A guiding question for understanding the strategies is: *For each strategy think of another example that fits the topic you are teaching now*.

You may also want to explore with the group which strategies they use in their teaching.

In the third part of the activity pre-service teachers identify these scaffolding strategies in two exemplary dialogues. They first do this individually and then compare and discuss their scoring in pairs.

Note: It would even be better to use a video of teacher-classroom interaction with a teacher scaffolding language in a mathematics lesson in your own language (preferable a video of the pre-service teachers in your group). If this is available, you may want to use this instead of the written dialogues.

This activity contributes to the achievement of the following learning outcomes:

- Understand difficulties student face with language in mathematics (especially multilingual students).
- Analyze language in classroom materials and teaching practice.
- Learn to know and use scaffolding strategies to support students in language-sensitive mathematics lessons.

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III. Connecting to practice

3.1 Tools for supporting language

Duration: 30

In this activity pre-service teachers explore eight tools and activities that support language proficiency in mathematics lessons. They explore these activities and analyse how these contribute to language development integrated in mathematical understanding. They also think about which subject-specific language goals can be addressed using each of these activities. See worksheet for activity 3.1.

This activity contributes to the achievement of the following learning outcomes:

- Develop knowledge about the approach of language-sensitive mathematics teaching and its tools.
- Learn to value the role of various representations and visualizations as a bridge for understanding and developing linguistic skills in mathematics education.

III. Connecting to practice

3.2. Analysing and redesigning a textbook lesson

or

Duration: 60 minutes

The aim of this activity is to have pre-service teachers (individually or in small groups) design their own language-sensitive lesson.

Working in small groups participants first select and analyse a paragraph from a mathematics textbook from a language perspective, identifying difficulties this may provide for their students' mathematical understanding. in activity 2.2 they have practiced analyzing one single textbook problem. Now they will analyze a paragraph (consisting of some theory as well as problems), again focusing on language. Preferably -if possible- ask your pre-service teachers to bring their own mathematics textbook (used in their school) and let them analyze a paragraph they will teach within the next two weeks.

The pre-service teachers analyze the paragraph guided by the questions on the worksheet and they predict problems their students might have. These problems may depend on the background of their students. They also discuss ways to overcome the

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difficulties they have foreseen. This will be the input for the (re)design of a lesson based on this paragraph.

Next pre-service teachers (re)design the lesson/teaching activity. For this lesson the pre-service teachers will:

- Formulate one or two content-related (mathematical) language goals for this lesson.
- Design one or two activities providing 'language support' to the students in reaching these goals (see activity 3.1).
- Justify their choices, based on what they learned about language sensitive mathematics teaching

During the session the pre-service teachers can only make a start with this design. It is helpful to have them work together in small groups even if they prepare a different lesson.

At the end of this session have all student groups present, in a short 1-minute pitch, their plans for the lesson/activity. If time permits in this session you may also ask them to give peer feedback.

Finishing the design (goals, teaching activities, materials) and trying the lesson out in class (if possible) is homework. The pre-service teachers fill in a short evaluation form (see worksheet 3.3) and they prepare to share the design and experiences in the next (and last session). Ask them for example to reflect on these questions:

- What are your content-related mathematical language goals?
- What activities did you have students do? Why these?
- What was your role as a teacher?
- What are your experiences: successes and challenges?

You may also ask them before or after that session to write and hand in a (brief) report you can use as assessment. It is also possible to assess the pre-service teachers based on the presentation of their experiences.

This activity contributes to the achievement of the following learning outcomes:

- Understand difficulties student face with language in mathematics (especially multilingual students);
- Analyze language in classroom materials and teaching practice;
- Learn to value the role of various representations and visualizations as a bridge for understanding and developing linguistic skills in mathematics education:
- Design classroom activities that support students' language proficiency as well as their mathematical understanding.

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III. Connecting to practice		
3.3. Sharing experiences and feedback		
		Duration: 30-60 minutes

The aim of this activity is to have the pre-service teachers share their design and the experiences with trying out their lesson.

You may have each of them give a short presentation (ppt or poster or oral communication – see activity 3.2) while the others react by providing feedback in the form of tips and tops.

In the whole group you can evaluate what students learned in this module, by discussing the arguments (justification) they had for designing the lesson (see worksheet 3.3) and connecting this to the other activities and theory in this module.

This activity contributes to the achievement of the following learning outcomes:

- Design classroom activities that support students' language proficiency as well as their mathematical understanding.

Materials and resources

Two presentations (pptx). Teacher Educator.

- PPT 1: Sheets to guide all sessions.
- PPT 2: Lecture on the relevance of language for mathematics teaching (activity 2.2)

Worksheets: Include all activities and links for this module.

Textbooks: brought by pre-service teachers (or the teacher educator)

Access to computers for internet research, accessing some of the resources with worksheets and collaborative work.

Optional (if available): video of mathematics lesson with teacher-classroom interaction (see activity 2.3)

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Granularity

If fewer time is available:

- Skip the lecture/presentation in activity 2.1 and instead have the pre-service teachers read an article on language-sensitive mathematics teaching (as homework) and discuss the main characteristics in the whole group.
- Select fewer tools in activity 3.1 or divide the tools between pairs of pre-service teachers and use the cooperative learning strategy 'expert-groups' (see references) to share findings.
- Have pre-service teachers do the analysis in activity 3.2 as homework and bring the result to the session. In the session have them (re)design the lesson to make it more language-sensitive.
-

If more time is available:

- Have groups give each other peer-feedback in activity 3.2 during the design process.
- Include an extra session for sharing and discussing the designed lessons and teaching activities.

References

Bosch, M. (Ed.). (2006). European Research in Mathematics Education IV: Proceedings of the Fourth Congress of the European Society for Research in Mathematics Education (CERME 4, February 17 - 21, 2005). Sant Feliu de Guíxols, Spain: FUNDEMI IQS – Universitat Ramon Llull and ERME.

Smit, J., van Eerde, H.A.A. & Bakker, A. (2013). A conceptualisation of whole-class scaffolding. *British Educational Research Journal*, 39 (5), (pp. 817-834) (18 p.).

Smit, Jantien, Bakker, Arthur, van Eerde, Henriette & Kuijpers, Maggie (2016). Using genre pedagogy to promote student proficiency in the language required for interpreting line graphs. *Mathematics Education Research Journal*, 28 (3), (pp. 457-478) (22 p.).

van Eerde, H.A.A. & Hajer, M. (2009). The integration of mathematics and language learning in multiethnic schools. In M. César & C. Kompulainen (Eds.),*Social interactions in multicultural settings* (pp. 269-296) (28 p.). Rotterdam: Sense Publishers.

Further readings

Hajer, M., Norén, E. (2017). Teachers' Knowledge about Language in Mathematics Professional Development Courses: From an Intended Curriculum to a Curriculum in Action. *Eurasia Journal of Mathematics, Science and Technology Education,* 13(7b), 4087-4114. https://doi.org/10.12973/eurasia.2017.00808a

In this article a plan for a PD-course is presented based on research. It is suitable for the educator.

Prediger, S., & Wessel, L. (2013). Fostering German-language learners' constructions of meanings for fractions—design and effects of a language- and mathematics-integrated intervention. *Mathematics Education Research Journal*, 25, 435–456.

In this article authors describe research on a language-sensitive approach to the learning of fractions. It includes examples of student work and dialogues as well as theoretical background. Example form this article can be used in the sessions.

Assessment

For assessment, you may either use the presentations (activity 3.3) of the pre-service teachers about their experiences when trying out in class the language-sensitive lesson (teaching activities) they designed.

If there is no opportunity for the students to try out a lesson. You may assess the preservice-teachers report on the design of the teaching activity for a language sensitive mathematics lesson (activity 3.2 + homework). This report needs to include:

- Subject-specific language goals.
- A justification of how this activity supports the development of mathematical language and mathematical understanding.
- A lesson plan and all teaching materials.

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