Maria-Cristina Popa (coord.)

Future-Ready Teaching: A Modular Curriculum for Primary School Educators and Prospective Teachers

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MODULE 1.
WHY MATHEMATICS ANXIETY DEVELOPS IN THE PRIMARY SCHOOLS

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Anna Bogacz

Społeczna Akademia Nauk

LESSON 1.1
Mathematics Anxiety Definition, Root Causes and Symptoms
Duration: 1 hour

Learning outcomes:

- To understand the essence of mathematics anxiety problem.
- To be able to identify students with mathematics anxiety.
- To discuss current educational approaches to teaching.
- To understand the necessity of adjusting content in order to avoid deepening the problem of mathematics anxiety.

Teaching methods: lecture, discussion, brainstorming, individual work.

Learning-Teaching Process:
Before the Classroom Time:

- Prospective teachers read necessary background information on math anxiety issues before class. They will also conduct some investigations to understand the extent of the problem. They will use online resources to gain a deeper understanding of this topic.
- Prospective teachers will receive basic facts about mathematics anxiety in the form of a short lecture.
- Then they are asked about their experience in learning math. Prospective teachers are encouraged to talk about themselves or their classmates if they faced any problems. Their answers are analyzed altogether.

Assessment Tools:
Different assessment strategies can be used in the module, depends on the facilitators' approaches. First, perform a diagnostic evaluation. Prospective teachers will be pretested on their knowledge and understanding of mathematics anxiety. Retesting will be conducted at the end of the module. Summative assessments in written and oral tests are designed to diagnose and measure their level of abilities.

Theoretical Knowledge:

Definitions

It is widely believed that certain subjects, such as mathematics, produce stronger negative emotions and emotional responses, particularly anxiety, than most other subjects. Math's anxiety is a significant problem in schools, universities and workplaces. The term was defined about 50 years ago, but over the years it has been poorly understood. Given the increasing importance of mathematical thinking in a variety of educational and professional settings, the construct of mathematics anxiety has received increased attention in recent years.

Early researches identified "emotional reactions to arithmetic and mathematics" or "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" (Prodromou & Frederiksen, 2018).

The Maths Anxiety Trust explains the phenomena as a negative emotional reaction to mathematics that led some people to experience varying degrees of helplessness, panic, and mental confusion when encountering mathematics problems. Most definitions and studies in the literature emphasize that mathematics anxiety is characterized by nervousness, apprehension, fear, and tenseness about mathematical operations.

Types of mathematics anxiety

Math anxiety has multidimensional nature. At least two interrelated factors have been identified in the literature on the topic of dimensions of math anxiety: the anxiety experienced during tests and the one related to learning mathematics. Test anxiety in mathematics is particularly related to exam situations, whereas learning anxiety in mathematics involves manipulating numbers, performing mathematical operations, or learning mathematical concepts in class. Both dimensions of mathematics anxiety significantly affect mathematics performance.

The multidimensional structure of mathematics anxiety is also reflected in the various methods of assessing mathematics anxiety. Questionnaires such as the Mathematics Anxiety Scale (mathematics anxietyS), the Mathematics Anxiety Rating Scale (mathematics anxietyRS), the Mathematics Anxiety Questionnaire (mathematics anxietyQ) and the Anxiety Toward

Mathematics Scale (ATMS) help to measure mathematics anxiety (Commodari E & La Rosa VL, 2021). Math Anxiety (RS) is a multidimensional measure that focuses on math test and number anxiety, whereas the ATMS assesses general discomfort in math situations and the fear related to math.

Math anxiety can manifest itself in different ways. Individuals experiencing mathematics anxiety encounter situational stress when dealing with mathematical tasks. It may manifest as a general aversion to mathematics, but in some cases, it can escalate into apprehension or even intense fear triggered by external pressures, such as during a testing scenario. Anxiety can affect individuals in different ways, causing cognitive, emotional or physical reactions. Math anxiety is more than just a lack of confidence in solving new, more difficult math problems. Physical symptoms include tremors, sweaty palms, nervousness, panic, shortness of breath, heart palpitations, sweating, nausea, stomach problems and nail biting or lip biting (Ruffins ,2007).

At the most basic physics level, children will often try anything to avoid math. Psychological symptoms include stress before classes, panic, expressionless during test, feeling helpless regarding academic tasks or homework or lack of interest in them. Feelings of helplessness are common and may cause children to stop listening or stop trying. Confusion and frustration can lead to crying and anger. Nervousness and extreme stress before and during exams may result in the need for extra time and support (Vitasari et al., 2010).

Students with mathematics anxiety have lower perceptions of their mathematical abilities and perform poorly on mathematical reasoning tasks, numerical information processing, and mathematics-related assessment situations.

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LESSON 1.2
Development of Math Anxiety in Primary School
Duration: 1 hour

Learning outcomes:
- To explain underlying conditions causing mathematics anxiety.
- To understand the importance of assurance the proper level of math performance in primary schools.
- To discuss way of adjusting the curriculum in order to limit the risk of mathematics anxiety.

Teaching methods: Lecture, discussion, individual work, group work.

Learning-Teaching Process:
Before the Classroom Time:
- Prospective teachers read necessary background information on mathematics anxiety issues before class. They will also conduct some investigations to understand the extent of the problem. They will use online resources to gain a deeper understanding of this topic.

In-class Activities:
- What causes mathematics anxiety? Brainstorming, analyzing the ides.
- Why mathematics anxiety affects primary school children? Discussion.

Assessment Tools:
Various assessment methods can be employed within the module, contingent on the instructors' preferences. Initially, an initial assessment will be administered, testing prospective teachers on their knowledge and understanding of the topic of mathematics anxiety. Upon module completion, a post-test will be conducted. Summative assessments, including written and oral tests, aim to measure and evaluate their higher-level abilities.

Theoretical Knowledge:

Mathematics anxiety has been observed in school children around the age of 6 years. One of the biggest factors in a successful math class is student mood. When students are relaxed and comfortable, success seems to come naturally. But when students feel stressed, rushed, or anxious, the results are very different. As a physiological response, stress can enhance performance. Personal experience in teaching high school students shows that too much stress can affect performance.

The report "Understanding Mathematics Anxiety. Investigating the experiences of UK primary and secondary school students" prepared in 2019 by University of Cambridge pointed many potential underlying conditions of math anxiety. These include some environmental factors, such as:

- **Negative experiences in class**, e.g. Poor performance in math due to lack of basic knowledge.
- **Teacher characteristics**, e.g. Female math teachers who are anxious are also more likely to become anxious themselves.
- **Parental gender stereotypes**, e.g. Parents who expect daughters to have more difficulties in math than their sons.

Additionally, **intellectual factors** may play a role in math anxiety. Children with developmental dyscalculia and other mathematics learning disabilities are at increased risk for mathematics anxiety.

Developmental dyscalculia is a specific difficulty in acquiring mathematical skills that occurs in approximately 6% of children (Devine, Soltesz, Nobes, Goswami, & Szűcs, 2013). Math anxiety is an emotional problem, while developmental dyscalculia is a cognitive problem. Many different cognitive abilities are associated with developmental dyscalculia. For example, it is associated with problems representing the size of numbers, poor working memory (the ability to hold information in mind while performing another task), difficulties with inhibition, poor spatial skills, or problems organizing sounds. It is unclear which of these factors actually underlies developmental dyscalculia, or whether dyscalculia actually represents a variety of math learning problems underpinned by a variety of different factors.

Moreover, other personal characteristics may influence their math anxiety. For example:

- Gender – girls are more likely to be afraid of math.

- Self-esteem – lower self-esteem leads to higher levels of math anxiety.
- Attitudes toward mathematics – people who like mathematics generally have lower levels of mathematics anxiety than people who dislike mathematics.

Exploring the relationship between math anxiety and achievement

Only a few longitudinal studies (most studies only provide a snapshot at a specific point in time) have examined the development of mathematics anxiety and its relationship to mathematics achievement (Ma & Xu, 2004). There is currently no consensus on which of these theories, if any, is correct. It's commonly known that the two are related: if children have math anxiety, they're more likely to underperform. When children perform poorly, they are more likely to develop math anxiety. In other words, math anxiety can be seen as both a cause and a consequence of poor math performance.

What causes math anxiety? There are three theories that link math anxiety and math performance (Carey, E. et. all 2019):

1. Poor performance leads to higher math anxiety (deficit theory).
2. Math anxiety leads to poor math performance (anxiety model).
3. Vicious cycle: the higher the level of anxiety, the worse the performance; poor performance leads to higher anxiety (reciprocity theory).

Because math difficulties often begin in early school age, math anxiety can develop or increase over time. The researchers define this as a decline in ability and explain this relationship in two ways. The first explanation roots in lower numerical/spatial ability, which leads to poorer math performance and thus math anxiety. The second explanation can be seen in avoidance behaviours, which increases the development of mathematical difficulties and thus generates mathematical anxiety. Thus, experiencing difficulty with mathematics may trigger a "vicious cycle" in which students avoid mathematics-related situations, resulting in fewer opportunities to improve mathematics skills.

The Deficit Theory

Deficit theory suggests that people who initially perform poorly in math are more likely to develop math anxiety. For example, children with math learning disabilities such as developmental dyscalculia (which causes poor math performance) have higher levels of math anxiety than children without math learning problems.

The Deleterious Anxiety Model

The detrimental anxiety model suggests that the relationship between mathematics anxiety and mathematics achievement is determined by the anxiety's disruptive effects on learning and remembering mathematics skills. Math anxiety affects math performance on multiple levels. On the one hand, it lowers math performance by reducing engagement with math problems, and on the other hand, by reducing working memory capacity, making it more difficult to solve those math problems.

First, there is evidence that people with math anxiety are simply unwilling to engage in math tasks. They are less likely to attend math classes, and they tend to answer questions quickly but inaccurately (perhaps because they are trying to "escape" from anxiety-provoking math situations). Second, even if they are solving a math problem, anxiety can distract them from what they are trying to learn or remember. The idea that anxiety may interfere with learning and memory is known as "cognitive impairment"—anxiety creates distracting thoughts and feelings that impair memory ability. This idea is supported by evidence that people with higher levels of math anxiety have poorer working memory (the memory used to store, process, and manipulate information) and that people with math anxiety are better at solving problems that require high levels of effort. Performance is particularly poor when it comes to memory problems.

The Reciprocal Theory

There is evidence that people with math anxiety are simply unwilling to engage in math tasks. They are less likely to attend math classes, and they tend to answer questions quickly but inaccurately (perhaps because they are trying to "escape" from anxiety-provoking math situations). Perhaps both play a role in the relationship between math anxiety and achievement. In other words, math anxiety may lead to poor grades, and poor grades may lead to math anxiety.

However, math anxiety may also leads to performance inhibition. This type of anxiety may initially be caused by environmental factors (such as adult role models) and genetic predispositions. The math anxiety-related effect on math performance may be explained by disruptions in executive functioning processes and working memory (interference account). This disorder may be caused by mathematics-related worries (e.g., negative thoughts and ruminations about one's abilities or the consequences of failure). Thus, situations that lead to mathematics anxiety impair available cognitive resources (e.g., working memory). Therefore, fewer resources are available for task-related problem-solving processes (e.g., computing strategies). This may result in children either switching to less demanding strategies (e.g., production deficits) or failing to successfully use higher-order strategies (e.g., use deficits), both of which result in poorer performance. The relationship between math anxiety and performance may be further influenced by the complexity and time pressure of the math problems that children must solve. Research using math assessments and more complex tasks suggests a stronger relationship between anxiety and math performance. Another stress-causing factor may be time pressure, as it appears to affect a child's arousal.

Early math anxiety may lead to severe math difficulties and impact children's social-emotional development. Children often develop math anxiety when they have not mastered basic math skills, and they are constantly expected to learn additional math when they have not mastered the basics.

Research has also found a positive correlation between teachers' levels of math anxiety and its impact on students. It appears that teachers and inappropriate teaching practices have a significant impact on students' mathematics anxiety levels. When students have teachers who care about their own math skills, student achievement trends decline.

Just as a strong building cannot be built on a shaky foundation, expecting children to learn new math skills before they have mastered the basics can lead to insecurities and a fear of math. But that's exactly what can happen when kids try to find the right answer to a math problem without understanding the concept. Elementary school students may see their peers excelling in math and assume that they are not as "naturally" good at math as other children. This can lead to doubt and reluctance to develop your math skills in more depth.

All arguments suggest that a deeper understanding of how to reduce mathematics anxiety in school-age children is particularly important.

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LESSON 1.3
Using Robotics as a Method of Teaching Maths in Primary Schools
Duration: 1 hour

Learning outcomes:

- To shape new methods of teaching.
- To arouse interest in robotics as an innovative method of teaching mathematics.

Teaching methods: lecture, discussion, individual work, group work.

Learning-Teaching Process:
Before the Classroom Time:

- Prospective teachers will read the necessary background information regarding the problem of mathematics anxiety and the use of robotics in education prior to the lesson.
- They will use online resources for in-depth understanding of the topic.

Assessment Tools:
Different assessment strategies can be used in the module, depends on instructors' approaches. First, the facilitator will perform a diagnostic evaluation. Prospective teachers will be pretested on their knowledge and understanding of mathematics anxiety. After completing this module, a post-test will be conducted. Summative assessments in written and oral tests are designed to understand and measure their higher-level abilities.

Theoretical Knowledge:
Adults often wonder why students spend so much of their free time playing video games. The answer is simple. It's charming. But it also forces you to try again and again until you reach your goal, and it's worth it! That's why integrating technological advances into teaching is one way to create classrooms that can meet the challenges of the 21st century.

Robotics represents a multidisciplinary and highly innovative field that includes physics, mathematics, computer science, industrial design and social sciences. Additionally, the design, programming, and use of robots and related services require teamwork, creativity, and entrepreneurial skills.

Elementary school students are naturally curious and often find science not only fascinating but exciting. Unfortunately, this curiosity eventually fades as we grow into adults. The key to educating young people who remain passionate about science and technology is to instill a lifelong interest in science, technology, engineering, and mathematics from an early age and continue that interest in subsequent school years.

Beyond the basics, math concepts can be difficult to understand and remember. Additionally, they are more difficult to use. Robotics is changing that. Robots can visualize how numbers on a page relate to construction, motion, and other real-world applications. Robotics takes abstract math concepts off the whiteboard and translates them into real-world demonstrations in front of children.

The foundations of modern computer science education were outlined in the 1980s. Since then, the use of educational robots has become increasingly popular. Robotics education projects have been successfully implemented both inside and outside the curriculum in several countries in Europe and the United States.

Both mathematics and programming require students to possess similar abilities, such as: the ability to think logically, the desire to understand problems and their solutions, the ability to be comfortable with failure, and the ability to learn from their own mistakes. Both disciplines teach how to analyze problems, design solutions and check the correctness of the solutions found.

Using robots in elementary school math classes can increase student engagement in improving math skills. Moreover, there is a competitive element to such courses. In this case, competition between teams can motivate students. Every team wants their robot to be the best and get the job done the best and fastest. The student self-corrects the error multiple times until the robot completes the task without error. Therefore, the mistakes students make represent an excellent learning environment for them because students naturally learn from their mistakes. They are an opportunity to think about them, eliminate them, and find the right solutions. In this way, students improve and develop logical thinking skills, patience and the ability to cope with failure. An error will not prevent you from continuing to work. on the other hand. The student wants to eliminate it as quickly as possible, which triggers a thought process that the teacher wants.

The judicious and purposeful use of programming in mathematics lessons develops students' reasoning skills and supports them in improving their mathematical skills.

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LESSON 1.4
Overcoming Math Anxiety at School and Home
Duration: 1 hour

Learning outcomes:

- To define possible solutions for overcoming mathematical anxiety.
- To discuss ways teachers and parents can support children suffering mathematical anxiety.
- To generate practical solution to for overcoming mathematical anxiety.
- To treasure ways teachers and parents can cooperate and support each other.

Teaching methods: problem solving, case study, collaborative learning.

Learning-Teaching Process:
Before the Classroom Time:

- Prospective teachers will consider the possibility to overcome mathematics anxiety. They will use online resources for in-depth understanding of the topic.

In-class Activities:

- What is the role of teacher in preventing mathematics anxiety? – case study.
- How can parents help primary school students to avoid stress connecting with learning basic math? – group work.

Assessment Tools:
Different assessment strategies can be used in the module, depends on instructors' approaches. At the outset, a preliminary diagnostic assessment will be conducted, evaluating prospective teachers' knowledge and comprehension of mathematics anxiety. Prior to engaging in this module, participants will undergo a pretest. Following the module's completion, a post-test will be implemented. Summative assessments, comprising written and oral tests, have been crafted to gauge and appraise their advanced-level capabilities.

Theoretical Knowledge:

The best thing you can do as a teacher is to be wary of math anxiety and catch it early. In the classroom, the teacher's role is to be prepared to adapt teaching methods to situations that may trigger high levels of mathematics anxiety.

How can you, as a teacher, help:

- Be aware of the demands on working memory that learning new content places on you, and make sure you take cognitive load theory into account as much as possible when designing activities. Math anxiety symptoms may be triggered when a child experiences cognitive overload.
- Break down new teaching moments into their smallest components so your students can continue to achieve small victories as they rise to the challenge.
- Build confidence through some standard definitions and explanations so that children can begin to internalize and remember. Sentence stemming is perfect for this situation.
- Provide plenty of opportunities for practice, especially through sample problem pairs, so children feel supported in their progress.
- Don't be afraid to provide additional concrete resources when crunching numbers. By starting with the concrete, you can deepen young people's understanding of new mathematical ideas and then gradually move from that idea to more conceptual ideas.
- Where resources allow, targeted one-on-one math interventions, such as those offered by Third Space Learning, are the gold standard for overcoming math anxiety disorders. Tutors are trained to support, guide and encourage anxious children through online math lessons.
- Promote the idea that it's okay to ask for help and make mistakes – Reinforce the idea that we learn when we make mistakes and we learn when we ask for help.

How parents can help:

- Don't expect too much from your child after a day of homeschooling, and while practice is important, make sure you don't force your child to do too much.
- Make learning math a daily practice: regular, little but often: 10 minutes a day is better than 45 minutes of intense study on a Sunday afternoon. When we have to remember something and retrieve it from our memory on a regular

basis, we are more likely to be able to remember it for a longer period of time.

- Try to focus on one or two math concepts at a time, because if we try to do too many things – especially too many different things, our brains can get overloaded.
- Only practice what you've already learned – Don't try to teach new things at home, especially if you expect your child to do most of the work alone.
- Be present with your child: Since young school children are not yet self-regulated enough to sit down and do homework on their own, it is important to be present with them.
- Make math a part of everyday life: There are plenty of opportunities to talk about math while shopping, decorating your home, cooking, etc. (you don't always have to ask them questions). When you start looking for math opportunities in your daily life, you'll find that they are everywhere!
- Make sure the child is interested in math: In addition to looking for natural possibilities, you can also provide opportunities to talk about and explore math, e.g. B. By playing board games and computer games.
- Don't tell your children that you're not good at math either – you'll only convince them that such ideas and statements are valid. Make sure they feel they can be good at math and have no reason not to be good at it. Help them stay positive even when things get difficult!
- Let your children talk about their fears. It's always a good idea to express these thoughts and feelings openly. Children should be given the opportunity to express their feelings - this often helps them feel like they are not the only ones having difficulties. Remember: If it's really good to talk, it's also good to listen when kids share these fears — making sure they know and feel they're being heard.
- Teach your children to ask questions when they don't understand. If your child mentions a math term that you're unsure about, check out our Junior Math Dictionary for Kids to find out what it means.
- Communicate with your child's teachers to discuss possible home and school strategies and work collaboratively. By working together, you have the best chance of helping your child cope with and overcome math anxiety.

The answer to a math problem is either correct or incorrect. Children can stick to this from an early age. The various topics are also closely related to each other. Therefore, if the foundation in one aspect is not solid, the development of overall learning will be affected. Another challenge is that mathematics is a subject filled with abstract concepts that are difficult to understand. Here it is important to make the math real. Both teachers and parents can find new, creative way of conquer mathematics anxiety.

One approach to addressing this issue involves instructing elementary mathematics through creative and captivating book concepts. These resources can be valuable for educators, parents, and other caring individuals seeking to involve children in mathematical activities—often without the children being aware of it.

Picture books provide rich opportunities to develop not only reading and writing skills, but also mathematical understanding. Books that connect math concepts to plots can introduce basic math concepts such as numbers, shapes, and patterns. They also encourage children's mathematical thinking by asking questions and making mathematical observations.

Books can engage young readers in understanding mathematical concepts and solving problems by presenting specific mathematical concepts. Many children's books are designed to teach mathematical topics through narrative. These books are written specifically to teach a single specific mathematical concept. They can be used by teachers in the classroom or parents with children to read aloud.

Marilyn Burns, one of today's most respected mathematics educators, has created a series of “Marilyn Burns Brain Day Books”. One section, “The Greedy Triangle”, tells the story of an anthropomorphic character who has the smallest number of sides of all polygons and wants more. This story introduces the names of polygons and encourages children to think about what happens when a shape has more sides and angles.

Marcia Brown's Stone Soup, first published in 1947, tells a French folk tale. Great for learning counting and addition. Books can also use mathematics to drive narratives, such as Madeleine L'Engle's A Wrinkle in Time — a young adult novel that has been in print continuously since its publication in 1962, won the Newbery Medal, and inspired two films adaptation. There's even a geometry lesson surrounding the story.

Teachers and parents can find many interesting resources online. The Charles A. Dana Center at The University of Texas at Austin operates the web-based Inside Mathematics portal, which provides free videos, tutoring tools, and other resources. Portals such as https://masterthecurriculum.co.uk or https://www.teachwire.net/ offer content from math games and surveys to lesson plans and worksheets. Enhance your students' math and thinking skills with these exciting classroom math activities.

Another challenge we face today is online and blended learning. Sometimes what is difficult to explain in face-to-face instruction is even more difficult on a screen. Additionally, children who are used to expending energy in physical education classes, playing on the school playground, and playing in amusement parks may have a lot of energy trapped in them. They find it difficult to concentrate. They can help kids get excited about learning while freeing up some of their energy.

Here are some ideas:

1) Shape Hunt

Goal: to think about shapes and identify them in home surroundings.

Instruction: Draw or print a variety of shapes on a piece of paper. The children's task is to find objects around the house that fit these shapes. You can set a time limit (5-10 minutes). Then see how many shapes they can find. You can award one point for each shape, or multiple points for irregular shapes like parallelograms and hexagons. This game is suitable for individual children or for siblings to play together. Brothers and sisters can compete with each other.

2) UNO as an Active Math Game

Instead of using UNO cards while sitting calmly around a table, you can turn this classic card game into an energetic active math game.

Before you start playing, assign some movement rules for every color. For example:

- *Blue — touch your nose.*
- *Yellow — jump high three times.*
- *Red — hop ten times on one leg.*
- *Green — be silent for 5 minutes.*
- *Wild card — spin two times.*

Whenever any player lays a card, the next player (or all of the players) needs to carry out the action assigned to that color the correct number of times.

3) Simon Says Shapes

Simon Says is another classic game to get kids moving. In this version of the game, it also helps kids learn geometry. The player chosen as "Simon" asks the other players to move their arms and legs so that they look like a shape. For example, when Simon says, "Show me a square!" children have to move their bodies to represent the shape of the square.

For older kids, you can play the Simon Says angle game. When Simon says "show me 45 degrees" or "that's a right angle", children have to use their arms or legs to show what the angle looks like.

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MODULE 2.
BASIC PRINCIPLES FOR USING ROBOTS IN PRIMARY SCHOOL MATHEMATICS CLASSES

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LESSON 2.1
Overview and Need for STEM and Robotics Coding
Need for stem and Robotic coding
Duration: 2 hours

Learning Outcomes:

- Discusses the impact of technology on educational approaches in our age.
- Becomes familiar with the stem approach.
- Becomes familiar with robotic coding.
- Recognizes the advantages of using robots in training.
- Becomes aware of the mental processes developed by robotic coding in individuals.

Teaching Methods/Techniques: discussion, narration, question-answer, discussion, problem solving, case study.

Learning-Teaching Activities:
Before the Classroom Time
Prospective teachers use the online teaching materials to learn about the topic.

In-class Activities

- Teacher candidates are asked about the effect of technology on their understanding of education in our age and the answers are analyzed together.
- Pre-service teachers are asked for case studies on the necessity of technology-based teaching tools used in education, the applicability and necessity of interdisciplinary understandings in education. It is discussed together on case studies.
- Prospective teachers are asked whether they have experiences with stem practices. In line with the answers, sample applications related to what the stem approach is and its applications are followed and read.
- Describe applications related to the use of robots in education.

- 2 groups are formed from teacher candidates by complying with the volunteer basis of 3-4 people.
- One group contends that, regardless of belief, the use of robotic applications in education diverts children from the benefits of traditional learning areas. This perspective argues that such technological reliance fosters individuality, posing a social problem for future generations. On the other hand, the opposing group advocates for the positive impact of robotic applications in education, asserting that they facilitate multifaceted development in children. This perspective suggests abandoning alternative methods in favor of creating learning environments exclusively centered around technological applications. The debate technique is employed here to present contrasting viewpoints on the matter.
- Stem is combined with prospective teachers with the idea that the features of Empowered Learner, Digital Citizen, Knowledge Constructor, Innovative Designer, Computational Thinker, Creative Communicator and Global Collaborator, which are within the scope of 21st century thinking skills in individuals, can be gained by using robotic applications in an integrated way. In particular, it is tried to raise awareness of computational thinking skills.

Assessment Tools:
There might be applied three types of assessment tools for this lesson depends on instructors' approaches: formative assessment (reviewing of homework and papers), summative assessment (giving tests oral or written) to measure prospective teachers' abilities and master skills) and diagnostic assessment (pre-test and post-test). Both written and test or oral assessment tools will be aimed at comprehension and measurement of their higher competencies.

Theorical Knowledge:
The 21st century, which is called the "Millennium Age", has also begun to be called the "digital age" in some platforms, especially in recent years. In this age of knowledge and creativity, digital transformation is inevitable in all areas. In order to keep up with

today's speed, approaches based on “learning to learn by the learner” come to the fore in education, which is the basis of human development, as in every field. There is no doubt that the stem approach, which is defined as an educational approach within the framework of 21st-century skills at every education level, from early childhood to adult education, based on the integration of science, technology, engineering, and mathematics disciplines, increases learning speed and provides strong motivation (Scaradozzi et al., 2015).

Robotics, which is discussed within the scope of stem, emerges with the combination of many engineering fields and is a common field of study that includes software, computers, machinery and control units as well as space sciences. Developments in the field of robotics, which is seen as the technology of the future within the scope of digital transformation, have also increased the interest in this field and the incentives/investments made in the field. In line with these developments in Turkey; coding and robotics education has started to be provided in many schools in the field of education. The first educational robot designed for education is the LEGO TC Logo, which was developed in 1988. Since then, many new educational robots have been created and studies have been carried out to use it in education to develop different competencies (Daniela & Lytras 2018; Eguchi, 2014). Many teaching tools such as Arduino, Mbot and LEGO robots that support robotic coding teaching; many programming tools such as Tinkercad, Mblock, Scratch for Arduino have been developed to program robotic circuits using a drag-and-drop method with code blocks. Students are expected to develop their coding skills and produce a number of prototypes in order to find solutions to many current problems by using these tools.

In the literature, robotic coding is defined as a complex problem-solving skill that includes many cognitive processes (Grover & Pea, 2013; Monroy-Hernández & Resnick, 2008) and there are many research results showing the benefits of robotic coding. Using robots in education creates self-confidence and motivation by providing different learning environments for children, makes learning more meaningful and permanent by offering a curriculum integrated with science and technology (Wood, 2003), and offers mental tools within the scope of modern technologies to solve problems (Jonassen, 2000). With robotic coding, students can have opportunities to develop their logical abilities and creativity, and the underlying features of reasoning and critical thinking (Scaradozzi et al., 2015). The use of robotic systems and the introduction of Robotics are highly effective in terms of cooperation and teamwork as well as problem solving and technology (Rudolfa et al., 2021; Yuen et al., 2014).

One of the most important gains of robotic coding in education is the positive effects of computational thinking, which can be expressed as doing what the human mind does well with the human mind and what computers do well with the computer. Some educators emphasize the importance of computational thinking by stating that it can be equivalent to "reading" and "counting" abilities, which are among the basic abilities (Wing, 2006). Within the scope of 21st century thinking skills, the standards developed by the International Society for Technology in Education (ISTE) for students in 2016 were determined as Empowered Learner, Digital Citizen, Knowledge Constructor, Innovative Designer, Computational Thinker, Creative Communicator and Global Collaborator. In short, computational thinking skills emerge as a skill that everyone should have in the 21st century.

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LESSON 2.2
Understanding Robotic Coding and Computational Thinking
Duration: 2 hours

Learning Outcomes:

- Explains the concept of computational thinking.
- Discusses the relationship of computational thinking with problem-solving thinking skills.
- It reveals the relationship and differences of computational thinking with computer science and programming.
- It reveals the relationship between computational thinking and robotic coding.
- Refers to the characteristics of an individual with computational thinking skills.
- Investigates and exemplifies the concepts and approaches of computational thinking.
- Prepares concept map, mind map related to computational thinking.

Teaching Methods/Techniques: discussion, narration, question-answer, collaborative learning, research groups, buzz groups, concept map, mind map.

Learning-Teaching Activities:

- Prospective teachers are divided into heterogeneous groups of 4-5 in terms of pre-learning.
- Each group discusses what "computational thinking" is in the form of buzzing groups.
- After the group discussions, student groups are asked to investigate the relationships and differences between computational thinking-problem-solving-computer-programming from the sources.
- In order to visualize the results of the research, groups create concept maps and mind maps related to the concept of "computational thinking" and share them with each other. It is discussed by the class on concept maps. A holistic concept map is created as a classroom under the guidance of the instructor.

- Groups conduct online research on how computational thinking can be acquired with robotic coding applications.
- Each group exemplifies the results of their research on how computational thinking can be acquired with robotic coding applications by using concrete research examples and presents them to the class.

Assessment Tools:
There might be applied three types of assessment tools for this lesson depends on teachers' approaches: formative assessment (reviewing of homework and papers), summative assessment (giving tests oral or written) to measure prospective teachers' abilities and master skills) and diagnostic assessment (pre-test and post-test). Both written and test or oral assessment tools will be aimed at comprehension and measurement of their higher competencies.

Theoretical Knowledge:
The concept of computational thinking was first used by Seymour Papert, a mathematician and computer scientist, in his study called Mindstorm (1980). Papert has conducted many researches to understand children's learning processes and to help children learn programming (Ellison, 2018).

According to the International Educational Technologies Society (ISTE) (2015), computational thinking is defined as a problem-solving approach that strengthens the combination of technology and thought, but it is not the new name of problem-solving skill. Computational thinking is a form of abstract thinking that can be used in daily life (Lye & Koh, 2014), including critical thinking, abstraction, and algorithmic thinking skills (Wing, 2008).

Computational thinking is an applicable universal skill that can be used by every individual, not only those who are engaged in the field of computers, but also those who are willing to learn.

Computational thinking is related to computer science and programming, but they are not exactly the same fields. Computational thinking is the whole of studies aiming at problem solving, critical thinking, understanding between human-computer interaction.

Some characteristic features of computational thinking (Hill, 2022):

- Formulating a computer and other tools to help us solve problems.
- Analyzing and logically organizing the data.
- Representation of data through abstractions such as simulations and models.
- Automation of solutions through algorithmic thinking (a series of sequential steps).
- Identifying, analyzing and implementing possible solutions with the aim of achieving the most results, efficient and effective combination of steps and resources.

Trends or attitudes within the framework of the basic dimensions of computational thinking:

- Trust in combating complexity.
- Tolerance for uncertainty.
- Insisting on working with challenging problems.
- Ability to cope with open-ended problems.
- Ability to communicate and work with other individuals to provide a common purpose or solution (ISTE, 2016).

Figure 1. Concepts and approaches of computational thinking

As a result of the studies carried out within the scope of the Barefoot project initiated in 2014 in order to help primary school teachers in the UK to adapt to computer science in new computer education programs; computational thinking is explained under two headings as “concepts” and “approaches” (See. Figure 1). Concepts: Logic, Evaluation, Algorithms, Patterns, Decomposition and Abstraction. Approaches: Tinkering, Creating, Debugging, Persevering and Collaborating (Üzümcü & Bay, 2018).

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LESSON 2.3
The relationship between mathematical thinking and computational thinking skills
Duration: 2 hours

Learning Outcomes:

- Understands the importance of mathematics education.
- Indicates difficulties encountered in mathematics education.
- Understands what is mathematical thinking skill and its components.
- Understands the relationship between computational thinking and mathematical skill.
- Discusses and visualizes differences and similarities between computational thinking and mathematical skill.

Teaching Methods/Techniques – Learning-Teaching Activities: discussion, buzz, reflective thinking writing, brainstorming, concept map, research groups

- Prospective teachers are divided into heterogeneous groups of 4-5.
- Each group discusses the aims and quality of mathematics education in the form of buzz groups.
- After the group discussions, student groups are asked to research the mathematical skills from the sources. After their research, each individual writes a paragraph together with the reasons for whether they have mathematical skills. People who volunteer read.
- Heterogeneous groups are asked to schematize the components of mathematical thinking skills. Each group hangs the diagrams/shapes they create on the board. The hanging diagrams are handled by the class and a common diagram is drawn on the board together.
- Teacher candidates were asked "What can be done to improve mathematical thinking?" A secretary is selected from the class. It is one of the criteria that this person can write quickly and legibly.

- Under the guidance of the instructor, the prospective teachers quickly tell the answers that come to their mind about the question asked, and the selected secretary writes down what is said on the board. Thoughts are not criticized in any way, and feedback is prevented by body language (gesture, facial expressions, nodding, etc.). When the reporting of the thoughts is finished, what is written on the board is reviewed by the class and what can be done to improve mathematical thinking is listed.
- It is asked whether mathematical thinking skills are related to computational thinking and volunteers are asked to express their thoughts in the form of idea scanning. Following the reported ideas and group resource research, the groups are asked to visualize the differences and similarities between computational thinking and mathematical skill in the form of a concept map.
- The concept maps created by the groups are hung on the board and reviewed by the class under the guidance of the instructor.

Assessment Tools:
There might be applied three types of assessment tools for this lesson depends on teachers' approaches: formative assessment (reviewing of homework and papers), summative assessment (giving tests oral or written) to measure prospective teachers' abilities and master skills) and diagnostic assessment (pre-test and post-test). Both written and test or oral assessment tools will be aimed at comprehension and measurement of their higher competencies.

Theoretical Knowledge:
The necessity of mathematics for both the world of science and daily life has made mathematics teaching from primary school to higher education compulsory and necessary (Sezgin, 2013). However, mathematics can be seen as a lesson that is thought to be successful by memorization, which is difficult to concretize and has complicated operations related to numbers by children since primary school. This situation emerges as a difficulty for children to learn, adapt to life and materialize. Some studies reveal that mathematics is perceived by children as a complex and time-consuming course and its purpose is not understood

by most teachers (Even & Tirosh, 2002; Krulick, Rudnick & Milou, 2003). In some definitions of mathematics, Van De Walle, Karp and Bay-Williams (2012) state that mathematics is considered by individuals as an area that is abstract and has no connection with real life due to the fact that mathematics is defined as a system that man develops by himself. However, mathematics has an important role in both the development of individuals' thinking skills, as well as in their career plans for the future, their success in life, and their academic development (Choi & Chang, 2011). Through mathematics courses, the development of basic process skills such as problem solving, computational thinking, communication, reasoning and association is calculated and multiple skills are taken as a basis.

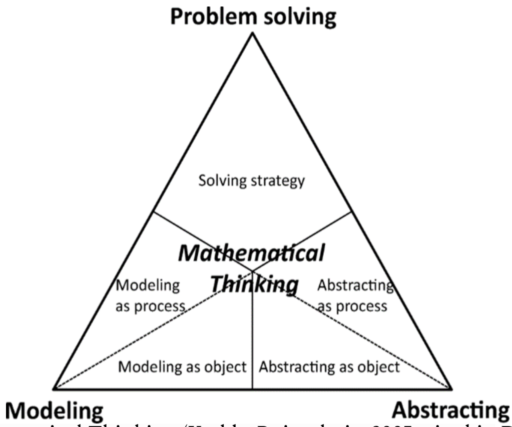

Figure 2. Mathematical Thinking (Kodde-Buitenhuis, 2005; cited in Drijvers Kodde-Buitenhuis& Doorman, 2019)

In Figure 2, it is seen that mathematical thinking consists of problem solving, modeling and abstracting components. It can be said that these components are also components of computational thinking.

We can think of mathematics as a discipline that helps explain the natural and designed world, which is at the center of science and engineering (Aminger et al., 2021). Due to the rapidly changing nature of the mathematics discipline, it is very important to include computational thinking strategies in the classes where this discipline is taught (Wilkerson & Fenwick, 2017). Computational thinking uses mathematics to represent physical variables such as space, volume, weight, and time, which are often areas of study of mathematics. Computational thinking, which is based on problem solving processes, can help develop mathematical skills through processes such as separation, algorithm, and modeling.

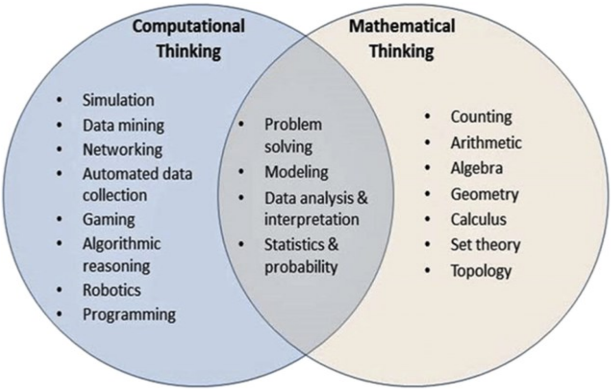

Figure 3. Similarities and differences between CT and mathematical thinking (Sneider et al., 2014)

In Figure 3, the similarities and differences of mathematical thinking and computational thinking as fields of study are schematized. Both have problem solving, modeling, data analysis and interpretation, statistics and probability areas of study.

When the common aspects of computational thinking and mathematical thinking skills in terms of competencies are examined, it is seen that skills such as abstraction, generalization, separation, algorithmic thinking and debugging are needed in both skills (Atmatzidou & Demetriadis, 2016). Mathematical thinking and computational thinking have many similarities in terms of cognitive processes such as abstract thinking, metacognitive strategies, flexibility, evaluating multiple possibilities, etc. These cognitive strategies can be developed at any age and can be effective prerequisites for later competencies. With computational thinking, children have the opportunity to offer alternative solutions to problems encountered in the field of mathematics, to organize data to compare these solutions, to use simulations, to fragment, to use algorithms in learning environments where digital teaching tools are used. Algorithms are at the center of computational thinking as well as important components of mathematics. Computational thinking allows students to establish mathematical models, compare these models with those known about the real world, and see whether this model is meaningful (Aminger et al., 2021). Mathematical thinking skills are often seen as a fundamental factor in revealing students' ability to learn programming (Sung, Ahn, & Black, 2017).

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LESSON 2.4
The Use of Robotics in Mathematics Education of Primary Schools
Duration: 2 hours

Learning Outcomes:

- Understands the importance of mathematics education in primary schools within the scope of 21st century skills.
- Develops understanding of the use of robots in primary school mathematics education.
- Understands the advantages of using robots in teaching mathematics.
- Has awareness of the elements to be considered in the use of robots in mathematics teaching.

Teaching Methods/Techniques – Learning-Teaching Activities: discussion, blended learning, narrative, question-answer, forum, brainstorming, idea scanning, collaborative learning, poster.

Distance education process:

- A forum is opened on the web 5 days before face-to-face training. The topic of the forum: "21. What is the quality of primary school mathematics teaching within the scope of 21st century skills?"
- The opening of the forum is done synchronously by the instructor on video.
- The forum is left open to comments asynchronously for 2 days.
- At the end of 2 days, comments made on a simultaneously determined date and time are handled and discussed with a short online meeting.

Face-to-face training process:

- The situations discussed regarding the quality of primary school mathematics teaching in online education under the guidance of the instructor and alternative solution suggestions are reviewed quickly in the form of idea screening.

- In these solutions, it is discussed whether the use of robots in primary school mathematics teaching will be efficient.
- Prospective teachers are divided into heterogeneous groups of 4-5 people.
- Each group prepares a poster on the advantages of the use of robots in primary school mathematics teaching.
- Each group presents the poster they have prepared to the class and what advantages it includes is discussed by the class.
- The instructor draws attention to the elements to be considered in the use of robots in teaching mathematics.
- For the next course, teacher candidates are given the task of examining sample applications related to the use of robots in primary school mathematics teaching and the course is terminated.

Assessment Tools:
There might be applied three types of assessment tools for this lesson depends on teachers’ approaches: formative assessment (reviewing of homework and papers), summative assessment (giving tests oral or written) to measure prospective teachers’ abilities and master skills) and diagnostic assessment (pre-test and post-test). Both written and test or oral assessment tools will be aimed at comprehension and measurement of their higher competencies.

Theoretical Knowledge:
The Mathematics course in primary school is a course that can help children create mathematical knowledge about their world. Unfortunately, when the teaching experiences of mathematics lessons in schools are examined, it can be said that children are very much removed from these skills and directed to memorization-based procedures. In this case, it is important to develop students' computational thinking skills both in terms of developing their mathematical skills and raising future generations with 21st century skills.

Individuals needed in today's societies are individuals who can determine their own learning goals independently, design their own application methods, make their own self-assessments, access different sources of information and evaluate their knowledge resources and have the ability to formulate their own views with this equipment. One of the ways to develop computational thinking in raising individuals with these characteristics is the use of robots in education in fields such as mathematics. Robotic coding is a technological tool that attracts great interest in primary education mainly due to its compatibility with science, technology, engineering and mathematics (stem) (Khanlari, 2019).

Robotic technologies can be considered as an excellent tool not only for robotics, but also for applied learning in the fields of science, technology, engineering and mathematics (Mataric, Koenig, & Feil-Seifer, 2007). Robotics allows students to systematically process tasks and develop their skills to develop step-by-step coding commands through computational thinking (Chalmers, 2018). Robotics plays an increasingly important role in updating the content of mathematics education.

The purpose of using robots in mathematics education in primary school is not only for children to learn mathematics, to build certain objects, to learn to command robots; it is to develop important skills that can be used in both daily, academic and professional lives in later life.

Abstract topics in mathematics can be learned through robotic activities; by presenting an environment of building, observing, and experiential learning of a range of physical objects. Programming is a big part of robotics as well as mathematics, and it can be very complicated for the child at first, but even the smallest students can make and program robots with many graphical programming possibilities, such as the LEGO WeDo interface.

Robotic coding contributes to the development of different skills of children of all ages and genders. For example, young students may develop fine motor skills when creating/configuring robots such as LEGO WeDo.

Robots are a good way for students with different individual characteristics such as the need for different teaching methods to learn mathematics and meet computational thinking (Daniela & Strods, 2019). Since teaching through activities is the most effective way to develop various cognitive processes of primary school children, using robots in primary school mathematics education will enable the solution of many problems by the child. It has also been revealed by scientific research in the field that the use of robots in mathematics teaching has many advantages.

These are as follows:

- Robots, in particular, can greatly increase the interest of students with negative attitudes towards mathematics and can be a remarkable tool for starting the lesson (Khanlari, 2019).
- Since robotics includes many different actions such as planning, building, programming, testing, it can enable children to focus on mathematics problems for a longer time through practical activities (Daniela & Strods, 2019).
- Learning mathematics with robots enables the child to learn by having fun and playing games in accordance with their developmental characteristics.
- It enables the relationship of mathematics with other sciences and allows the child to establish interdisciplinary connections (Silk et al., 2010).
- The use of robotic applications in the solutions of the problems related to ratio-proportion, integers, algebra equations, measurement, estimation and geometry in mathematics teaching allows the discovery of abstract concepts in a concrete way by applying them in real life (Çınar, 2020; Stripling & Simmons, 2016). With the help of applied activities, robotic technologies can help young people translate abstract mathematics concepts into concrete real-world applications (Nugent et al., 2010).
- Robotic applications improve visual learning.
- Robotic applications enables the child to work with his/her own manual labor and allows him/her to learn permanently. People remember 10% of what they read, 20% of what they hear, 30% of what they see, 50% of what they see and hear, 90% of what they learn by doing and experiencing while learning 70% of what they say.
- Robotic applications enable students to learn mathematics through academic discussions and collaboration with their peers (Kopcha et al., 2017). Because students try to cope with some problems while learning with robotic technologies and they need peer interaction in solving problems.
- In addition to improving students' numerical thinking skills, they also develop computational thinking through robots and have skills related to how they can use their mathematical skills elsewhere (Bers et al, 2014). In this way,

it also contributes to the development of problem solving skills (Petre, & Price, 2004). Mathematical knowledge is applied to find out how to solve different complex problems.

- Robotic applications in mathematics teaching enable the development of ideas and algorithmic thinking in the field of engineering at an early age.
- Robotic applications in mathematics teaching also provide students with some skills in terms of discovering, structuring and applying what they have learned (Ching et al., 2019). When students mathematically describe a technological design problem, they develop more complex solutions and insights into those solutions.
- With robotic applications, learning environments that enable children to express themselves and experience their feelings of achievement in the field of mathematics can be created.
- Robotic applications allow children to unlock their own creative potential by giving them the opportunity to carry out original studies in the field of mathematics.
- In teaching mathematics with robots, children are given progressive tasks, which can make them more willing to finish a job and not give up even in difficult tasks.

Despite the many advantages mentioned above, it should also be taken into consideration that children's interest in robotic coding will not be sufficient for them to continue to learn mathematics concepts and to continue the development of their mathematical skills. The design of robotic activities in mathematics teaching should both encourage student participation at the beginning of the course and continue actively until the end of the unit (Silk et al., 2010). Individual differences in the cognitive characteristics dimension of students (for example, some students may have difficulty in algorithmic thinking) should be taken into account in the planning of robotic coding training, and attention should be paid to conducting robotic coding applications in cooperation with students' peers.

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MODULE 3.
HOW TO IMPLEMENT THE BLENDED LEARNING AND TEACHING IN THE PRIMARY EDUCATION

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LESSON 3.1
Blended Learning Approach - Definition and Conceptualization
Duration: 1 hour

Learning Outcomes:
The prospective teachers will be able:

- To clarify the blended learning approach.
- To differentiate between blended learning approach and face to face education.

Teaching Methods/Techniques: individual work, discussion, collaborative learning, question-answer, mind mapping, group work

Learning-Teaching Activities:
Before the Classroom Time, prospective teachers use the online teaching materials to learn about the topic: blended learning approach in higher education.

In-class Activities

- In the first part, the trainer will provide some basic information about the topic and will introduce the first activity.
- Individually, the participants will respond to some questions regarding their prior knowledge about the topic of blended learning. More specific, the questions will be: What do you think blended learning is? What it is not? How is this approach different of traditional teaching approach? Every participant will respond to this question through a Mentimeter link (www.mentimeter.com). The responses will be showed to all participants.
- The trainer will build on those responses and emphasize the characteristics of blended learning approach and how it is different on the other teaching approaches.
- In groups of 3-5, the participants will discuss about their experiences in using blended learning approaches and how it can be used in primary school setting.
- Every group will present their work in front of others.

Assessment Tools:

- Self-assessment- every participant will have 1 minute of self-reflection about the importance of using blended learning approach in one's own pedagogical activity.
- Peer assessment will be used to determine how the groups study, understanding the group's processes.
- Formative assessment: evaluating the work and homework.
- Summative assessment: evaluation of oral tests or written examination to measure the skills and knowledge acquired by prospective teachers knowledge.
- Diagnostic assessment: evaluation of pre-test and posttest to measure prospective teachers' gained competencies.

Theorical Knowledge:

An educational approach that uses more than one delivery method in an effort to improve student learning outcomes and/or program delivery costs is known as blended learning (Singh & Reed 2001). The concept of blended learning is founded on the notion that learning is a continual process rather than a one-time event (Garrison & Kanuka, 2004). Blending offers a number of advantages over adopting a single learning delivery method by itself (Singh, 2003). It has also been suggested that blended learning entails combining conventional in-person instruction with online exercises and materials (Downes, 2008). Blended learning has many benefits, including the ability to personalize learning in ways that enable thoughtful reflection and differentiate instruction across a diverse group of learners. Online educational content delivery that incorporates the best features of classroom interaction and live instruction is one such benefit. Instead of being seen as a proportion of delivery modalities, blended learning should be understood as a pedagogical strategy that combines the efficiency and socialization chances of the classroom with the technologically enhanced active learning opportunities of the online environment (Ferdig, Cavanaugh, DiPietro, & Black, 2009). Originally, there were six different types of blended learning models: the face-to-face driven model, the rotation model, the flex model, the online lab model, the self-blended model, and the enriched virtual model. However, Staker and Horn decided to eliminate the face-to-face driven model and the online lab model, leaving only four types of blended learning models that are still in use today. Station rotation, lab rotation, flipped classrooms, and individual rotation are the four categories into which the rotation model is split. The station rotation model and the flipped classroom model are the most common. The presence of direct teacher instruction, student collaboration, and technologically supported online learning are parallels between the two methods. The timing of online learning is what distinguishes the two models. In the flipped classroom learning model, online learning occurs before to classroom learning, while in the station rotation learning model, it occurs after class learning has ended. To improve students' comprehension of the learning material presented in class, online learning using the station rotation paradigm is used. According to the flipped classroom paradigm, online instruction involves preparing students before class by delivering them educational materials via online media.

Flipped classroom gives students the benefit of greater control over their own learning. Students can choose when they watch instructional videos at home, and they also guide class discussions by asking the instructor for clarification, so their needs guide how class time is used. When they do hands-on activities and practice their new skills in class, students can have more autonomy. They can explore new concepts in their own way, at their own pace, in a supportive and controlled environment. (Bergmann, J., & Sams, A., 2012)

The four pillars of the flipped classroom approach:

- F: Flexible Learning Environment – A flexible learning environment

When you eliminate the model of traditional classroom information delivery, you also get rid of traditional rows of benches in favor of more flexible classroom arrangements. The furniture must be modular to allow arrangement in various groups and individual work. Also, the scheduling of lessons/lessons must be flexible to allow students to fully explore a topic and understand it at their own pace.

- L: Learning Culture – The culture of learning

Instead of a traditional, teacher-centered culture, the flipped classroom puts students at the center of the lesson. Students guide the pace and style of learning, and the instructor plays the role of “the guide who accompanies them.” When students need to apply the new information in class, teachers will help students through an experiment or guide them through a set of exercises.

- I: Intentional Content – Intentionally chosen content

Instructors/teachers who adopt the flipped learning model are always looking for ways to maximize classroom time so that students are actively engaged in learning and hands-on practice. This approach requires prioritizing lessons that work in this model and discovering ways to encourage learners to work independently.

- P: Professional Educator – Professional educator

The model requires instructors/teachers to constantly monitor their students to identify who needs help and why. Teachers must be receptive and flexible and must understand that this very active type of teaching requires a high level of pedagogical ability. Although they seem less visible in a flipped classroom, instructors/teachers need to be at the top of their teaching skills to help students develop.

For all of our students, learning should be active and rich. Learning may be made more enjoyable and applicable for students through blended learning. Therefore, exposing them to technology at a young age can help them imagine careers that rely on technology. Additionally, young children can establish cooperative learning practices that will equip them for future employment and democratic involvement. We come across issues that are challenging to resolve in a face-to-face teaching framework for the beginning when teaching and learning mathematics. They may lack enthusiasm, drive, and a positive outlook, and others may not be planning to specialize in it, thus they may not give basic mathematical concepts much thought. Thus, implementing a mixed learning strategy might raise learners' interest and attitude. Active learning and interaction between students and the learning environment's mediator are made possible by blended learning. Along with examining the advantages of web-based technology in mathematics education, the usage of blended learning contributes to the diversification of instructional delivery in mathematics curriculum (Awodeyi, Akpan, & Udo, 2014). According to one study, utilizing a blended learning strategy enhanced students' accomplishment scores when compared to other strategies and had positive effects on their attitudes toward mathematics (Awodeyi, Akpan, & Udo, 2014). (Iozzi, & Osimio, 2012). Additionally, susing a BL aproach, student spent more time on studying.

Al-Zoubi and Bani- Doumi (2012) summarized the factors which contribute to the success of blended learning:

- Communicating and guidance.
- Collective work.
- Encouraging innovative work.
- Participation of the students in choosing the suitable blend.
- Continuous communication.
- Repetition.

The blended learning paradigm is used to raise students' motivation and level of knowledge, improve critical thinking abilities, learning outcomes, and mastery of subjects. However, no prior research has examined the impact of the blended learning model with metacognitive methods on primary school kids' mathematics understanding ability and self-regulated learning.

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LESSON 3.2
The Impact of Blended Learning Approach on Reducing Math Anxiety in Primary School

Duration: 1 hour

Learning Outcomes:

The prospective teachers will be able:

- To recognize the advantages of using blended learning approach in teaching mathematics.
- To recognize blended learning solutions for reducing math anxiety in primary school children.
- To classify the blended learning instruments by the teaching methods types.

Teaching Methods/Techniques: question-answer, group work, collaborative learning, discussion, brainstorming.

Learning-Teaching Activities:

Before the Classroom Time, prospective teachers use the online teaching materials to learn about the topic: the effect of blended learning methods on reducing mathematics anxiety in primary schools.

In-class Activities

- The session will start with a brief introduction where participants will write down one important information, they remember from the first session answering the following question: *The most useful idea about blended learning is...*
- Next, the participants will be divided into groups of 3-5. They will be asked to reflect on: a. the advantages and limits of using blended learning for teaching and assessment in primary school, especially for mathematics classes; b. some teaching methods that can be adapted for a blended-learning approach.
- The group work will be presented in front of the other participants. If needed, the trainer will add new information and structure the participants ideas.

- The second part of this session will address the topic of using blended learning for reducing math anxiety in primary school setting.
- The trainer will present some brief information about math anxiety. He will give every participant a list of anxiety problems and behaviours of children in schools.
- In pairs, (2 participants), they will search on the internet some resources they may use to reduce math anxiety. Every pair will argue their choice.
- At the end, the resources of all pairs will be added on a list and the whole group will make a hierarchy with the most useful in reducing math anxiety and enhancing motivation to learn math.

Assessment Tools:

- Self-assessment- every participant will have 1 minute of self-reflection about the importance of using blended learning approach in one's own pedagogical activity.
- Peer assessment will be used to determine how the groups study, understanding the group's processes.
- Formative assessment: evaluating the group work and homework.
- Summative assessment: evaluation of oral tests or written examination to measure the skills and knowledge acquired by prospective teachers' knowledge.
- Diagnostic assessment: evaluation of pre-test and posttest to measure prospective teachers' gained competencies.

Theorical Knowledge. Teaching methods that can be adapted for a blended-learning approach

The use of modern methods by applying BL to teaching mathematics in primary education changes the children's vision of mathematics as a difficult and complicated discipline.

In primary education, BL tools can be used every day in any discipline and especially in mathematics. BL can be applied to teaching new concepts, to consolidating knowledge and evaluating math results in primary education using various online tools.

Mathematics teaching methods in primary education are classified into:

- traditional/classical methods: explanation, exposition, conversation, exercise, problematization, demonstration, observation;
- modern methods: problematization, algorithmizing, cube, cooperative learning, mosaic, brainstorming, case study, programmed training, simulation methods, research project/theme, cluster technique, Gallery Tour technique.

Applying these methods with BL will lead to active learning that will develop critical, creative thinking and responsibility.

The following are the most effective and used teaching methods - learning mathematics in primary classes through the use of BL (Lin, Tseng, & Chiang, 2017; Abramovitz et al, 2012):

- Explanation is a verbal method of knowledge assimilation that creates a descriptive model at the level of cause-effect relationships. Using this method with the application of images or films (YouTube) to explain the importance of mathematics in real life will positively influence the affective-emotional resources of the students and will favor the understanding of an aspect of reality. The explanation can be used at any stage of the lesson and is complemented by the demonstration (https://learningapps.org).
- The demonstration ensures the reflection of the object of learning at the level of perception and representation by means of intuitive material. So there are a lot of images that can be used to apply the demonstration method for presenting objects and phenomena or their substitutes for study. The children's level of knowledge and their age determine the optimal ratio between demonstration and explanation (https://livresq.com/ro/).
- Conversation is the method based on question-answer dialogue, with the aim of carrying out tasks and learning situations. For this method we can apply various online tools to create a conversation with mixed tools (https://coggle.it/).
- The observation consists in the analysis of objects and phenomena that constitute the content of learning with the aim of identifying their significant characteristics. To apply this method, images can be proposed that represent certain elements of the object of observation and the student observes, recognizes, describes and analyzes significant elements of the object (ttps://www.socrative.com/).

- Problematization is the method based on the construction of problem situations and represents one of the most useful methods in teaching mathematics, due to its heuristic and activating potential (https://mathigon.org/activities).

We can create a problem situation by applying any online tool that can represent a contradictory situation for female students from a cognitive point of view and contradictory for a student from a cognitive point of view and created by the simultaneous existence of two realities: previous experience and the element of novelty with which the child faces. This cognitive conflict is important from a formative point of view because it incites the child to seek and discover, to identify new solutions through trial and error, to relationships between what is known and what is new. Problematization is a pedagogical method by which the child is stimulated to consciously contribute to his own training by participating in a new learning experience with the role of restructuring and developing the set of skills and knowledge.

- Learning through discovery is associated with problematization in inductive, deductive or analogical reasoning. Inductive discovery is useful in the process of forming operative schemes. The deductive way of learning through discovery is specific to learning activities in which the student is asked to identify working methods. Discovery by analogy consists in applying a known procedure to another similar case.
- The exercise is a method based on motor and intellectual actions, performed by children consciously and repeatedly, with the aim of forming skills and habits, of automating and internalizing some work methods and calculation algorithms (ictgames).
- Algorithmizing is a method based on the use and capitalization of algorithms in learning. The algorithm is made up of a suite of operations and executed in a certain, approximately constant order, through which a logical chain of contents is reached. There are a number of platforms that involve the creation of an algorithm based on a low (https://scratch.mi).

Math anxiety and online solutions to reduce math anxiety

Math anxiety is a challenging problem not only for students learning complicated math, but also for the ones in primary school.

One recent research (Ramirez et al, 2013) shown that children of 6 years old say that they feel anxious about math. In the study of 154 children in grades 1 and 2, researchers asked them, "How do you feel when taking a big math test?" Almost half of the children were at least somewhat nervous about math and the ones with higher scores on anxiety, had lower scores on math tests.

This is why it is important to be aware, as teachers, of the signs of math anxiety and to develop teaching and learning solutions aiming to improve their attitude towards mathematics.

First, the main emotional and behavioral signs of math anxiety are:

- low self-efficacy;
- avoiding the homework;
- feeling of inferiority;
- dependency of others in solving math problems;
- feelings of shame, guilt, fear, frustration;
- fear of failure;
- surrender to the topic.

The physiological symptoms are (Ruffin, 2007):

- fast breathing;
- stomach pain;
- fast heartbeat;
- cold;
- sweaty palms.

The psychological signs are (Vitasari et al., 2010):

- learned helplessness;
- nervousness before and during classes;
- lack of interest;
- sel-critical cognitions;
- low perceptions of their math skills;
- impairments in math related skills.

Example of learning and evaluations apps that can be used to reduce math anxiety:

- **LearningApps https://learningapps.org/** – "The application is easy to use and provides a variety of types of exercises, which teachers can use at any stage of the lesson, adapt or make from scratch." (Learning Apps, 2020) Advantages: educational designed to support the learning process, teaching through interactive activities, Exercises made by others can be used and edited by users or can be created from scratch; a variety of resources can be integrated to propose tasks: video, audio, text, images; Can be used at any age, the exercises performed can be integrated into any stage of the lesson;Students can work in groups (they can collaborate to make a tasks) or individually; (Andron & Kifor, 2021).

- **Wordwall** (https://wordwall.net/) -The application allows the creation of interactive educational games in digital format, which can be inserted into other learning platforms or distributed via links and resources in pdf format, related to the games created (Wordwall, 2020). Advantages: It generates interaction and collaboration, it can be used regardless of age and number of participants;Can be used to create activities that are both interactive,as well as printables;The activities created are carried out using a system of templates;If an activity does not correspond to the class or the level of the students, it can be easily customized;Wordwall activities can be integrated on another website, can be integrated into Google Classroom, can be sent by e-mail or the link can be uploaded on social networks; The applications created can be integrated in any stage of the lesson or can be sent to the students in the form of homework; Students can simultaneously use the same application in Multiplayer format at: https://goWordwall.com; (Andron & Kifor, 2021).
- Video editors- they are useful because are successfully integrated and used in Flipped Classroom; captures students' attention more easily, as they are used to this type of material; inserting some questions in the educational video involves the student in his own learning process. Some examples are ***Screencast-O-Matic*** (The easiest way to create instructional videos is to use screencast videos, Video screencasts are recordings of your computer screen), ***Moovly*** (is a video editing program for animations, video presentations, animated infographics) (Andron & Kifor, 2021).

Other resources:

- Miro - https://miro.com/;
- LearningApss - https://learningapps.org/;

- Kahoot! - https://create.kahoot.it/;
- https://www.powtoon.com/;
- https://tinytake.com/;
- https://camstudio.org/;
- https://animoto.com/;
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LESSON 3.3
Practical Applications - How Can Blended Learning Be Used In Primary School Mathematics Classes?
Duration: 1 hour

Learning Outcomes:
The prospective teachers will be able:

- To implement blended learning solutions for building specific math competencies for primary school children.
- To build learning activities aiming to reduce math anxiety in primary school children using blended learning approach.

Teaching Methods/Techniques: individual work, group work, discussion, collaborative learning, question-answer.

Learning-Teaching Activities:
Before the Classroom Time, prospective teachers use the online teaching materials to learn about the topic.

In-class Activities
This session aims to help participants apply blended learning activities for building mathematics basic competences.

The competencies proposed are:

- Recognition and use of numbers in elementary calculations.
- Sorting and representing some data in order to solve the problem.
- The use of unconventional standards for measurements and estimates.

The learning domains the trainer/ participants can choose are: numbers, geometric elements, measurements, estimates, life sciences, earth sciences, physical sciences. Our proposal is to choose two learning domains for conducting this activity. In the following section, we will work on the domains: numbers and geometric elements.

For the *NUMBERS* domain we have the specific skills "Using numbers in elementary calculations" which includes:

recognizing and writing, comparing numbers, ordering, operations with numbers.

The session is aiming to help participants apply information about blended learning in learning design for mathematics in primary school setting (Menezes Luís, Oliveira Hélia, Canavarro Ana, 2015).

The stages of the organization of the activity are:

I. In the first part, the participants are organized in teams of 3-5 members. The trainer has two possibilities for organizing this activity: either he determines the subject of the given activity in advance related to the application of BL in classes I and II by field and then the grouping will be done according to the desired field; or the students are grouped according to other criteria, such as personal, common interests, after which the trainer associate the domains. If the students do not know each other or there are difficulties in forming the groups, we can use an online tool like the Random Wheel. This tool can also be used by students for teaching/assessment during classes with BL implementation.
II. In the second stage, it is proposed that each group create an exercise in *Wordwall* from the chosen field for teaching a lesson topic.
III. In the third part, it is proposed to create an exercise to consolidate knowledge with the help of online resources.
IV. Forth, it is proposed to carry out a knowledge verification exercise with the *LearningApps* tool. The applications used can be diverse, it is important to achieve the proposed objective and the implementation of BL.

After each group has completed these exercises and presents, we suggest that the students solve the proposed exercises to check the correct wording and the achievement of the proposed objectives.

Assessment Tools:

- Self-assessment- every participant will have 1 minute of self-reflection about the importance of using blended learning approach in one's own pedagogical activity.

- Peer assessment will be used to determine how the groups study, understanding the group's processes.
- Formative assessment: evaluating the group work and homework.
- Summative assessment: assessment in an oral or written examination to measure the skills and knowledge acquired by prospective teachers.
- Diagnostic assessment: evaluation of pre-test and posttest to measure prospective teachers' gained competencies.

Theoretical Knowledge:
The school curriculum in primary education is classified by fields: *numbers, figures and geometric bodies, measurements, data, life sciences, earth sciences, physical sciences*.

One of the most important fields is the field of NUMBERS, for this field the basic knowledge that a teacher must possess when teaching the concept of number is based on the following instructions (Dumitru, Dumitru, Stroiescu-Logel, 2017):

- the teacher (teacher) must know the teaching-learning methodology regarding the formation of the concept of natural number, as a property of equivalent finite sets or using Peano's axioms;
- the teacher will apply the methodical procedures for learning natural numbers of any size, on given concentrations, taking into account the positional nature of the 10th decimal numbering system;
- the teacher must be able to direct the teaching-learning process for learning the algorithms for composing and decomposing numbers and establishing the reality of order between them;
- the teacher will use methods and strategies in order to stimulate the intellectual capacities of the students, their skills and interest in mathematics;
- the teacher will distinguish in the description of natural numbers aspects related to the graphic sign (corresponding to the number), the name of the number in linguistic terms and the proper notion of number.

In order to be able to effectively prepare and carry out introductory lessons in the study of natural numbers, we consider it is necessary for the teacher to know some notions, relationships, methods and algorithms, which form a mathematical model of natural numbers. Ignorance or incorrect application of them by the teacher creates in students minds wrong representations of the multitude of numbers, making the process of correct acquisition of mathematical notions and relationships, of mathematical language, difficult.

Research shows that children aged 3 to 4 years are able to locate a series of objects in a system of spatial relationships. Hence the idea of a group that tends to define numbers and perform operations with numbers. To the age of 4-5 they manage to reproduce an object according to a model, here the concept of geometric figures is introduced. To the age of 6-7 they manage to organize the physical space, so they can describe different properties of the objects or figures that they surround.

The teacher should know that the notion of fundamental size, like the notion of quantity, is a primary notion in mathematics teaching system. The introduction of this term is also notion is done without giving it a definition, the understanding of each quantity based on examples (Marsh, J., & Drexler, P. ,2001).

From a methodological perspective, teaching-learning issues measurement units and measurement operations will fundamentally be based on an active practice in the classroom and outside the classroom (Marcuţ, 2008).

It is important to explain the notion of size so that it is understood first intuitively and then rationally. For the practical activities, the sizes are carefully researched by the teacher.

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LESSON 3.4
Practical Applications - Designing Blended Learning Math Lessons for Primary School Education
Duration: 1 hour

Learning Outcomes:
The prospective teachers will be able:
- To implement blended learning solutions for building specific math competencies for primary school children.
- To build learning activities aiming to reduce math anxiety in primary school children using blended learning approach.

Teaching Methods/Techniques: individual work, group work, discussion, collaborative learning, question-answer.

Learning-Teaching Activities:
Before the Classroom Time, prospective teachers use the online teaching materials to learn about the topic.

In-class Activities
The session 4 is similar as method to session 3, but the activity is related to building different math competences, as following:
- Locating and relating some geometric elements in the surrounding environment.
- Manifesting curiosity for phenomena / relations / regularities / structures in the immediate environment.
- Generating simple explanations by using elements of logic.

For the field *GEOMETRIC FIGURES AND BODIES,* we have the specific competences "Highlighting the geometric characteristics of some objects located in the surrounding space" which includes: orientation and movement in space in relation to landmarks/directions, Identification of flat geometric shapes.

After a guided lesson, students perform self-reflection as well as other members of the group analyze performance by highlighting the positive moments and offering ideas for improving the quality of the lesson (Menezes Luís, Oliveira Hélia, Canavarro Ana, 2015).

The stages of the organization of the activity are:

I. In the first part, the participants are organized in teams of 3-5 members. The trainer has two possibilities for organizing this activity: either he determines the subject of the given activity in advance related to the application of BL in classes I and II by field and then the grouping will be done according to the desired field; or the students are grouped according to other criteria, such as personal, common interests, after which the trainer associate the domains. If the students do not know each other or there are difficulties in forming the groups, we can use an online tool like the Random Wheel. This tool can also be used by students for teaching/assessment during classes with BL implementation.

II. In the second stage, it is proposed that each group create an exercise in Wordwell from the chosen field for teaching a lesson topic.

III. In the third part, it is proposed to create an exercise to consolidate knowledge with the help of online resources.

IV. Forth, it is proposed to carry out a knowledge verification exercise with the LearningApps tool. The applications used can be diverse, it is important to achieve the proposed objective and the implementation of BL.

After each group has completed these exercises and presents, we suggest that the students solve the proposed exercises to check the correct wording and the achievement of the proposed objectives (Svetlana Skvortsova, Garan Marina, 2017).

Assessment Tools:

- Self-assessment- every participant will have 1 minute of self-reflection about the importance of using blended learning approach in one's own pedagogical activity.
- Peer assessment will be used to determine how the groups study, understanding the group's processes.
- Formative assessment: evaluating the group work and homework.
- Summative assessment: evaluation of oral tests or written examination to measure the skills and knowledge acquired by prospective teachers.
- Diagnostic assessment: evaluation of pre-test and posttest to measure prospective teachers' gained competencies.

Theoretical Knowledge:

The school curriculum in primary education is classified by fields: *numbers, figures and geometric bodies, measurements, data, life sciences, earth sciences, physical sciences*.

In acquiring knowledge of GEOMETRY, a significant role is played by the teaching methodology of these notions by the teacher. The success of students' understanding of geometry notions also depends on how the teacher manages the teaching-learning and evaluation process. He has the role of guiding the students to become aware, discover and apply through transfer these knowledge, skills and skills (Dumitru Ana, Dumitru Logel, Maria Luiza Ana, Elena Stroiescu -Logel, 2017).

In order to achieve the goals set out in this, the study of QUANTITIES AND UNITS OF MEASUREMENT in primary school seeks that, based on observations and intuitive representations, students get to know some basic notions about quantities and units of widely used measure, strictly necessary for man. Also, the training of the skill to measure, to use some measures and measuring tools by hand, to know some units, the training of the ability to correctly appreciate the various sizes, as well as the understanding of the need to adopt the standard unit of measurement is aimed at.

The teacher should know that the notion of fundamental size, like the notion of quantity, is a primary notion in the teaching-learning system of mathematics. Also, the introduction of this notion is done without giving it a definition, the understanding of each quantity based on examples (Marsh, J., & Drexler, P., 2001).

To be able to explain and apply the notion of size correctly, methodically, the teacher must know the seven physical quantities from the International System: length, mass and time (in mechanics), temperature (in thermodynamics), electric current intensity (electricity), luminous intensity (optics) and the quantity of substances. The rest of the quantities are defined with their help through definition relations, being derived quantities. For each fundamental quantity, the fundamental units are associated: meter, kilogram, second, kelvin, ampere, candela and mole. for these units, prototype standards are built, after which identical copies of three orders are made, only those of the third order end up in daily practice, which become measures.

From a methodological perspective, teaching issues of measurement units and measurement operations will fundamentally be based on an active practice in the classroom and outside the classroom (Marcut I, 2008).

It is important to explain the notion of size so that it is understood first intuitively and then rationally. For the practical activities, the sizes are carefully researched by the teacher.

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MODULE 4.
BLENDED LEARNING/TEACHING AND ITS PRACTICE IN UNIVERSITY INSTITUTIONS

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LESSON 4.1
Understanding Blended Learning
Subject: Need for blended learning
Duration: 1 hour

Learning outcomes:

- The discuss the main teaching approaches.
- To understand the benefits of the blended learning.
- To discuss different blended learning models.
- To understand how to start with the blended learning.

Teaching methods: discussion, presentation, learning by doing.

Learning-Teaching Process:
Before the Classroom Time:

- teachers prepare one slide on what they imagine blended learning is and how they would implement it in the classroom activities.

In-class Activities:

- Each of the teachers presents their own slide, their own understanding, and perspective as well as possible ways of implementing blended learning into their activities. All teachers discuss the presented ideas and share knowledge and suggestions.
- Presentation about blended learning, its benefits, the main teaching approaches, blended learning models, etc. by trainer.
- Teachers are asked to work in groups of two and to present a possible example of one of the blended learning models' implementations in their classroom.
- Presentation and discussion on the tools for teachers interested in introducing blended learning in their classroom.

Assessment Tools:
To create Kahoot quiz and later on write a one paragraph self-reflection piece about the skills teachers have, and need to improve in the future. In addition, listing new things they got to know in the lesson.

Theoretical Knowledge:
Blended learning has become increasingly common in schools over the past decade as educators look to incorporate technology into teaching tools. Although this approach is growing in popularity, it is still relatively new to the field of education, making it difficult to determine its true effectiveness. Many teachers and educators say that blended learning offers many benefits to students due to its ability to personalize instruction through a competency-based approach.

This style of teaching, known as blended learning has become increasingly popular in recent years. Educators and teachers have become aware of what benefits can it bring to students who are able to study at their own pace and in a more personalized and in a manner that is more personalized and tailored to their specific requirements. Blended learning is a method that mixes traditional training methods (in-class, instructor-led) with eLearning content to create a more adaptive and customized learning environment for the end user. Blended learning provides students with the structure and interaction of a typical classroom setting as well as the dynamic and adaptive learning opportunities that are accessible outside of the traditional classroom setting.

This type of learning is finding its way into educational institutions around the world for a number of reasons. Teachers, parents and students recognize the benefits of combining online learning with teacher-led classroom learning. These benefits include:

- Parental involvement in Their Children's Education Today, parents have more options than ever before to participate in their children's education. When a child obtains an online education, parents are able to maintain a connection with their child's development and keep track of what is being taught on a daily basis.
- Blended learning provides students with a lot of advantages, two of which are convenience and adaptability. Blended learning enables students to develop greater adaptability in their learning approaches. Participating in online learning may provide a realistic alternative for students who wish to learn outside of the classroom. When children return to school after being absent due to illness, a snow day, or a lengthy family vacation, this may help them reduce the amount of missed instruction and make-up work.

- With good reason, the ability to customize one's education is by far the most often stated advantage of blended learning. Students are not hindered by peers who may be performing at a greater or lower level than they are; rather, they are allowed to learn at their own speed and advance at their own rate of growth. If students require further training in a specific area, blended learning ensures students receive the extra guidance they need and become proficient in the subject before moving on to the next level. Blended learning mixes classroom-based education with online and independent study.
- Blended learning allows teachers to teach multiple learning styles simultaneously in the same classroom, helping teachers teach all students in a way that suits their respective learning styles. This is one of the biggest benefits of blended learning. There are four key forms of blended learning that are relied on by the vast majority of educators today. The following are the four models:
- Students engage in a rotation, moving sequentially from one learning style to the next. For example, students can take turns studying online, completing assignments with pen and paper, working in groups, and participating in class. There are also a number of submodules that fall under the umbrella of the rotation model. These submodules include individual rotation, station rotation, lab rotation, and flipped classroom.
- **Flex model**: The flex model is primarily based on online courses, even though the actual classes are conducted in a traditional school setting with a teacher present. Flex models are becoming more and more popular. Central to the concept is the use of an online platform; however, there will also be a coach on site in case any issues arise. In a flexible learning paradigm, teachers are also responsible for leading class discussions, creating projects, and any other enrichment activities that may benefit student learning.
- **A la carte model** allows students to supplement the learning they have completed in traditional schools by enrolling in fully online courses.
- **Enriched virtual model** focuses primarily on using online learning as a framework for academic activities. Students

can take courses remotely and online from anywhere. However, you are obliged to attend classes in person with your respective teachers.

Teachers who would like to introduce blended learning to their classrooms should use these simple tools, which were highlighted by the higher education professionals who use these simple tools in their classes. They say that the tools, listed below are fully adaptable for younger students and for students in universities, as well. These tools help teachers provide clear instructions in online environments.

Kahn Academy	It's a 100% free tool, which is used to personalize learning (every student might practice at their own pace, fill in the gaps and then follow their classmates), find already created math, science, and more lessons that can be adapted to every need and to empower teachers to identify gaps, provide instructions and meet the needs of each and every student.
Edmodo	A free LMS that integrates social media savvy with educational materials, secure student-teacher contact, and formative evaluation. The student planner and discussion threads allow students and their families to quickly get answers to questions and keep up with what's occurring in class. Put up a warm-up question or conduct a quick poll to gauge student interest in the day's material or to check for comprehension.
GoClass	Tool, that helps to create, edit and manage lesson plans. This tool allows engaging with all of your students at the same time, wherever they are. Compatible with iOS and Android devices.
LessonPaths	LessonPaths can be utilized in classrooms and online. LessonPaths is a fantastic resource that can be used in any classroom situation, whether it's a lecture, a group exercise, or a casual talk. As a teacher, you have access to many teaching materials. Lesson plans, webpages, videos, and blogs are examples. Want to teach your kids about molecular science or a fun way to memorize numbers? LessonPaths has instructional resources for any situation. The

	work only requires visiting LessonPaths' website. Once you've accessed the website, look for the section with class-related content and click it. After choosing a subject from the list, teachers can search through a wealth of resources to share with their class. Most providers will include high-quality films you can show in class or assign as homework.
Kahoot	It is a tool that lets you create a learning game or pop quiz on any topic and in any language. Also, you can host a live game or share the game with the players who are remote.
Otus	It is a tool that allows educators to make decisions and create learning paths based on student growth data, stored on a platform. It has an integrated learning management system, you can give grades, analyse results and student data, as well as plan future classes.

If you're just getting started with blending, the following are the first five techniques you can employ:

- Start with basic technological elements. Even if all of the technology tools at our disposal are remarkable, some are easier to use than others. Choose the tools that require the least "knowledge" or technological expertise on your part. More folks will utilize it if it is simple to comprehend.
- Start small. You do not need to totally revamp your course to accommodate blended learning. As you become accustomed to it, gradually raise the dosage.
- Modify your work based on feedback. As you continue to apply the blended learning technologies in your classroom, solicit feedback from your students and make any necessary adjustments. Participation is the most influential aspect in deciding the outcome of the program. Do not attempt to compel something that is manifestly not going to succeed.
- Concentrate your efforts on teamwork. Blended learning is most effective when a significant emphasis is placed on collaborating to solve challenges. Make it a point to verify that the tools you utilize facilitate digital communication in a variety of ways (chat, groups, forums, etc.).

- When ready, begin scaling. When you have successfully incorporated little pieces of your course material into one another, it is time to flip your classroom. Using videos and infographics, transform your lectures into Internet-friendly bite-sized content. Participate in activities and hands-on learning to make the most of your time in class.

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LESSON 4.2
Blended Learning Capacity Building Framework for Higher Education Institutions
Subject: HEIs framework for blended learning adaptation to school's environment
Duration: 1 hour

Learning outcomes:

- The discuss the framework dimensions for HEIs.
- To understand differences between school's framework and HEIs framework.
- To discuss benefits of HEIs framework for blended learning.
- To understand how to adapt the framework to schools.

Teaching methods: discussion, debates

Learning-Teaching Process:
Before the Classroom Time:

- teachers find one practice for blended learning implementation in HEI from their city or the closest one.

In-class Activities:

- Presentation about HEIs framework and eight dimensions for teachers by trainer.
- Each teacher presents their own best case found in their regional HEI.
- Teachers get into two groups and prepare for the debates. One group against and one group for HEI framework for blended learning implementation in schools.
- The general discussion: on which dimension you will start working in your school?

Assessment Tools:
A quiz about HEIs framework dimensions; self-evaluation by stating the number from 1 to 10 about the knowledge before the lesson and after.

Theoretical Knowledge:

The pervasive use of technology in our daily lives has fundamentally changed not only the way we live but also the construction, distribution and reconstruction of knowledge. Many current assumptions about what and how students learn in higher education are being challenged by technological innovations. Today's higher education institutions must enable students to "continuously learn, unlearn, and relearn" through learning experiences that require the use of technology to construct and interpret knowledge. Students should be well versed in technology-intensive situations, be able to find creative solutions to complex challenges, and collaborate with colleagues from diverse backgrounds through good communication. Given the constraints faced by higher education institutions, blended learning limits sustainability and scalability within and between programs. Here, we would like to propose a holistic framework and associated self-assessment tools to help higher education leaders systematically review and refine their strategic planning processes and plans for blended learning, thereby improving higher education institutions' ability to advance, sustain, and expand their blended learning Ability. Learning Improve learning practices. The framework consists of eight dimensions. These dimensions are defined and explained based on insights into the practices and challenges associated with blended learning highlighted in the reviewed literature. By considering these strategic factors, universities are more likely to develop and implement coherent internal and external processes that maximize the learning potential of integrating blended learning into their programs and courses.

1. *Vision and philosophy*. A vision is a descriptive picture of an organization's potential future. Implementing blended learning in higher education requires a coherent vision based on the institution's philosophy of learning and teaching in a blended learning environment. Educators can advance their institution's vision and philosophy by using clear and widely accepted pedagogical arguments in favor of blended learning. This enables them to provide students with a more engaging and meaningful learning experience. Furthermore, new opportunities presented by evolving technologies suggest that blended learning may require new interpretations of its blended learning and

learning in higher education, including the nature of activities and the scope of online courses. For example, the emergence of online virtual laboratories provides new learning opportunities for risk-free, repeatable experiments and simulations outside of university physical laboratory spaces. Another contemporary example is the "flipped classroom", which reallocates time between lectures and class discussions. In this type of blended learning, lectures (often in the form of YouTube-like video streaming presentations) are given as assignments and accessed by students before face-to-face classes. Class discussions promote student reflection and inquiry, and teachers' adaptive teaching within a learner-centered paradigm.

2. C*urriculum*. It is a systematic and targeted bundle of competencies (value-based knowledge, skills and attitudes) that learners should acquire through organized learning experiences in formal and informal contexts. It specifies what to learn, why to learn and how to support learning. Blended learning helps ensure high-quality education in higher education. Today's education system should move away from teaching facts because people are constantly learning new things and the facts they already know are constantly changing. Instead, the curriculum is oriented and designed to help students find a balance between acquiring the relevant knowledge they need in life and developing 21st century skills that will serve as their universal toolbox for processing, analyzing and creating knowledge and dealing with problems. Social, economic and political change in the knowledge age. This balance is important because it ensures that learners gain both the knowledge they need for daily life and the skills they need to succeed in the 21st century. Bloom's revised hierarchy of learning areas states that students must move from lower-order receptive skills such as memory and comprehension to higher-order productive skills such as application, analysis, evaluation, and ultimately creation. This thought process ranges from remembering to understanding to creating new things. Higher education represents the final step in formal learning and can be considered the penultimate institution in a student's

educational career to develop this 21st century toolkit. Because of this important function, universities can no longer serve as places where content information is learned through the transmission of PowerPoint presentations; courses must be designed to promote higher-order thinking and 21st century skills at the project and course levels. As a method of achieving these course objectives, blended learning must be pedagogically appropriate; this may include the use of online resources to support or support face-to-face teaching to engage students and improve their learning outcomes.

3. *Professional development of lecturers/teachers/teaching staff.* When higher education institutions lack motivated, committed, and well-prepared faculty, blended learning efforts are likely to fail. Educators need to understand how blended learning can expand their learning and teaching methods. The purpose is to highlight the difference between meaningful use of online technologies in a blended delivery approach versus simply posting course materials online. In addition to understanding blended learning, teachers must be prepared to use online technology to engage students. These professional development programs are more about how to deal with a challenge than why or for what reason. Establishing an independent central unit to facilitate blended learning, such as an intensive teaching and learning center, is critical to facilitate professional development beyond the teaching of technical skills. Faculty should be aware that in addition to acquiring technical skills, professional development can also help to better understand the paradigm shift in learning and teaching styles that will result from the implementation of blended learning in higher education institutions. The unit can also provide teaching advice and support in the design of blended learning.
4. *Learning support.* Although today's children can be described as "digital natives" who are "born digital," it is important to understand that while technology is an integral part of the daily lives of the vast majority of students, not all students Have digital equipment that enables digitization. Learning online is easier. Where there is a mix of traditional and online training, this can make learning more difficult for them. By providing study

aids by loaning laptops or tablets to students in need, you can close the digital divide within universities and improve educational equity. Additionally, research shows that students often lack the experience needed to teach effectively using technology. This is because students often use technology to entertain and communicate rather than to acquire and build knowledge. In order to successfully use available technology resources in the classroom, students need instructional guidance and technology support. They need guidance to learn independently and at their own pace, which is especially important in an online learning environment. Therefore, higher education institutions should provide students with timely and ongoing student support so that their learning in blended learning environments is guided and supported. Higher education institutions want to establish dedicated advising centers where students can get help, advice and courses. Through joint courses and individual tutoring with professionally qualified academic advisors and tutors, students develop the skills needed to become active, autonomous learners with the ability to self-regulate their own learning. Gender aspects must be considered when designing learning supports because men and women learn differently and use online technologies differently.

5. *Infrastructure, facilities, resources, and support*. Campus-wide wireless networks, technology-rich learning communities, and digital learning device (laptop/tablet/mobile device) programs for faculty and students are key infrastructure and facility components that facilitate "bring your own device" methods and promote individual and self-directed learning and group collaboration. Infrastructure and facilities are regularly upgraded to meet the changing learning and teaching needs of students and teachers. Educators can explore using current online resources in their courses to enhance blended learning. For example, a learning management system is more than just publishing presentations and collecting assignments. In addition, it provides teachers with a comprehensive, collaborative, real-time learning environment to share learning and teaching resources. Additionally, learning-related data

collected from students using LMS learning analytics tools, such as: B. Student engagement statistics and assessment results reporting can influence decisions on the design of future learning and teaching activities. Only professional technicians and possibly trainee technicians with the necessary skills and expertise can provide adequate technical and service support. This technology and service support team should be available to students and teachers at all times. Because the support required often includes step-by-step instructions and troubleshooting, team members may need to provide one-on-one support to teachers to demonstrate exactly what is technically possible and how to use these tools in a hybrid fashion within the learning environment.

6. *Policy and institutional structure*. When policies are supported by appropriate organizational structures, they can drive organizational change and progress. Universities should develop a master plan for blended learning as well as regulations, specific standards and procedures needed to encourage faculty to engage in blended learning. For example, blended learning initiatives for teachers at the grassroots level should be expanded to promote teacher innovation. This is because adaptability and independence are key components of the innovation-driving equation. Additionally, motivational factors, such as rewards for innovative teaching, can play a key role in promoting widespread use of blended learning. They convey a clear message to teaching staff about the goals of the institution. Teachers are more likely to use blended learning strategies if they perceive that improving the quality of learning and teaching will help their promotion and employment or be part of regular staff evaluations. However, it is important to recognize that context, which may include factors such as the demographics of the student body and faculty traditions, play an important role in determining meaningful and enforceable rules. Additionally, it is important to recognize that it may take several years for policy to have a significant impact on the combination of face-to-face and online learning. Universities can create a new institutional framework to oversee and support blended

learning. For example, establish a blended learning steering committee within the college, chaired by the provost or vice president (academic or teaching committee) to oversee and guide the blended learning plan. To promote collaboration and collaboration, a coordination working group reporting to the Steering Committee will draft a set of guidelines. These standards apply to administrative, academic, and faculty units. Each instructor may be assigned a blended learning consultant or instructional designer to support the instructor's current blended learning strategy.

7. *Partnerships*. Higher education institutions (HEIs) often form partnerships in order to benefit from the skills and experience of each participant and further common goals. There are two types of partnerships that can be established in blended learning: internal and external. Faculty work with engineering and teaching/learning support departments to develop and promote blended learning strategies through internal collaboration. Interdepartmental collaboration should be actively encouraged, such as sharing resources and recommending the most effective approaches. This can reduce duplication of resources and further optimize spending at the faculty level. Furthermore, globalization enables higher education institutions to interact across national borders to achieve common goals. These goals may include sharing technology, research, or resources to promote the application of promising blended learning strategies. The process of establishing scalable funding mechanisms to ensure the financial resources needed to fully support blended learning in external collaborations involves communication and interaction with government. In addition, there are opportunities for universities to collaborate with private companies and organizations such as Apple, Microsoft and Blackboard, as well as open source communities such as Moodle. This type of collaboration enables universities to access and evaluate a variety of learning technologies and work with relevant industry experts to determine the future direction of blended learning practices at the institution.

8. *Research and evaluation*. Research and evaluation must inform and advance blended learning approaches; continuous revision and improvement are needed to improve the quality of learning and teaching at the university. Research and evaluation must inform and promote blended learning approaches. Before deciding whether to implement a measure on a large scale, it may be useful to conduct a number of pilot projects to test a variety of possibilities and potentials. This critical step should be completed before the new venture is fully implemented. It will help higher education institutions identify and correct any errors and gauge faculty and student perceptions of new courses. Blended learning approaches, on the other hand, require the development of a range of pilot project approaches in order to sustain and scale them. Research and evaluation can also use "big data" analytics in learning analytics to provide evidence of student learning engagement, collaboration, and learning outcomes. These statistical results may lead higher education administrators to further support blended learning approaches through policy measures. It could also encourage more teachers to use blended learning as an effective learning method. Research teams can conduct case studies at the institutional level to gain insight into promising practices of pioneering teachers, thereby informing other teachers exploring the use of blended learning in their own courses. Teachers interested in and motivated by blended learning can engage in action research to document their practices and the results of these activities. Incentive programs for academic engagement related to blended learning can be delivered in a similar manner to professional development and policy. All these factors contribute to the development of a science teaching culture, thereby improving learning and teaching standards in universities.

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LESSON 4.3
Self-assessment tool for hybrid learning readiness for higher education institutions and assessment of blended learning implementation
Subject: Evaluation of the institution readiness to implement blended learning
Duration: 1 hour

Learning outcomes:

- To discuss the framework of the self-evaluation tool for HEI readiness.
- To discuss the framework of the evaluation of the blended learning.
- To understand differences between organization readiness and readiness of lessons.
- To evaluate individual organizations and individual classes.

Teaching methods: lecture, discussion, problem solving.

Learning-Teaching Process:
Before the Classroom Time:

- Teachers on a piece of paper, write down positive and negative things about the school if it would go to blended learning. The same with the subject they teach – the pros and cons of going online. What would be possible? What would be not? What will be the differences?

In-class Activities:

- Presentation about evaluation tools for HEI and for the blended learning itself for teachers by trainer.
- Each teacher presents what they've done at home and discuss it with other teachers, find similarities and differences.
- Teachers evaluate their school with spidergram and evaluate their subject readiness for blended learning (oral presentation).

Assessment Tools:
Formative assessment – do wide analysis of possible improvements in your school and subject teaching materials, based on the provided methods.

Theoretical Knowledge:
The process of building blended learning capabilities requires allocating resources and mobilizing employees. While the framework discussed outlines a holistic approach to implementing blended learning, the self-assessment tool enables universities to reflect on their existing blended learning strategies, identify gaps between these strategies and their vision of how blended learning can improve learning and teaching, and New strategies may be developed or existing strategies modified to close these gaps. The self-assessment tool presented here covers all strategic dimensions (and sub-dimensions) of the framework. Because there are different types of blends – low-impact blends, medium-impact blends, and high-impact blends – a range of levels is needed to reflect institutional strategies for supporting blended learning practices. Reference to UNESCO's stages of progress therefore proves to be valuable in tracking the agency's position in promoting ICT integration. To reflect the different types of integration in higher education settings, UNESCO's work was revised and the steps in the self-assessment tool were labeled "Consider", "Develop/Application", "Infuse" and "Transform". Each level is preceded by a general discussion of the characteristics or indicators. There is also a blank space below where users can indicate where their higher education institution is currently located.

This self-assessment tool creates a visual representation in the form of a spider diagram, allowing university leaders and policymakers to gain a comprehensive understanding of all aspects of an existing program and the relationships between different dimensional phases. Snapshots taken during the exercise can also be used to track and review capacity evolution over time. This means that the results of the self-assessment tool serve both parts of the assessment: describing the existing situation and guiding development to higher-level institutional strategies for implementing blended learning practices at the university. The framework can then be used to set achievable goals and initiate/modify activities and strategies based on the results. The interactive tool can be accessed through this website and can be tested online: https://blishedlearning.bangkok.unesco.org/dynamic/.

It is important to note that this self-assessment tool was not developed for the purpose of benchmarking an institution or comparing one institution to another. Rather, its purpose is to analyze successes and identify areas within the institution that can be improved. More specifically, the self-assessment tool can be used at the institutional level to determine the college's position in each sub-dimension, identify gaps in strategies related to each sub-dimension and its blended learning vision, and strategically plan how it should be implemented through New strategies or revision of existing strategies to fill gaps. This will be done at the institutional level. Ultimately, higher education institutions can make progress toward potentially fruitful practices by using blended learning to improve learning and teaching.

Another established evaluation method suggests that four main aspects need to be examined to determine the effectiveness of blended e-learning: strategies for delivering e-learning courses; high-quality e-learning systems; and blended e-learning effectiveness.

The success of blended e-learning depends on the quality of the e-learning system and the e-learning course delivery method, both of which are influenced by the degree of "e-learning readiness" of the institution in terms of budget and policy support, cultural awareness, and infrastructure. The proposed framework aims to help address two things: identifying the factors that influence the effectiveness of blended e-learning and quantifying the effectiveness of blended e-learning in higher education. A total of 67 items were developed, of which 23 related to the topic of course module design strategies, 24 to the topic of e-learning preparation, 15 to the topic of high-quality e-learning systems, and 7 to the topic of course module design strategies. Issues in effective blended e-learning.

Dimension	Component	Item
E-learning Course Delivery Strategies	Course Module Layout	Plan of each unit of study Prerequisite Information for Modules Module in school is simple to grasp Differential Progress in Modules of a Course

Dimension	Component	Item
		Resultant Knowledge Acquired from Each Module Structured consecutively during the course
	Course Module Evaluation	Harmonization of Study Units Module prerequisites are necessary for this course. Periodic revisions to the course modules Learning Materials for Individual Modules Goals for each unit of study Complication of Units in a Course Superiority of Instruction in Separate Course Modules
	Student Assessment	Exams are assigned at random online Understanding of evaluation standards Encouraging comments Policy on Grading
	Course Module Planning	Examining the requirements of students for learning Evaluation of Learning Materials Methods of Teaching Resources for the Study of Individual Course Modules Pleasure for the Students Examining Media as a Learning Tool
E-Learning Readiness	Institutional Policies	University plans to employ ICT for online education Representational Policies for Online Instruction Coaching for the adoption of e-learning among staff Online education grants

Dimension	Component	Item
	E-learning Culture Awareness	How people view the benefits of online education views on online education Use of e-Learning to Improve Academic Performance Cultural expectations for online education
	E-learning Infrastructure	The availability of computational resources Course module creation instruments Modern infrastructures for distributing instructional modules Technology for capturing lectures
	E-learning Costs	Expenses incurred in creating course modules The Expense of Electronic Learning Systems The ongoing expense of online education systems Fees associated with tech support and online training
	E-learning Support	Instructional Design and Instructional Support for Online Courses Provide assistance whenever needed Strengthening employees' abilities to use e-learning Webinar training for employees Help with IT Education
Quality E-learning Systems	E-learning Management System Design	The pliability of the modular system for instruction Streamlined interface Consistency in the underlying platform for individual modules User-friendliness

Dimension	Component	Item
		Appropriate for use in a variety of cultural contexts Content from all modules can be accessed easily Organization of Events The Administration of Users User information safety Cooperative education Interactive learning
	Student Learning Management	Student monitoring Time management Learning to follow Employing e-portfolios
Effective Blended E-Learning	Impact on E-learning Readiness, Quality of E-learning Systems and E-learning Courses Module Delivery Strategies	Student retention Student access to instruction Cost-effectiveness Effectiveness and calibre of professors Academic performance Enhancement of research and instruction

The proposed framework aims to help address two things: identifying the factors that influence the effectiveness of blended e-learning and quantifying the effectiveness of blended e-learning in higher education. A total of 67 items were developed, of which 23 related to the topic of course module design strategies, 24 to the topic of e-learning preparation, 15 to the topic of high-quality e-learning systems, and 7 to the topic of course module design strategies. Issues in effective blended e-learning.

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LESSON 4.4
Blended Learning New Design Approaches
Subject: Course design processes
Duration: 1 hour

Learning outcomes:

- To understand and distinguish three main course design processes.
- To understand how to switch among methods.
- Integrate the discussed methods into their teaching environment.

Teaching methods: lecture, discussion, lesson plan preparation.

Learning-Teaching Process:
Before the Classroom Time:

- Teachers bring to class one of the lesson plan.

In-class Activities:

- Presentation about course design processes (low; mid; high) for teachers by trainer.
- Teacher discusses each of the methods and thinks about the possible implementation of the part of the method.
- Each of the teachers tries to adapt their brought lesson plan to each and every method, presents it to all other teachers, and discuss.

Assessment Tools:
Pre-post assessment of the main design approaches.

Theoretical Knowledge:
By analyzing several blended learning course design processes, we were able to establish three main design approaches:

- Low-impact blend: incorporating additional activities into an existing course.
- Medium-impact blend: substituting existing course activities.
- High-impact blend: construction of the blended course from the ground up.

Low-impact blend: incorporating additional activities into an existing course. Using a low-impact approach, traditional face-to-face training is supplemented by some digital-based exercises. Researchers found that most teachers simply incorporate digital elements into traditional teaching practices when building hybrid courses. “Course Half Syndrome” is a term used to describe what happens when novice educators first try a blended learning course that adds additional online activities to the end of an existing course. Some educators believe they can reap the benefits of blended learning by simply incorporating some new content into existing courses, rather than reviewing the objectives of the entire course against a teaching framework. In some cases, however, the additional activities respond to educational needs and prove to be an extremely useful supplement to the standard curriculum. This is true in various scenarios. McCarthy’s work demonstrates this by integrating online activities into a course called “Imagining Our World” with the aim of motivating students to engage in more dialogue with their contemporaries. McCarthy encourages his students to post some of their work on Facebook, in addition to more traditional teaching methods such as lectures and tutorials. In addition, students were asked to provide feedback on the performance of their peers. Subsequent conversations are moved into students' actual classrooms to facilitate the beginning of meaningful relationships between them that will build on the initial connections they made with each other online. McCarthy hopes the new online activities will achieve the goal of strengthening existing personal connections between students. He evaluates his work by having students provide weekly comments, conducting pre- and post-semester surveys, and conducting project-specific reflections at the end of the semester. He found that additional activities on Facebook provided students with a platform for initial academic and social contact with their peers while achieving various learning goals. This was an important insight for him. When looking at low-impact strategies, we come up with four advantages and five disadvantages.

Benefits of the low-impact blend

- Simple techniques for building blended learning courses that can encourage wary instructors to try blended learning. Teachers who could benefit from blended learning may be hesitant to try it because they view it as extremely complex and technical.

- A quick way to create blended learning courses. Teachers can simply add new activities that meet specific teaching needs without spending additional time and effort revising and re-planning the entire course or exploring the many possible blended learning components and delivery methods.
- If used with care, the risk of malfunction is low. Faculty teaching hybrid courses highlighted three main risk factors: concerns about lower student evaluations, concerns about losing control of the course, and uncertainty about the impact of online learning on classroom interactions. Increasing exercise while maintaining a typical exercise regimen can help reduce these dangers.
- Designing hybrid courses requires little expertise in teaching standard courses. With limited expertise, instructors can identify portions of the course that would benefit from additional online activities.

Challenges of the low-impact blend

- Teachers must have some grasp of technology in order to successfully use this technique. To successfully integrate technology into instruction, teachers must be able to: Determine which technology tool is needed to achieve a specific instructional goal; Specify how the tool will be used to help students achieve that goal. Improve students' ability to use appropriate technological tools at different stages of the learning process (exploration, analysis and production); select and apply technological solutions that enable them to identify professional development needs and resolve related difficulties.
- Low-impact mixing is likely to produce two independent paths. When you add online assignments to a traditional course without reducing class time, you typically end up with two unique courses: an online course and an in-person course. Students may find participating in new activities more of a burden than a benefit. Many students may view the additional activities as just another assignment in an already busy course.

- Adding new activities without deleting old ones significantly increases the teacher's workload. As online teaching tools continue to grow in popularity, teachers may face time constraints and work pressures.
- Administrators often notice an increase in activity in existing courses so teachers are not compensated for their efforts. One of the main issues preventing teachers from using e-learning is the lack of adequate compensation and incentives.

<u>*Recommendations*</u>

- An instructor should begin by incorporating a straightforward online activity that they and their students can easily administrate, such as an online discussion forum or the Facebook activity that McCarthy incorporated into his course. If further online activities are necessary for the future, a replacement-based strategy with moderate impact could be considered.
- The addition of an activity must be driven by a genuine educational need, not technology for technology's sake. Therefore, teachers must evaluate what is lacking or flawed in their courses and understand how to employ technology and instructional methods to address these issues.
- The additional activity must be fully included in the course. It is essential to consider the link between the classroom and online activities.
- Course tasks and activities should not be overloaded. The viewpoints of students on course components should be investigated. Consistent and transparent communication with students regarding their thoughts and expectations is necessary for the blended learning experience to be effective.
- A low-impact mix is advised for teachers who lack expertise in blended learning development. It is easy to install and has a low rate of failure.

Medium-impact blend: substituting existing course activities. An example of a medium-impact approach would be to restructure existing courses to replace some face-to-face activities with online ones. This technique is based on the assumption that certain components of the course may benefit more from implementation than online activities. In some cases, remaining in-person activities will proceed exactly as before, while in other cases, classroom activities will be modified in some way. An example of how this strategy can be used is in the redesign of a second-grade political science course. The course initially takes the form of three one-hour lectures. The teacher noticed that the same four or five students tended to dominate class discussions about case studies. Using alternative technology, three lectures were reduced to a total of two, including online discussions. Using a learning management system (LMS), teachers divide the class into groups during online discussions and measure the time spent in discussions. The LMS is also used to provide information to students about the nature of their contributions and the frequency and duration of their contributions. The professor's decision to participate in class discussions counts for 10% of the final grade. The redesign enables students to engage in longer, more serious discussions.

Benefits of the medium-impact blend

- This approach allows educators to start with a simple plan and then gradually implement more complex curriculum components.
- Experience gained using this strategy can increase teachers' confidence in their ability to lead blended learning courses.
- This approach may be useful for educators who have some expertise in developing blended learning but do not want to risk making significant changes to their current courses. It is difficult and difficult for teachers to invest a lot of time and effort into creating a new course. Therefore, most teachers prefer to teach using the traditional methods that they have been taught since it is familiar and comfortable to them.
- Allow teachers to continue to experiment with new learning methods and educational technologies without compromising the overall effectiveness of the regular curriculum. Learning how to use technology in an acceptable and successful way is a difficult task, but it can be improved with practice.

Challenges of the medium-impact blend

- Since there is no way to go back to the previous teaching model, educators must have a thorough understanding of technology principles and a level of confidence to adopt this strategy. If teachers are unwilling to use their technology skills, this knowledge alone will not support student learning. However, such knowledge is essential.
- Creating hybrid courses requires time and effort to swap and integrate new course components.
- There are no clear guidelines for determining how much or which parts of a course can be replaced. These decisions are influenced by a variety of factors. The most important of these are the type of content taught in the course and the objectives of the instructor.
- Candidates with knowledge of leading standard courses will be preferred. One of the biggest hurdles in building a blended learning course using this approach is determining which parts of the course don't work well when delivered in a traditional format, and then determining whether they would be more successful if offered online. If you have little or no experience teaching this course, you may find this process difficult.
- Successful implementation requires long-term, extensive planning as well as progress monitoring and evaluation. The incremental process of adding new resources or technologies to replace existing components and then evaluating whether the use of these new resources or technologies helps students achieve their learning goals can provide a good balance between the online and face-to-face portions of a course. This balance is the result of a favorable online to face-to-face composition ratio.

Recommendations

- Introduce new procedures gradually. You should start publishing some course content online. This reduces personal time. You can add online material as needed to balance in-person and online learning.
- The delicate balance varies from dish to dish. Differentiating factors include student type, teacher experience, teaching style, course objectives, and Internet resources. Some courses

learn more through face-to-face meetings, while others prefer online learning.

- Continuous review and course evaluation is required to achieve balance. When iteratively redesigning a course, evaluation feedback is critical. Knowledge of blended learning design can help teachers achieve this balance. Finding a balance between face-to-face and online communication is difficult and takes practice.
- Teachers who have taught traditional courses should have no problem switching to this style. When updating a course, several important decisions must be made, such as how much content can be replaced. The instructor's knowledge and experience aids in the decision-making process.
- This approach requires intuitive support. To make blended learning work, you need to provide teachers with the technical support they need, account for their workload, and address their concerns and objections. He also said that teachers should continue to learn and improve. This helps teachers develop new teaching and technical skills and figure out how to teach lessons to achieve their goals.

High-impact blend: construction of the blended course from the ground up. Blended learning courses are built from the ground up as part of a high-impact methodology. In the studies conducted, this strategy has been called various names, including total redesign, complete redesign, and radical change. It is necessary for teachers to examine the learning outcomes of everyone in the course rather than looking at the course as a whole. Teachers are responsible for identifying teaching methods that will produce the desired results for each individual. Applying this strategy at the learning outcomes level gives teachers access to the most useful combination of technologies to create high-quality courses. The typical paradigm for curriculum development is called constructive alignment and stipulates that assessment tasks should be linked to learning outcomes. The technology follows that model and is consistent with it.

Benefits of the high-impact blend

- Enable participants to improve the quality of existing courses and minimize or eliminate any problems arising from them. When teachers start from scratch, they have a better chance of creating more successful lessons, which is especially helpful when usual methods run into difficulties.

- Enable more seamless integration of in-person and online experiences. To successfully integrate the face-to-face and online components, the course had to be rebuilt from the ground up.
- Enable teachers to take full advantage of blended learning and better meet student needs. Building a course from the ground up allows teachers to rethink and design the entire course based on student needs. The teacher's ability to explore and incorporate a wider range of distribution strategies into the course is one of the factors that contributes to the overall effectiveness of the course.

Challenges of the high-impact blend

- To execute this method properly, a large amount of technological proficiency as well as confidence is necessary. Teachers who have a high degree of technological proficiency can quickly learn new technological abilities and easily incorporate them into their lesson plans. One of the most important factors in the integration of technology in the classroom is the educators' belief that the technology they utilize will facilitate a more effective approach to achieving their teaching goals.
- This method has a higher failure rate than the other methods because it may introduce a completely new curriculum that is not tested on the children.
- Instructors must explore a diverse array of potential combinations of learning components and recognize their full implications. Teachers are placed in complex situations, which causes them to have to adapt their curriculum because of the large variety of media distribution options, the diversity of technology combinations, and the lack of examples to follow for specific combinations of technology.
- This position is necessary for someone who has prior experience in the design of integrated learning. Combining learning that is both academic and practical is difficult for teachers who lack the necessary knowledge and skills. Teachers can have a greater understanding of the

interaction between teaching and electronic media by becoming familiar with it and then experimenting with blended learning in small steps.

- The procedure of creating and deploying a new hybrid learning course may need a significant amount of time. The creation time for a blended teaching style is typically twice the length of a traditional teaching style.

Recommendations

- Instructors that have minimal to no experience in the design of blended learning should initially attempt to experiment with one of the other two approaches to blended learning in order to gain experience that will be beneficial when they implement this method. To create a successful blended education course, a large amount of expertise and experience is necessary to assist with the selection of educational activities that are more effectively taught in the classroom as well as others that must be prepared for online distribution. One of the most detrimental practices that teachers can participate in is not utilizing the most effective methods to transmit lessons to their students.
- Educators should devote extensive effort to the planning process. Because creating a comprehensive course for a blended learning project can take a significant amount of time, instructors should have at least six months of lead time, with a year being ideal. The greatest obstacle to executing a successful blended learning experience is a lack of time.
- Educators should take into consideration a variety of methods of presentation when they combine. Using a variety of teaching methods in e-learning promotes the greatest likelihood of success.
- Having institutional support is essential to the success of this strategy. A comprehensive design of the course is necessary to create an effective hybrid learning experience, this must happen with a high degree of institutional support, including time off, professional development, money, and technical assistance. Professional development should concentrate on the efficient utilization of new educational tools that teachers have never encountered

before. This is caused by the large number of online components that must be accounted for, and teachers should be taught about this area.

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MODULE 5.
USING ROBOTIC APPLICATIONS IN PRIMARY SCHOOLS MATH

Prof. Linda Daniela
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University of Latvia

LESSON 5.1
The Essence of Robotics in Education
Duration: 1 hour

Learning Outcomes:

- To know and aware the theoretical and practical aspects of robotics in education.
- To formulate, analytically describe and present scientifically improved information about robotics in education.
- To facilitate the development of their knowledge, abilities and skills regarding education by focusing on the use of robots for the purpose of education in kindergarten.
- To understand the main concepts, theories, research methods and results of robotics in education.
- To discuss the interaction between robotics and education.

Teaching Methods/Techniques: individual work, discussion, question-answer, collaborative learning, question-answer, mind mapping, research, poster.

Learning-Teaching Activities:
Before the Classroom Time, prospective teachers use the online teaching materials to learn about the topic: essence of robotics; robotics vs robots.

In-class Activities

- Student individually chooses 3 scientific articles from databases on *educational robotics* or *robots in education* and prepares a summary about main ideas in scientific articles.
- In a group of 4 or 5, prospective teachers participate in the discussion and sharing of findings, ideas regarding the educational use of robots or robots in education, from a prepared summary. In the following step, prospective teachers should find common and different ideas, findings, and choose the most appropriate based on the discussion in their groups.

- In clusters, prospective teachers plan a theoretical presentation that will be used as a poster. Students choose ideas and findings that they want to utilize to create a poster about Educational Robotics or Robots in Education.
- Groups exhibited pre-prepared posters and discussed the benefits and drawbacks of educational robots or computers in the education field.

Assessment Tools:

- Self-evaluation of one's own pedagogical efforts via the acquired knowledge, comprehension and skills regarding the implementation of educational robots in the educational setting.
- Peer assessment is important in order to determine the groups' methods of study, they understand each other's processes.
- Formative assessment: the analysis of written work and exams.
- Summative assessment: the evaluation of oral tests or written exams that are intended to assess the abilities and knowledge of potential teachers.
- Diagnostic assessment: the evaluation of pre-test and post-test to assess the prospective teachers' abilities.

Theorical Knowledge:

The field of robots is a combination of science, technology and engineering. The primary purpose of robots is to create machines that are intelligent (Alici, 2018). On the one hand, robots could be considered a final example of fashion's influence, almost every aspect of production can be automated: robots that weld parts to cars on production lines, robots that interact with humans in professional services (Staples, 2018). Today, robots are commonly utilized in industries like the automotive industry to complete simple repetitive tasks, or in fields that require man protection (Britannica, 2021). These are traditional robots that require each movement to be programmed to a human, a programmer, and an engineer or robotic expert. Medicine, agriculture, transportation, industry, education, and entertainment are all areas where robots have become more involved, although there are differences in each of the aforementioned areas regarding the functionality of robots and their technological solutions, their usage, and their capabilities. Robot technology won't show up as fully-formed humanoids robots with human-like intelligence capable of accomplishing anything. It's a science-fiction dream. Instead, robot technology will emerge with special-meaning tools that will allow us to improve our quality of life in many aspects, whether caring for their loved ones or making our businesses more productive (Hawes, 2021). Robotics is a science that will change the services and capabilities provided in these industries, as technological developments and innovations around the world do. Autonomous robots are the ones able to make their own decisions. Decisions taken by autonomous robots are quite simple at the moment – mainly related to how to move or where to move, but robots will become more complicated because of increased awareness of the use of artificial intelligence (AI) for robots in the real world (Hawes, 2021).

Keyword "robotics"

Isaeka Azimova's literary accomplishments take a significant part in the field of robots because of her science-fiction narrative, "Runaround", which was first published in 1942 (Asimov, 1950). The word "robots" was first used by McCauley in his book on the subject (2007). Several mechanical and automated technological solutions have been developed several years before Mr. Azimov first conceived of the term "robotics", it is interesting that this was the author who first conceived of the term and still prevales today (Gasparetto & Scalera, 2019).

Concept of the keyword "robotics":

- Robotics – science on the design and operation, exploitation of robots (Oxford Learner's Dictionary, 2018).
- Robotics – as the design, creation, and utilization of machines (robots) to complete tasks that traditionally require human intervention. Robots are commonly employed in these fields including the automotive industry to complete simple repetitive tasks, and in fields that require human safety in an hazardous environment. Many aspects of robotic technology involve the artificial intelligence of robots; these robots may have the same capabilities as humans, including temperature-sensing, vision, and touch. Some are even capable of simple decision making, and current research on robots is intended to create robots that have a degree of autonomy

that will allow them to move and decide in an unstructured environment. Today, industrial robots do not resemble humans; a human-like robot is called an android (Britannica, 2021).

Robotics, as a separate science and academic discipline, include teaching subjects or scientific directions such as engineering, programming, algorithms, mathematics, physics and other engineering-related disciplines. These fields of science are very extensive and their highest achievements, such as artificial intelligence, trials in the 3D printing of human organs, synthesizing of new chemical compounds and the development of mathematical or design solutions at a high level, may not be comparable to the extent of educational robotics knowledge, the results achieved by different education sets (Yueh & Chiang, 2020). Over the following 10 years, robots will increasingly have the capacity to assess and respond to the environment appropriately, as a result of the development of semantic intelligence. For instance, in the future the robotic will determine whether the object in front is a human or machine (Horng, et al., 2019).

Keyword "robots"

For the first time, the word *robot* were used by Karel Chapek in his science-fiction play Rossum's Universal Robots. The term was invented by the writer's brother Josef Chapek in 1920. The word derived from the word "robot" which, in Czech and also Slavic, means "forced labour" (Moravec, 2021). In the 1920 s, the robot is technically not yet possible, but the public is presented with a science-fiction-worthy idea of robots - devices that perform human-specific functions without the presence of the man itself. In 1926 the world is introduced to one of the first robots Televox, which as a large part of the early robotic devices were intended to perform popular truco like smoking, firing a gun or whistling a song (Corn & Heflin, 2021).

Concept of the keyword "robots":

- A robot is a "machine capable of automatically performing a series of complex actions, especially what can be programmed with a computer" (Oxford Learner's Dictionary, 2018).

- Robot is "an autonomous machine capable of capturing its environment, making calculations for decision-making and carrying out actions in the real world without direct human intervention" (Alami et al., 1998).
- A robot is a mechanism, with some autonomy moving in its work environment and carrying out the tasks for which it is intended (Rubio et al., 2019).

Nowdays's robots are characterised by four major features:

- mobility, which is crucial to the profession in locations like hospitals and offices;
- interaction between sensors and actuariates that are collecting the relevant information from the environment and allowing the robot to act on the environment;
- communication facilitated by computer interfaces that have voice recognition and speech enhancement capabilities;
- autonomy as the capacity to think for themselves and make decisions about environmental impact that are independent of external supervision (Catlin & Blamires, 2019).

Modern robots are mostly equipped with some kind of artificial intelligence. They are computer systems that reproduce the performance of human cognitive actions. As a result, machines are constructed that are capable of carrying out activities that require a specific form of intelligence, such as the ability to percieve and represent changes in the environment and to adapt their functions accordingly. For robots to be fully autonomous, artificial intelligence gives them the ability to complete difficult tasks in complex environments that change rapidly, such as driving a car and changing to a new road condition without human supervision or control (UNESCO, COMEST, 2017).

Educational robotics and Robotics in Education

Robotics in education include a variety of choices. These applications include replacing an educator with a robotic device (reading texts, etc.), utilizing robots to assist with communication (promotion of students, etc.). Still, there is not a definitive understanding of the objective of employing robots in education. (Scaradozzi et al., 2019).

Educational robotics is a field of study dedicated to enhancing the learning experience of people, with two key aspects (pedagogical and technological):

- implement, refine, choose appropriate activities and tools (e.g. guidelines and templates);
- technologies that involve robots that participate in active ways and every activity is based on the needs of the classroom and the most effective methods are employed. (Angel-Fernandez & Vincze, 2018).

Educational robotics refers to a field that is the intersection of different knowledge, such as robotics, pedagogies and psychology. The educational robotics are based on the theories in pedagogy and psychology, such as S. Papert, Lev Vygotsky and Jean Piaget (Scaradozzi et al., 2019), with the main focus on the targeted design of knowledge.

Benefits of Educational robotics:

- enhances problem solving skills for students, helping to better understand complex concepts, explore and make decisions;
- increasing self-efficiency: The management of the robot contributes to experimentation, detection and rejection, which in turn increases the students' confidence, as the student feels that he controls the equipment. It also strengthens the critical thinking of student;
- increases student's ability to think strategically: A student is taught how to think of larger problems as a series of smaller problems that can be solved separately. Learn to focus on important information and reject non-essential;
- increase creativity by playing games with knowledge in a more entertaining manner. Learning is fun and interesting for the student;
- increasing the motivation level because of the educational nature of robots, students are encouraged to participate in activities and have a strong interest in them. (Evripidou et al., 2020).

Skills developed by educational robotics:

- *Team work*: promoting socialisation and cooperation, because only by collaborating and combining, knowledge and abilities can they be shared students will solve problems.

- *Leadership and conviction*: more complicate tasks increase confidence in yourself and your own abilities. This self-respect is accompanied by a tolerance for disappointment when they don't make what is being offered to them for the first time.
- *Promoting of entrepreneurship:* students create new abilities based on experiments and failures. As a result, they are motivated by the desire to innovate, think independently and, as a result, execute their projects.
- *Logical thinking*: robotics promotes logic and thinking. It's a procedure that involves numerical calculations and logical programming to enhance the capacity of analytical thinking.
- *Creativity*: the imagination is always present because students are required to create different models, robots, and structures.
- *Curiosity*: faced with the traditional redistricting system, the child himself is a protagonist because he has to make material using his own resources. The curiosity to discover something new increases their learning capabilities.
- *Focus*: works with the more troubled children who have issue to be focused.
- *Mathematics*: improving of problem solving, mathematical operations and reasoning (Amo et al., 2021).

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LESSON 5.2
Robotics for Education in Primary School
Duration: 1 hour

Learning Outcomes:

- To facilitate the development of their knowledge, abilities and skills regarding education by focusing on the use of robots for the purpose of education in kindergarten.
- To understand the diversity of educational robots in education in primary school.
- To select, describe and present information about robotics in education primary school.
- To understand the design and functions of educational robots in primary school

Teaching Methods/Techniques: group work discussion, collaborative learning, discussion, question-answer, brain storming.

Learning-Teaching Activities:
Before the Classroom Time, prospective teachers use the online teaching materials to learn about the topic: history of robotics; generations of robots; qualification of robots, taxonomy of educational robots.

In-class Activities

1. Students analyze the taxonomy of educational robots. In-group work, students find examples of robots according to taxonomy: Build Bots, Use Bots and Social Bots. The examples of robots collected in table, for example, in the Google Drive.
2. Group of students present examples of educational robotics. During the presentation, each individual teacher who wants to participate chooses and focuses on one of the most important ideas, findings for themselves.
3. In the same group prospective teachers discuss notes and fulfil, make corrections, changes in prepared tables. After

groups present prepared examples on diversity of educational robots.

4. Two potential teachers will choose one educational machine from pre-prepared examples in the educational field. They will concentrate on the use of robots in the primary school classroom. Students investigate the educational robotic system by concentrating on the design, functions, structure, and the principles of action associated with it at the primary school level, etc.
5. Students make an advertisement of educational robot for education in primary school. Prospective students present and describe information about selected educational robot in education in primary school.

Assessment Tools:

- Self-evaluation of one's own pedagogical efforts via the acquired knowledge, comprehension and skills regarding the implementation of educational robots in the educational setting.
- Peer assessment is important in order to determine the groups' methods of study, they understand each other's processes.
- Formative assessment: analyzing of homework and papers.
- Summative assessment: evaluation of oral tests or written examination to measure the skills and knowledge acquired by prospective teachers' knowledge.
- Diagnostic assessment: evaluation of pre-test and posttest to measure prospective teachers' gained competencies.

Theorical Knowledge:

History of robots

The idea of an automatically working creature/device stems from the mythology of many cultures around the world. Engineers and inventors from ancient civilizations, including Ancient China, Ancient Greece and Ptolemy Egypt, have tried to build both mechanical machines and various animal and human-like installation (Michaud & Matarić, 1998). The development of robotics as science started in 1495, when Leonardo da Vinci outlined plans for a mechanical device that looks like an armed knight (humanoid). The mechanisms inside the robot were designed so that the knight sat, waving his arms, moving his head (Gomez et al., 2021).

Sils Hughes (2014) has highlighted major achievements in robotics history:

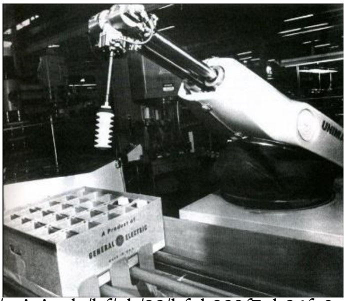
1. In 1495: The robotic figure, or mechanical knight, of Leonardo da Vinci was a humanlike machine that was designed and built by him around 1495.

https://blog.salvius.org/2014/01/a-history-of-robotics-da-vincis.html

2. 1937-1938: Electro is a term used by the Westinghouse Electric Corporation to describe a robotic device that was created between 1937 and 1938. Seven feet high, has a weight of 265 pounds, resembles a humanoid, he can walk with a voice command, speaks about 700 words, smokes cigarettes, bursts balloons and moves his head and arms.

https://www.theoldrobots.com/Electro.html

3. In 1961: The first modern robots are usually mentioned by Unimate and Shakey. "Unimate", made in 1961, is designed to be the first industry robot - a giant robot arm that performed welding work with hot objects.

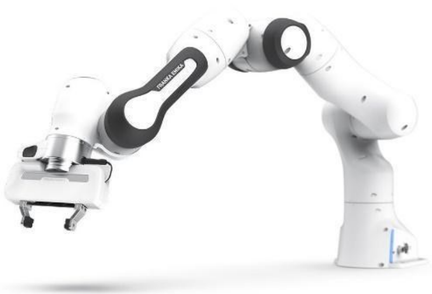


https://i.pinimg.com/originals/bf/eb/82/bfeb828f7ab26fe0ca40062baf454b10.jpg

4. In 1991: The P series is a chronological progression of prototypes of humanoid robots developed by Honda. P1, P2, P3, P4 and then ASIMO were developed in the 2000 s.

https://miro.medium.com/max/810/0*i1kcE4jN9LmOvbA2.jpg

5. In 2017: Franc Emika's Panda is cobot, nimble as a human hand with a human touch, a perfectly smart interactive solution, easy to install and intuitively use.



https://www.mathworks.com/products/connections/product_detail/franka-emika-robots.html

Generations of modern robots (Moravec, 2021; Veinberga, 2022):

- 1st generation robots before 1980; mechanically, stationary, accurate, physically rough without external sensors. These machines have the ability to make accurate movements at high speed, many times, for a long time. Such robots are widely used in industry today.
- 2nd generation robots from 1980. till 1990; The robots were intelligent. Robots possessed both visual and tactile systems as well as position and pressure sensors. A second-generation robotic system has a basic degree of machine intelligence. This type of machine is equipped with sensors that communicate with the outside world.
- 3rd generation robots middle of 1990s; robots became mobile and autonomous, able to recognize and synthesize speech, already navigation systems or remote and artificial intelligence are built into. The concept includes two major developments of smart-robot technologies: an autonomous robot (works itself) and an insect robot (a lot of robots controlled by one central computer).
- 4th generation and 5th generation robots since 2000 robots that are already increasingly integrated into society, for example, are gaining human traits - a sense of humor, compassion. Future robots are certainly closely associated with artificial intelligence. More and more robots will be made like a man with all its capabilities.

Educational robotsics are primarily based on the creation of the programming language S. Papert invented (Papert, 1980), which was intended for children and adolescents and was particularly popular in the educational sector. Papert believed that computers could be used not only to provide information and instructions, but also to allow children to experiment, explore and express themselves (Resnick & Robinson, 2017). In 1969, Papert invented the first educational programmable robot named Turtle (Resnick & Robinson, 2017).

In 1998, in close collaboration with S. Papert, LEGO created something completely new. LEGO introduced the world to Mindstorms (Waterson, 2015), which can be considered a renaissance of educational robotics. LEGO Mindstorms is a robot designed for children who can both be designed/build and coding.

Today, the ideas on the inclusion of robotics activities in the learning process are no longer new, but there is still a question of how to use them to promote the development of certain competences, and what pedagogical principles should be taken into account to improve students' motivation to seek new innovative solutions (Daniela & Lytras 2019).

Classification and taxonomy of Educational Robotics

Two types (Catlin et al., 2018).of educational robots exists based on the ideas of S. Papert:

- **Build Bots -** students need to put together before use, for instance, LEGO Education robots: *WeDo 2.0*, *MINDSTORMS EV3* and *SPIKE*, *Arduino strater KIT* , LittleBits and others.

https://www.lego.com/cdn/cs/set/assets/blt706e02efdd6fd911/45300.jpg?fit=bounds&format=jpg&quality=80&width=1500&height=1500&dpr=1

https://i.pcmag.com/imagery/reviews/01H1ssVkSYUmZYQVdCGBkTk-1..v1569474795.jpg

https://www.lego.com/cdn/cs/set/assets/blt9b787a707934f39c/45681_alt1.png?fit=bounds&format=png&width=320&height=320&dpr=1

https://static.generation-robots.com/13055-large_default/official-starter-kit-arduino.jpg

https://cdn.shopify.com/s/files/1/0994/3066/products/littlebits-gizmoes-gadgets-2nd-edition-konstruktors_grande.jpeg?v=1595347729

- **User Bots** - student can remove from the pack and use it immediately, for instance, Bee-Bot and Blue-Bot, Ozobot, Sphero programmable robot-balls, Photon.

https://www.roboplay.lv/image/cache/catalog/ext4oc/60/dda6-fdb61a30-6140-800x800.jpg

https://skolam.lv/images_mod/products/blue-bot_left_lg921109.png

https://techcrunch.com/wp-content/uploads/2017/02/ozobot_evo_white.jpg

https://www.robot-advance.com/EN/ori-sphero-bolt-2132.jpg

https://photon.education/wp-content/uploads/20220316_Robot_UPDATE032022.png

When classifying types of educational robotics, the principle of white box and black box can be used to distinguish between groups of two robots (Alimisis et al., 2019):

- Black box robots are ready-made devices with which pupils can work. There is no build option, no connecting of parts or designing, and the student does not know what is inside the robot and does not understand how it works. This kind of robot gives student specific learning opportunities that will focus more on learning outcome as a result of programming, coding and problemsolving. For instance, Photon robot.
- White box robotics kits allow students to become ideamakers (Suomalainen et al., 2020). Students make robots themselves by using a variety of components, parts, sensors, electrical components, and planning the design of

robot. Many skills has developed during the teducation process by using white robot kits. Robotics technology components, combined with digital manufacturing and self-made electronics, become unique manufacturing tools that can create a learning environment that attracts and maintains the interest and motivation of pupils with practical, fun learning activities (Alimisis et al., 2019).

The taxonomy of educational robots is based on three objectives:

- use the results of studies of a single educational robot for all pupils of the same class as a whole, not individually or in pairs;
- give educators the opportunity to review and compare the technical state and capabilities of the various available robots;
- provide up-to-date information on education robots, preferably online (Veling & McGinn, 2021).

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LESSON 5.3
Robotics for Mathematics Education in Primary School
Duration: 1 hour

Learning Outcomes:

- To combine the statements of robots in education with the understanding of math education processes in the context of utilizing robots in math.
- To utilize the theoretical and practical aspects of robots in the education process for the planning of math teaching/learning methods.
- To combine the statements of robots in education with the understanding of math education processes.
- To know the interaction between robotics and mathematics education.

Teaching Methods/Techniques: individual work, group work, discussion, collaborative learning, question-answer.

Learning-Teaching Activities:
Before the Classroom Time, prospective teachers use the online teaching materials to learn about the topic.

In-class Activities

- Individually, a student groups robots into 2 categories: usable in mathematics education in primary school, not applicable in mathematics education in primary school. Student uses materials from previous lessons: a table of educational robots and an advertisement.
- In a group of 4 or 5, prospective teachers share and discus examples of robots for categories. In the next step, prospective teachers should find common and different examples of robots by categories and choose the most suitable according to the results of discussion in their groups. In the discussion, the student justifies the view why the robot was included in one or the other group. During the discussion, attention paid to the essence of mathematics education: student's acquire specific

mathematical skills and knowledge and, for instance, transversal skills as well.

- In group work, students make a list of linking a educational robots with mathematics learning outcome from standard or program. Group of students present examples of educational robotics and mathematics learning outcomes. During the presentation, each individual teacher who wants to participate chooses and focuses on one of the most important ideas, findings for themselves.
- In the same group, prospective teachers discuss notes and fulfil, make corrections, changes in prepared list. After groups present prepared examples on connected mathematics learning outcome and educational robots for primary school education.

Assessment Tools:

- Self-assessment about one's own pedagogical activity by the acquired knowledge, understanding and skills implementing systematically and consciously the educational robotics in the educational institution.
- Peer assessment is necessary to determine how the groups study, understanding the group's processes.
- Formative assessment: analyzing of homework and papers.
- Summative assessment: evaluation of oral tests or written examination to measure the skills and knowledge acquired by prospective teachers' knowledge.
- Diagnostic assessment: evaluation of pre-test and posttest to measure prospective teachers' gained competencies.

Theorical Knowledge:

Educational robotics may affect student learning, particularly in the fields of STEM (science, technology, engineering and mathematics) (Castro et al., 2018). Recent studies have focused on the latest updates to educational robots, their primary goal is to teach science, technology, engineering and math through activities that utilize robots, their sensors and their programming or coding. This is done in a new, current manner. These goals for education also involve the arts and the social sciences, where STEM is now considered a form of art (Benitti, 2012). The approach to use and integrate science, technology, engineering, arts and mathematics (STEAM) in education, has been rapidly introduced and frequently used in recent years as a pedagogical alternative, providing more comprehensive and attractive education to boost the growth of pupils' different skills (Leoste & Heidmets, 2019).

Pedagogical conditions and strategies for the use of educational robotics in the teaching/learning process:

1. educational robotics as a learning tool, strategies when a robot is used as a ICT tool / recourse to achieve the aim and to attain learning outcomes, e.g. in mathematics;
2. educational robotics as object for cognitive action, robotics is a separate school subject and pay attention to Curricula;
3. the educational use of robots that act like humans and have social capabilities, these robots are referred to as social robots;
4. educational robotics as tool that can help students develop cognitive and social skills (Angel-Fernandez & Vincze, 2018).

The most common and effective teaching methods in the context of educational robotics:

- projects, challenges, competencies-based learning;
- problem solving, cooperation;
- discovering, adventuring;
- simulations (Amo et al., 2020).

Social interaction, cognitive function, teaching method, student characteristics, key features and content shall be the basis for evaluating the quality of the robotic education and using the correct teaching methods (Chootongchai et al., 2021).

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LESSON 5.4
Students' Practices on Robotics Applications in Mathematics Education in Primary Schools
Duration: 1 hour

Learning Outcomes:

- To implement the theoretical and practical aspects of robotics in education for planning mathematics teaching/learning.
- To use the acquired and consolidated knowledge in one's practical activities, integrating systematically and consciously the mathematics education and robotics in one's own pedagogical practice.
- To be able to make decisions corresponding to the concrete situation in the math education, including the ensuring of the teaching/learning process and the learning environment.
- To reflect on one's learning process and results, and advance their further development of professional knowledge, skills and competence.
- To select the appropriate strategies for planning the math activities by using robotics.

Teaching Methods/Techniques: group work, discussion, collaborative learning, question-answer, case study, modeling of pedagogical situation, brain storming.

Learning-Teaching Activities:
Before the Classroom Time, prospective teachers use the online teaching materials to learn about the topic.

In-class Activities

- Pair of prospective teachers choose one educational robot for mathematics education in primary school. Students identify and select 4-5 learning outcomes in mathematics by using Standard or Programme.

- Students define what type of evidence they consider acceptable to prove the learning and acquisition of skills and knowledge.
- Students define assessment tasks to identify the learning outcomes and level of acquired skills and knowledge.
- Students design the proper teaching/learning plan to facilitating students' math learning outcomes acquisition by using educational robot.
- Students as teachers show and manage the planned math lesson by using educational robots. Other students in group are taking pupils position.
- After a guided lesson, students perform self-reflection as well as other members of the group analyze performance by highlighting the positive moments and offering ideas for improving the quality of the lesson.

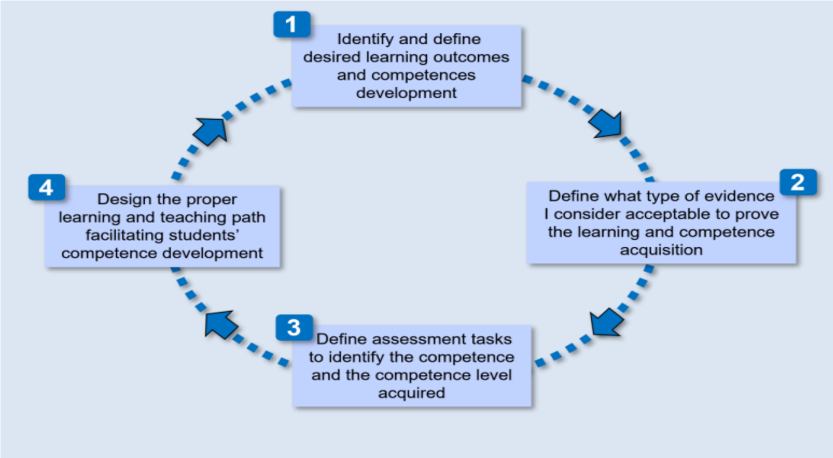
Assessment Tools:

- Self-assessment about one's own pedagogical activity by the acquired knowledge, understanding and skills implementing systematically and consciously the educational robotics in the educational institution.
- Peer assessment is necessary to determine how the groups study, understanding the group's processes.
- Formative assessment: analysing of homework and papers.
- Summative assessment: evaluation of oral tests or written examination to measure the skills and knowledge acquired by prospective teachers' knowledge.
- Diagnostic assessment: evaluation of pre-test and posttest to measure prospective teachers' gained competencies.

Theorical Knowledge:

The backward planning approaches

Backward approach in designing competency-based learning experiences adapting the Polaris model proposed by Trentin (2010).



Plan of Math lesson:

Description	Content of Lesson
Grade	
Topic	
Date, time	
Learning outcomes	
Educational resourses	
Teaching Methods / Strategies	
Steps of lesson • **Start** / introduction • **The main body of the lesson** / understanding, using, specific learning activities • **Closure** / reflection	

References

Trentin, G. (2010). Network Collaborative Learning: social interaction and active learning. Oxford, UK: Chandos Publishing Limited.