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## 1. Application of online and traditional STEM education

### 1.1. Current situation of STEM education

**STEM-courses of study** (Science, Technology, Engineering, Mathematics)

**STEM** stands for Science, Technology, Engineering and Mathematics. It includes all technological, technical, exact-scientific and mathematical training.

STEM (Science, Technology, Engineering and Mathematics) is the future of education in the Netherlands. STEM, also known as STEAM, includes skills and knowledge needed to train the new generation to be leaders and innovators for solving complex global problems. STEAM education is also a paradigm shift from traditional education based on repeating and reproducing knowledge to a more modern way of working where the learning process is just as important as the result. Inquisitive, discovering and design-based learning are central!

STEM education STEM education means that students must gain the theoretical and practical knowledge through an interdisciplinary approach in science, technology, engineering, mathematics while gaining the skills from the new digital and modern age of the 21st century:

- Knowledge in STEM
- Computational thinking
- Program
- Robotics
- Learning how things work and creating things that work
- Lifelong learning
- Algorithmic thinking
- Thinking outside the box
- Critical thinking
- Creative thinking
- Development of communication skills
- Acquisition and strengthening of presentation skills
- Acquire and strengthen and strengthen decisiveness
- Acquire and strengthen time management skills
- Problem solving
- Problem-based learning
- Project-based learning
- Logic
- Research
- Perseverance
- Innovation
- Cooperation





- Leadership
- Entrepreneur
- Team spirit
- Discovering lifelong passion
- Troubleshooting
- Learning to anticipate and avoid problems
- Structural thinking
- Create things that work
- Necessary skills for the future
- Mathematics in action

Due to its creative and entrepreneurial nature, the term STEM is increasingly being replaced by STEAM (with Arts added). The combination of the STEAM fields makes progress possible by stimulating learning with mistakes, by experiencing and by thinking in a solution-oriented way. It saves time by combining lessons and the interactive nature makes learning more fun. Children discover how much fun it is to work with technology, how it works for you and what you can do with it.

Technological progress, the demand for solutions in areas such as healthcare, ICT and sustainability make the world look different for our children once they start working. Let them get acquainted with their future world in an accessible way, now the social demand to train new innovative thinkers of the future is greater than ever! Climate goals, energy transition and far-reaching ICT developments cry out for new knowledge and skills of today's students and tomorrow's employees.

### **Development of distance learning due to closure of schools due to Corona**

In 2020, schools and pupils were confronted with distance learning, as a result lessons were given through forms of online learning and E-learning. There were virtual classrooms where zoom, teams and other platforms were used. Schools were forced in a short time to create curricula for remote/home learning, a leap to online learning became a necessity.

A pitfall was that frontal teaching (teaching for the board) was now given via a digital connection between teacher and student. This form of remote teaching was filled with emails in which the homework was given in the form of assignments. Sometimes supplemented with physical teaching or learning material that could be picked up at the school. The pitfall was that students found the lessons boring, distracted, or started doing other activities and that was not noticed.

During the COVID-19 pandemic, the teaching staff was not well prepared for online education and virtual school, they were quickly forced to use digital platforms and online resources to manage the entire educational process.

In North Macedonia, it was so difficult to respond quickly and adapt to the new way of teaching, such as active online communication between teachers, students and parents during the end of the school year and achieving the learning objectives. Some of the educational institutions stopped their teaching activities and did not continue at all because they stopped the educational process. As time went on during the recovery process, uncertainty still exists on the part of institutions, parents, and students. This situation affected part of the educational





institution and their decision to close.

Because many young students are not yet able to learn fully or partially independently, the Achilles heel of this form of distance learning quickly became the lack of help. Lack of help from parents at home, getting used to a new form of teaching or lagging availability of computers and internet have led to a knowledge gap of students.

A major complaint from parents was the difficulty of keeping students motivated at home to continue to follow the lessons and do the homework. It also turned out that some students did not have a suitable computer, tablet or internet at home to follow the lessons. Families where there was little financial scope were the victims of not being able to learn.

### **Depression, learning delays; students have been seriously affected by the lockdowns**

Since the lockdown, pupils in secondary schools have been in average 27 weeks behind the education schedule before corona, according to newspapers. Yet schools do not think that is the worst thing they indicate: lack of motivation, ability to work together and depression in students worry them more.

Big mouths, hanging in the chair, constantly in discussion: the difference between her students before and after the lockdowns is immense in most counties.

High school students have suffered more from the lockdowns than elementary school students. They were in full or partial lockdown in average 40 weeks, an entire school year. The biggest concern for schools now appears to be: how do we 'turn' students back on?

Their motivation has disappeared, they have not learned to plan, they have difficulty working together and retaining attention. In addition, they suffer from depression, are not themselves and prove difficult to manage.

### **Extra role of teachers, dealing with students with depression**

With the increase in distance learning, the social function that students have a great need for, belongs to a group of like-minded people, disappears. This need among students blocks a rapid advance of distance learning. The increasing number of depressions among young people means that teachers must be able to recognize signs of depression better in order to be able to respond to it as much as possible. Parents can also discuss picked signals with the teacher to draw up a plan of action together to help the students who need it.

### **New or sharpened teacher skills with or through distance learning**

As a teacher, how do you deal with a depressed student?

A gloomy mood, irritable behavior, fatigue, not feeling like school and concentration problems occur in every student. When this takes a long time, there may be depression. What can you do as a teacher if you suspect a depressed student?

About 2 percent of children up to the age of twelve have depression. During puberty, this percentage increases to about 8 percent. In girls, depression is twice as common as in boys. It is important to keep a close eye on pupils with depression, to provide appropriate help at school and, if necessary, to refer them to external counsellors.

When you as a teacher or parent suspect depression, it became important to share this with colleagues, for example in an internal care consultation. After consultation with between school and parents, and (depending on the age) the student, external help was often sought





through the general practitioner.

### **Tackling depression at school**

A development that stood in the way of effective online learning, the motivation of parents, students and teachers were therefore often under pressure. Remember that parents are not teachers and often had to work themselves.

And teachers are an extra bottleneck, because many are old school educated and formed in live. A switch to online teaching is especially not supported by the group of teachers, about 75% immediately switch back to offline learning at school and frontal education. Teachers in particular need to be given more attention, what do teachers need to embrace online learning in such a way that programs are embraced that match the learning style and needs of students.

The question that arises as a result of all the research is 'is the teacher able to develop into a hybrid teacher when, as now, an educational development is occurring?'

A secondary question is 'how do you make online education possible with parents who alternate the role of parent with coach and/or teacher?'

And you can ask parents when they have to work themselves or all have a different level of experience and education. Something that our investigations in every country painfully expose.

### **Support for parents and teachers in corona time**

Due to the corona measures and online education, there is an increasing number of young people who have to deal with loneliness and depression.

In order to be able to help the young people, pupils and parents were made aware of the initiatives in their countries for help from many professional coaches who want to have free walking conversations, round-the-table conversations or video calls with young people who are stuck in the difficult time when online learning became a must, and they were no longer allowed to go to school.

The importance of also being able to learn with each other under the guidance of a teacher was emphasized once again.

The ambition in Estonia is a striking and good example of an ambition to connect with contemporary developments in sustainability, energy aggregation and ICT. The current priorities of the Estonian Education Development Plan 2035 by the Ministry of Education and Science:

- **Offer all people** more contact with the world of work during their studies and provide more practical professional and technological skills in secondary education; to promote the practical teaching of STEAM subjects in general education and to expand the possibilities of STEAM education.
- **Digital Pedagogy:** Educators are aware of the development trends, opportunities, threats and methodologies of new technologies and purposefully apply them to learning. Smart learning materials and methodologies help to learn and teach in an engaging and effective way, to give and receive immediate substantive feedback.
- **IT education:** the ability to create information technology in all age groups creates equal opportunities and a prerequisite for increasing competitiveness





## 1.2. Publications aimed at analyzing of traditional and online STEM education

### Research into better STEM education

There is too little interest in STEM at all levels of education. Over the next four years, three regions will conduct research into better STEM education at an early age. "In children between the ages of nine and fourteen, vocational images become fixed," says the researchers.

In four thematic groups, education researchers across the country will work together to take issues such as inclusiveness and multilingualism, ICT in education and futureproofing to a new level.

### Schools should focus more on STE(A)M education

The curriculum in education must change to better prepare students for their future, according to advice given in each country and reports.

The focus to fill the curriculum with more focus more on STE(A)M education - an interdisciplinary approach to learning that combines academic concepts with real-world, practical lessons, so that students can connect school with community and work.

- Reforms of the national curriculum are needed to make learning more relevant to the labor market. Such actions relating to evaluation and assessment and improvement of the quality of education include, for example:
- Reform of curricula and programmes for compulsory education in order to increase their relevance and attractiveness, better adapt them to children's developmental stages and place greater emphasis on learning outcomes;
- Support the development and consistent use of quality handbooks while reducing reliance on textbooks for education;
- Better adapt vocational education programmes to the needs of the labor market; • Strengthening the competence of teaching staff at all levels of education; • Strengthening central, local and school-level management capacities, and ensuring harmonized and transparent policies
- Working on inspiring learning and motivation programs to teach and embrace the new techniques in learning. Let them experience the new techniques and skills in, for example, blended learning programs. To turn 'unknown but unloved' into 'it's easier and more fun than I thought'.
- In all programs, look at teachers with compassion, they are forced during the corona crisis to switch to forms of online education from one day to the next. Many have had bad experiences because it was jumping into the deep end.

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## 2. STEM education in The PROJECT PARTNERS COUNTRYS

Here are a number of inspiring initiatives that are interesting for several countries and serve as a good example in the ambition to have more online teaching programs.

### **O-LABZ**

Go-Lab is a support platform, created over the years based on various projects, that allows students of different ages to learn concepts related to scientific topics such as physics, chemistry, computer science, electronics, biology and others. The platform offers online labs (Labs) and pedagogical applications specifically designed to facilitate learning (Apps).

The goal of Go-Lab is therefore to facilitate the use of innovative learning technologies in STEM education, with a focus on online labs (Labs) and investigative learning applications (Apps).

Using the Go-Lab ecosystem, teachers can find different Labs and Apps and create custom Inquiry Learning Spaces (ILSs). In addition, the Go-Lab initiative provides training for teachers on the topics of Inquiry-Based Science Education (IBSE), the development of 21st-century skills and the use of ICT and the Go-Lab ecosystem in the classroom. Go-Lab is a free platform that can be used by any teacher in any country. In addition, Go-Lab's premium tools and services are designed to meet the needs of educators and educational organizations such as ministries of education, teacher training, schools, teachers, and online lab providers.

Go-Lab is maintained by the University of Twente (The Netherlands), the Swiss Federal Institute of Technology Lausanne (EPFL, Switzerland) and IMC information multimedia communication AG (Germany).

### **CS FIRST (12)**

CS First is a free, easy-to-use computer science curriculum designed for students ages 9-14. Teachers use the content of the videos to teach kids and teens the basics of coding with Scratch for CS First, a special version of the Scratch encoding editor on the CS First website.

### **PhET colorado (13)**

The PhET Interactive Simulations project, developed by the University of Colorado Boulder since 2002, aims to create free, interactive simulations for students about math and science (physics, chemistry, mathematics, earth sciences, and biology).

With an intuitive game-like environment, simulations on PhET, based on extensive educational research, engage many students by allowing them to learn through exploration and subsequent discovery through the ability to access many specific videos and simulations, shared by other teachers.

Simulations on PhET are based on extensive educational research and engage students through an intuitive, game-like environment where students learn through exploration and discovery. Teachers, on the other hand, have access to specific directions such as videos and shared simulations that allow them to suggest innovative activities in their classrooms.

### **Microsoft Education**

This microsoft-proposed platform aims to develop next-generation hardware, software, and services for the education of children and young people, from kindergarten to high school.

The project, the development of which began in 2016, aims to support teachers in building activities based on the research and development of computational thinking. The platform provides the user





with a series of videos on different areas of STEM topics, such as astronomy, physics, chemistry and others. The project was created to provide classroom schools with opportunities for improving the technical skills of the 21st century.

### **World Robot Olympiad (WRO)**

WRO is an international robotics competition for children and young people interested in robotics and technology.

Team's design and build a robot and program it.

Depending on the category, this is either a LEGO robot or a free choice of hardware and software.

### **FIRST LEGO League program (FLL)**

FLL promotes and popularizes STEM subjects and aims to give the best knowledge and skills to the children. One can take part in the program, starting from the age 4 and ending at 16. There are a lot of students, who start as a contestant and end up as a trainer/coach/volunteer in the future.

The program has three different levels and age groups, who have the possibility to compete in tournaments:

FLL Discover age 4-6

FLL Explore age 6-10

FLL Challenge age 9-16

Competing and taking part in the Challenge program, teaches the kids about STEM based subjects, how to be like an engineer, how to collaborate with other people and classmates, also how to embrace each other's differences and most of all, how to have fun while learning.

### **FIRST Robotic Competition (FRC)**

The FIRST Robotics Competition is an international high school robotics competition. Each year, teams of high school students, coaches, and mentors work during a six-week period to build robots capable of competing in that year's game that weigh up to 125 pounds.

Robots' complete tasks such as scoring balls into goals, placing inner tubes onto racks, hanging on bars, and balancing robots on balance beams. The game, along with the required set of tasks, changes annually. While teams are given a kit of standard set of parts during the annual Kickoff, they are also allowed and are encouraged to buy or make specialized parts. The FIRST Robotics Competition is one of four robotics competition programs organized by FIRST, the other three being FIRST Lego League Explore, FIRST Lego League Challenge, and the FIRST Tech Challenge.

### **Skills Labs (Greece)**

Since the 2019-2020 academic year, the Ministry of Education, in collaboration with the Institute for Educational Policy, has introduced the concept of 'Skills Labs' in all public schools in the country. These Labs are part of the mandatory hourly program as recognized by the Ministry. In this context, an open call is communicated annually for organizations to create educational content, a board makes a final selection and uploads the approved courses in an online platform. After that, each individual school has the freedom to choose a course to implement throughout the year during the time allocated to the 'Skills Labs'. These labs are focused on the cultivation, refinement, and practical practice of various skills for elementary to high school students.

For the 2021-2022 academic year, several STEM-related courses have been made available to schools across Greece, aimed at cultivating the competencies below (as described by the Ministry and the Institution)





- Technology skills
- Media management skills (computer skills, Digital literacy, technological literacy, media literacy, internet security)
- Robotics (modelling and simulation skills, scientific/computational thinking) Strategic thinking (organizational thinking, case studies and problem solving)
- Side-thinking (creative, productive, holistic thinking), constructions, games, applications)
- Constructions, toys, applications
- Computational thinking skills (scientific/computational thinking mediation) • Digital citizenship skills (e-government, digital citizenship, safe internet browsing, protection against technology addiction, resilience)
- 21st Century Digital Learning (4cs in digital environment) (digital communication, digital collaboration, digital creativity, Digital critical thinking, combined digital technology, communication and collaboration skills)
- Ecological literacy - World Heritage and local natural heritage
- Climate change literacy - Natural disasters, civil protection

### **Kvark (Teadusteater) (Estonia)**

KVARK acts on behalf of a science-based society on the basis of reasoned statements and does not blindly believe in or present its views. In creating such a society, it is important to assess the importance of science and at the same time to continue to independently discover, research and question the world. They are suitable for anyone interested in science and STEM subjects. Their core value is a science-based approach. This is the basis for solving the challenges of our daily work, selecting projects and managing the company

### **Informatics Olympiad in Italy (and North Macedonia)**

The national informatics is organized and managed by the National and International Computer Science Olympiad Committee, which consists of representatives of: MIUR, AICA (Italian Association for Computer Science and Automatic Computing) (co-founder of the Olympiad), high schools and universities.

The organizational structure of the committee is divided into three operational units, technical-didactic, administrative and communicative. A similar initiative is found in North-Macedonia.

### **OO Techniek (Netherlands)**

Integrating science and technology into your curriculum is quite a challenge. OO Techniek supports this with free teaching materials. The program contains a continuous learning line and challenging and creative assignments that fit in with the living environment of the pupils (4-13 years). Through exciting assignments, they are encouraged to investigate and design solutions themselves. Every year, Stichting Techniekpromotie develops 4 assignments: 2 for the lower grades and 2 for the upper grades.

### **Work on Robots (Netherlands)**

Work on Robots is the latest program from Stichting Techniekpromotie in cooperation with the Ministry of Defense. This robotics examination program has been developed for students in the upper secondary school and Technasium and can easily be integrated into the curriculum (physics, computer science). Students can also include the project in their profile paper. In Work on Robots, teams program and build a robot with Arduino. This robot receives an assignment which it has to carry out as well as possible.



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### Survey research

Striking and interesting survey results in the affiliated project countries are shown below. The degree of willingness to implement online learning broadly varies per country, yet it can be seen that there is still resistance to take a broad approach to the chosen path of online and offline learning.

This is partly due to the forced situation due to covid and lockdowns, on the other hand, it is to be expected that teachers and students show resistance to changes.

A lot of research has been done over the years into people's willingness to change, researchers conclude that about 10% of the world's population is change minded.

Of the 90% others, most people are willing to change when there is a need, and they can influence it with their craftsmanship and experiences gained in practice. Something that is also respectful to do.

On average, 44% of all respondents want to continue using the online tools. That does not mean that it happens, the willingness to embrace online learning resources is high within the profession of teachers. As if this profession is waiting for the change, the willingness to change is significantly greater than with other changes we encounter in everyday life.

### Subjects or tools that should be present in a curriculum for teachers/tutors according to digital learning/distant learning?

1. Skills for digitally tracking student progress.
2. Being able to create/design digital diagnostic formative assessments
3. More learning resources available online that can be worked on together with the pupils.
4. Digital testing
5. Making videos (with PowerPoint) that help students to understand physics.
6. Basic training in programs like Teams
7. Digital skills, structure and presentation of lessons, encourage interaction, testing opportunities, promoting self-reliance among students, providing work-related control opportunities among students.
8. Interaction with students
9. High-quality digital testing programs
10. Prowise presenter (drawing)
11. Google Meet (communication)
12. Snappet (for learning)
13. ICT infrastructure is in place. Problem is the interaction with the pupils. Due to GDPR, it cannot be required to turn the camera on
14. Online applets
15. Video conference software with the ability to form groups, how to work with online groups effectively
16. Digital (formative) assessment
17. An easier way to monitor students' progress while working on a project
18. I have a very practical vocation and don't want to teach with distant learning anymore
19. A program like Teams. This provides the ability to divide classes into small groups and allow them to get started with assignments in groups. The teacher can then respond to this. However, it is necessary to have the right skills as a teacher for this. Both from the program and didactic. I would like to develop both for the future.
20. Creating interaction between students





21. Creating a safe environment
22. Less is more; how to prioritize so you're not talking for hours on end
23. Digital skills; using things like PowerPoint, whiteboard apps, quiz apps and breakout rooms
24. Easy to use software to remotely assess students.
25. Digital content that can be used and/or edited.
26. As a teacher it is important to know how the students fare."
27. Basic training for new teachers
28. Good equipment with which you can design online lessons. So good laptops, a second screen and more digital animations to make teaching material interesting.
  
29. Teachers should be able to work with Zoom/Teams and with platforms like its Learning/Fronter etc.
30. A laptop or device, a google account, knowledge of google products and some creativity
31. Teams/ Zoom/ LMS,
32. but most of all, an AR-system that connects to every student and in which you can alter real time either with the class or individually. This is a huge challenge. Imagine augmenting all of STEM; math, atoms, language, real time 3D view, boiling water, installing machines, etc. There is work for at least a century.
33. to differentiate
34. testing
35. programming
36. Focus on grammar, reading and math, but also enough attention for arts & crafts, STEAM and SEL. Children need to be educated in more than the main curriculum (even if online teaching asks a different form).
37. Online teams/zoom courses
38. The students need to practice with the basic online tools, like mailing, chatting, using Microsoft Teams.

**What would teachers like to see in a platform for distant learning (e.g. polls, uploading, forums, assessments, glossary, wikilinks, tests, other)?**

1. Scheduler / upload possibilities / study guide / collaboration space
2. Make it easier to use methods digitally
3. Use Digi board software online as well
4. Compatible software for administration - teaching – presenting
5. Differentiation within groups of students- personal contact
6. Emphasizing the class spirit
7. More cooperation per course from several institutes. For example, one person from each ROC (Regional training center) from each program in a working group.
8. Work of the kids and a good communication
9. Forums
10. Tools for visualization
11. Reliable digital assessment with the ability to input formula's/calculations.
12. A variety of tools
13. The best thing is if you have the content of the teaching material and tests and assignments in a program. In addition, the program must have the possibility to divide classes for differentiating with students. Most obvious the picture and sound quality must still be good with large classes It is useful if the students are displayed





- one at a time. To prevent the teacher from forgetting them.
14. An example could be that the teacher is able to see if a student has at least opened a website or page that was passed as homework or during the lesson.
  15. The software from MS Teams, 'Its learning' offers these possibilities.
  16. The platform should have a possibility to upload work, do tests and assessments
  17. A forum might be handy to share experiences and possibly ideas about how use different educational techniques.
  18. Realtime Virtual Reality with AR capabilities to:
    - view and speak to each other in 3D
    - work with AR applied to STEM curriculum
  19. Short videos of basic experiments (for physics); without commercials!
  20. I would like to see more different ways to help the students to evaluate their own work and for teachers to support different ways of testing and assessing the work and progress of the students.
  21. Assessments, documents, tests/practice tests
  22. A good way to take online tests for math. There are various options, but none of them is really suitable.

**When training is offered and would lead to qualifications. What are suggestions on what certification you would prefer, and why? (Think of EVC or a comparable certification).**

1. Knowledge of Microsoft or Google programs
2. Some pupils benefit from distance learning because they cannot concentrate in a normal classroom. To accommodate this, distance learning should also be offered by an ROC. There should be good rules for this, also for the area of certification and financing.
3. I would like to follow a course in which digital didactics are central. A lot is possible, but if you don't know this, it is difficult to implement.
4. One training course with different entry levels dependent on experience of the attendees
5. Everything that helps to motivate my students in their new way of life (more distance and online).
6. Social skills online.



### 3. Best practices

#### **Good practice**

Many experiences have already been gained with online learning and distance learning under duress as a result of lockdown during the corona times. The great transition has mainly taught that students can offer a challenging learning environment in which the group feeling is approached as much as possible and attracts the attention of young students.

An example that comes back to all of us is the role of Robotwise lessons. Where technology and even art find their way into the lesson programs. A good example that not only gives voice lessons but when added Art to it, STEAM learning was born. What is striking about this initiative is that teachers are trained online, so that they can immediately experience the advantages and disadvantages of online learning and can take this into account in their own lessons.

#### **STEAM education prepares students for the future - RobotWise**

RobotWise will support online lessons with co-teacher and robots. Central is the investigative character from STEAM education. This stimulates 'out of the box' thinking and thus appeals to the problem-solving ability. The learning system tries out different possibilities, investigates what works and what doesn't and makes it possible to quickly adapt to the most effective learning environment. Through the coaching role of the teacher, children are encouraged to help each other and really work together.

Core objectives of different subjects can be linked to each other in order to achieve multiple cross-curricular goals with one lesson. This saves time, which you can put into more attention for the children. Educational robotics can be used as early as group 1 of primary education, which makes a cascading introduction of STEAM education possible. From simple control and code drawing to actual programming language learning.

The approach and benefits of curricula in which students stimulate curiosity by letting them discover is central:

- RobotWise makes STEAM education tangible in the classroom in an inspiring way;
- Working with RobotWise saves time because the didactic method makes it possible to work across disciplines;
- Teachers are trained 'on the job' to grow in their coaching role;
- 21st Century skills, such as computational thinking, creative thinking, media literacy, information skills and ICT skills are integrated into RobotWise's working method;
- Learning by researching, discovering and designing;
- Children enjoy working with the robots and hardly notice how much they are learning.





### **What is the RobotWise Challenge?**

A crazy way to learn to program and be creative with technology and robotics. The nice thing about this Challenge is that you can participate from home, usually only need a laptop, PC or tablet and you have a chance to win a super cool prize every week: a RobotWise workshop with the winning student in the classroom in the new school year (so after the summer holidays). This

RobotWise workshop also gives substance to the technique lesson and lets young people discover their talent for technology and science.

### **Fun weekly task for primary and secondary education**

I can participate in this fun educational Challenge, whether you are homeschooled or at school! So if there is time left in addition to homeschooling, every student can just participate. But teachers can also specify this Challenge as a weekly task. And when the submission of school / students is live on their channel, the school can promote it for a chance to win a RobotWise workshop for their class.

The Challenges are suitable for primary and secondary education. Depending on the support from home, children from the age of 6 can participate in the Challenges. One Challenge is more reading than the other Challenge, but it is mainly visual programming where you quickly see the output. A great opportunity to work together with the people who stay at home.

### **Win and win a robot workshop for the whole class!**

The most original, coolest, funniest or most special entry is the winner, who will be chosen by a 'jury'. Of course, the number of 'likes' that the student has also counts! If the student has won, they will contact the student and school via email and organize a robot workshop for the entire class.

Due to the coronavirus, they will do this for the next school year when offline education can also be given freely again.

This is a way to make the participation of teachers and students bigger, because one student can make the difference for the whole class, it's form is inspiring.



The initiative is a good example of providing young learners with a challenging learning environment where teachers learn how to organize effective lessons when online learning is part of the curriculum at school. This is not the only initiative and there is plenty to learn about effective forms of online learning.

The corona crisis has taught us that online learning is not only an opportunity for young learners, but also sparks the discussion about how inspiring the frontal education system of offline learning is. A development in which we can take a step forward in learning in a society that requires students with 21st century skills and knowledge of contemporary new techniques.

### **A second at least as good example of online and offline-STEM education**

FIRST® LEGO® League guides children and young people in STEM learning. The FIRST LEGO League is the world's most accessible and controlled robotics competition, enabling children and teachers to work together for a better future. Students understand the basics of STEM and apply their skills in an exciting competition as they develop learning habits, confidence, and teamwork skills along the way. This form is a good example in the cooperation of countries how STEM learning can be fun and challenging.

#### ***FIRST® LEGO® League Challenge***

FIRST LEGO League Challenge is a research and robotics tournament for 9-16-year-old students. It combines the fun of technology and science with the exciting atmosphere of a sports event. They explore real existing problems such as resources, recycling, energy, or the coexistence of humans and animals. Challenge makes it easier for children and young people to access scientific subjects and to awaken their motivation to learn an engineering or IT profession at an early age.

#### ***FIRST® LEGO® League Explore***

FIRST LEGO League Explore has been developed to bring children from six to ten years to the STEM theme. The children will be introduced to the topics by the colorful bricks they already know. They explore real existing problems such as resources, recycling, energy, or the coexistence of humans and animals. On the "journey" the children learn to work together in a team and explore the wonders of science and technology.



## 4. Identified gaps

Gaps and improvements related to STEM education, explored based on our joint studies, are presented below:

1. In terms of inequality in education, several countries have a rural-urban performance gap;
2. Is the difference between girls and boys in math performance large;
3. Difference in learning conditions that are worse in rural areas or specific regions, such as damaged floors, old electrical networks, which is reflected in a greater concentration of double shifts and satellite schools;
4. Some schools need repairs, are prone to infrastructure problems as well as a lack of suitable materials and learning materials and insufficient support for teachers;
5. Access to broadband connectivity for marginalised and low-income populations - and low levels of ICT uptake - remain huge challenges for equal access to education in the context of the COVID-19 pandemic;
6. According to UNICEF survey with an A-selection to school principals, teachers and parents, it shows that:
  1. internet access was a barrier for 37% of households as parents reported children having to share laptops and computers with other family members;
  2. A small proportion of parents said they did not have access to a laptop or computer;
  3. About three-quarters of teachers were unable to maintain regular communication with students during distance learning;
  4. More than three-quarters of parents struggled to support their children with distance learning;
  5. More than half of those surveyed had technical difficulties accessing the necessary equipment, such as a lack of connectivity, computer or printer;
  6. Sometimes the limitation of stable internet was the reason that there was no good communication between student and teacher;
7. STEM software;
  1. Training for working with STEM education;
  2. Skills development to students through STEM education;
  3. An effective strategy for STEM education engagement

### **The lessons of remote learning gaming**

Many young learners between the ages of 9 and 12 enjoy gaming with games where they work together to complete an assignment. In some games, they form a group that goes on a mission or tries to carry out assignments well. Collecting is an element that encourages them to perform.

Often they are classmates, schoolmates or friends with whom they play games together. This platform therefore knows how to create a group of belongs. The speed and challenge within the games can also be seen in forms of distance learning that appear in the market under the name blended learning.

### **Blended learning**





Blended learning is a learning model that has been known for some time and is used in education. It combines online learning with classroom learning and is now increasingly even finding its way into business.

Blended teaching or learning is the use of online and offline teaching materials at different stages of the learning process. Depending on your preference and situation, you offer teaching material in a combination of online and offline learning. This way you create a powerful lesson: varied, appealing and clear at the same time.

### **Online teaching**

Maybe work and many unconsciously already blended. Online teaching is a collection of all teaching techniques using tools connected to the Internet. For example, the smartboard is probably connected to the internet. The online learning environments of teaching methods are also an important component. There are also many tools that can be used in the lesson: from simple quizzes and online tests to Google Classroom and instructional videos. Officially, you only speak of blended learning when [30 to 79 percent](#) of a lesson is online oriented.

### **Better educational outcomes**

[Research](#) shows that the effect of blended learning on educational performance – regardless of the subject – is small to medium. Blended learning also promotes the motivation of students. In addition, moving images are attractive and stimulate a more active processing of the teaching material.

Digital teaching material also offers the possibility to only allow students to move on to the next part if they have mastered the subject matter sufficiently. If applied properly, it therefore makes a positive contribution to the learning outcomes.

Events in which a strong emotion is evoked are things that are therefore stored in the long-term memory. Interactions that evoke a strong emotion thus ensure a great learning capacity of the student.



### Clear vision

How do you ensure the right mix between online and offline learning? There is no clear guideline (yet). Which form a school chooses depends on several factors.

In [this OVM article](#) you can read more about the various factors with which you can achieve an ideal mix. Whatever choice you make, always work from a vision. Only when you have the intended effect for students clear, blended teaching makes a positive contribution to your lessons.

### An ideal mix

Variety is the magic word to come to an ideal mix. The use of different forms of learning in which the (preferred) learning styles of pupils must be considered.

Connecting with what students already do or find interesting in their free time is a frequently heard advice and makes learning more attractive. For example, the following ideal *blend* of learning forms is proposed:

- **Gamification:** when you use games as a learning intervention, you use their binding power. Read [here](#) how you can start with that.
- **Online instruction:** Enter online instructional videos as homework. You can see how to apply this form of teaching ([tipping the classroom](#)) [here](#).
- **Social learning:** Include in the design of the lesson how students communicate with each other. Offer facilities where students can learn from each other, for example through a WhatsApp group.

### Online tools

Online tools include all learning resources and educational tools that are connected to the Internet. In education, online is quite a broad concept. Think of the online learning environments for teaching methods, smartboards and tools that you can use as a teacher during the lesson: from quizzes and online tests to Google Classroom and instructional videos.

1. [Create an online quiz](#) with which you can, for example, gauge the prior knowledge of students in a playful way at the start of a chapter.
2. Use [smartphones during class](#) as voting boxes, the result appears in graph form on the IWB. [Kahoot!](#) and [Socrative](#) are similar tools.
3. Movies are enlightening and interesting. On sources such as YouTube, [Schooltv](#) and [Teleblik you will find a lot of film material that you can use for](#) instructional purposes.
4. Online tests: Easy to check and reuse, digital [testing](#) offers many possibilities.

**Gaps and improvements, regarding STEM education, investigated based on the study are being presented below:**

1. Specific STEM software
2. Trainings for working with STEM
3. Increasing the engagement, skills, and achievements of students
4. Promoting a positive image of science education and STEM based on facts
5. Sufficient and advanced reality/virtuality tools
6. Digital learning materials for students and teachers



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## 5. Conclusion and recommendations

**'Tell me and i forget,  
Teach me and I may remember  
Involve me and I learn'**

### **Online learning, opportunity or threat?**

Young learners are naturally used to dealing with digital environments that are challenging and sometimes competitive, communicating through a digital learning environment is not unknown to them.

Nevertheless, the lesson among young people is that switching completely to digital education is a bridge too far. A mix of online and offline tools is the most desirable form because students are more involved in learning. And getting students to experience and engage is an effective learning style.

The form and degree of offline and online tools will show that generations will grow into new forms. This change is characterized by the traveler model in the change. The goal is more online learning and how we get there cannot yet be predicted, we will grow there and gain insights through experiences that sharpen the form.

Accelerated learning with learning systems such as 'accelerated learning' have already done wonders for students in higher professional education and universities. It has many similarities with context-rich learning because the experiences from practice are central to it, something that gives young people in general more meaning.

Accelerated learning, developed by Bulgarian scientist Lozanov, not only offers techniques and tips to learn "brain-friendly", it also makes you enjoy learning again.

Younger people ask a lot of evidence and ask a lot why, the current generation is also called the why generation. When the online tools give many answers to their questions, an intrinsic motivation quickly arises to want to learn without experiencing it as learning.



There is a weak spot to be discovered in the growth towards more online tooling, that is the teachers. Teachers are less focused on online tools and lack the knowledge, insights and experiences to make it easier to master than young people.

Older people are less able to come up with what young people need, so the advice is to involve young graduates in the development of lesson packages, to continue to test lesson packages with the young student to see which environment gives them the most learning efficiency.

Learning together is a solution for young people, developing together and learning how online learning will take the best form is therefore the advice for teachers. Do it together and learn from each other what works and what doesn't. In addition, it is wise to share experiences broadly among teachers and to ask students what does not work and what wishes they have for digital learning.

### **Overall suggestions?**

Based on studies by the project partners, the following recommendations have been formulated as a condition for successful implementation of STE(A)M education.

- **STEM attractiveness.** In order to ensure that more and more students have to deal with STEM concepts in an educational context, it is essential that this is done in an 'attractive' way. By making STEM fun, challenging, stunning, and relevant to students' pre-existing interests, their participation will undoubtedly increase. This can be achieved through gamification practices, innovative didactic practices (flipped classroom, project-based etc.) and so on.
- **Practical and applicable in real life.** In order to ensure that students engage with STEM in a meaningful way throughout their studies, but also throughout their lives, and to use it as a useful tool, it is important to actually present it as such. By linking the STEM concept to daily activities while emphasizing their practical applications, the student will play a more active role in the learning journey. This can be achieved through gamification practices, innovative didactic practices (flipped classroom, project-based etc.), collaboration with industry, resources for self-learning, and so on.
- A need for collaboration between software companies and schools, more quality educational software is needed
- Increase hours to be devoted to digital skills and more teacher training - Often "digital skills" are confused with what is really just computer literacy; a more solid basic training should be offered before moving on to the use of the many tools available. These basic skills would also represent the starting point for working with their students.
- Training that includes a comparison of best practices and achievements at European level
- It would be nice to also integrate some "modules" for robotics education (in-person and distance)



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