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Erasmus+

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For teachers:
Some tips and tricks

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The structure of the module plan

- 1 module per topic
- A module can include up to 5 lessons
- Each lesson has the same structure

A lesson structure: approx 90 minutes

Warming up
5 min

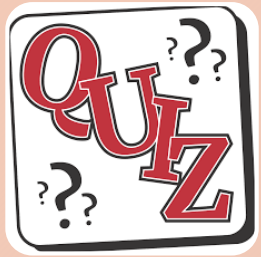
Introduction
10 min

Robotics activity 1
20 min

Midactivity check
10-15 min

Robotics activity 2
20 min

Discussion
10 min



Quiz
5-10 min

1. Warming up

Interesting activity

Connects prior knowledge with a new topic

Catches the attention of students

- The interesting activity should be connected with the topic we intend to teach during the particular lesson
- Students can follow the topic if they have some previous knowledge connected with the topic you are talking about and it means that there shouldn’t be much new information
- There should be only one interesting fact/object as the development of the attention span of primary school students should be supported gradually

Tips

1. Warming

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2. Introduction

Learning objectives to be reached

Basic terms

Basic information about new topic

Rules for classroom behaviour

The basic information about the topic should be very short and clear. If there are new terms, which students do not know yet, then teacher should explain the meaning of the term and explain in detail what is the role of this term and why it is important, but we should be aware about student's cognitive load capacity. If there is no previous knowledge about the topic, teachers have to remember that students need to process this information and it takes particular amount of cognitive load. To support the development of new knowledge students, need to develop schema in their brain. It can be supported with visual or audial information. The additional information shouldn’t cause more cognitive load. For example, much additional text, a lot of tiny details, a lot of changing pictures etc. can cause extra cognitive load which prevents student's ability to process new information and develop new knowledge

The teacher explains the objectives of the lesson and explains how it is connected with the knowledge students already have. It should be explained where students can use such knowledge to let them understand why they have to learn something new

The teacher has to explain classroom rules. How to work with robotics sets, how to work in groups, how to ask questions. Sometimes teachers assume that students must know that, but at the beginning of new lessons (for example, robotics), students are not aware about tiny details, that at the end of lesson they have to put them back in boxes, that the details can’t be taken home etc. Later on, when it is a routine then students will know the rules. But there can’t be too many rules at one moment because it can cause cognitive load

Tips

2. Introduction

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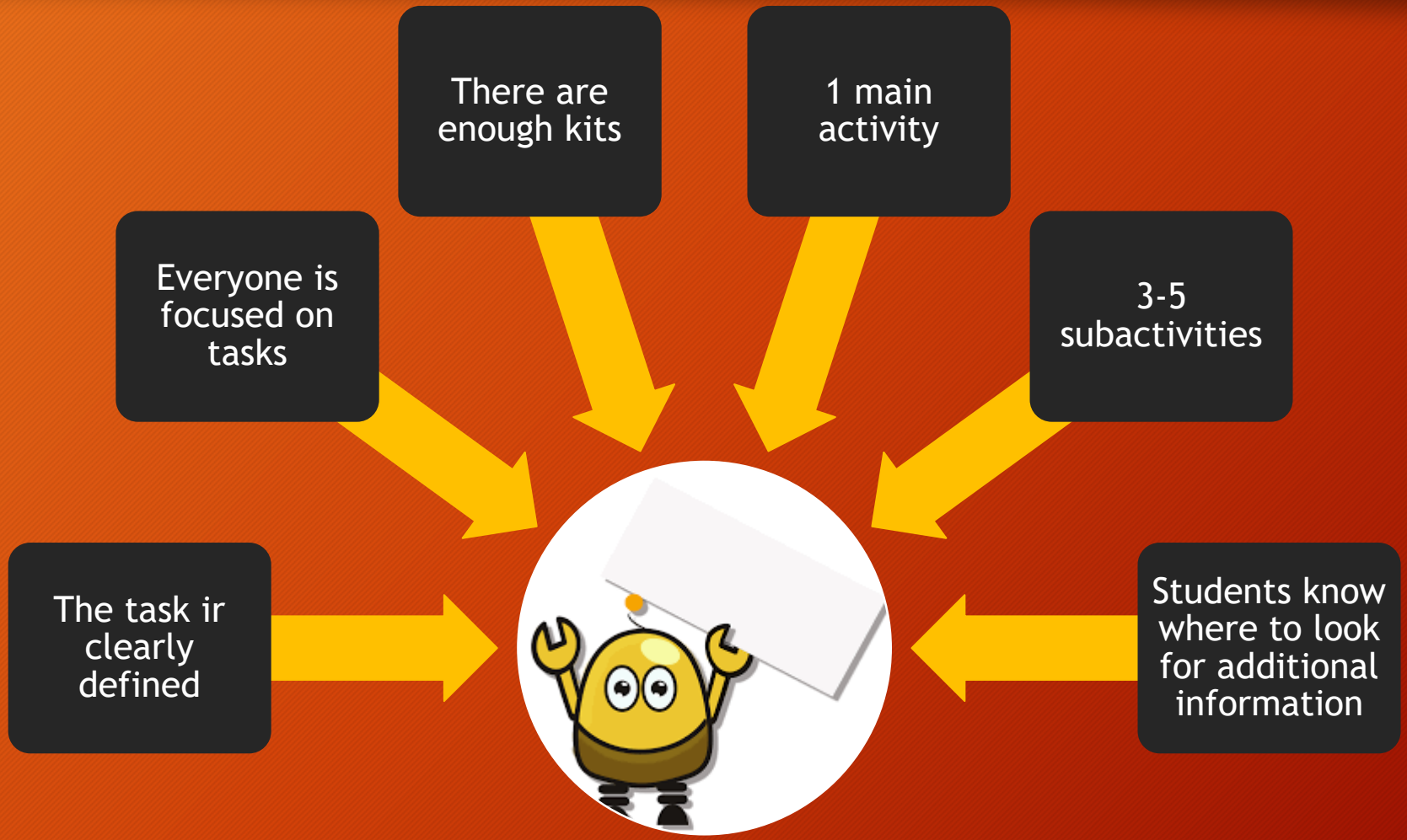
3. Robotics activity (part 1)



- The teacher makes sure that the attention of students is gained. In most cases students are interested in robotics but some students may be scared of new information. It is the task of the teacher to ensure that all students are focused
- The teacher makes sure that everyone is focused on the task and if not, teacher gives extra explanation about new information to let students integrate the new knowledge in the schema of the previous knowledge. Such explanation will ensure that the cognitive load of students is balanced. Otherwise, students will not be able to follow the topic because of extra cognitive load and it can lead to avoidance motivation
- The teacher makes sure that there are enough kits to organize the work. If there are amount of kits which is lower than the number of students present in the class then teacher divides students in the groups. The division in can be done by random principle but it is advisable that teacher organizes some activity to to divide students – for example students makes the line according to the date of birth and then teacher divides them in the groups or there are pictures cut in the pieces (for example 5 pictures are cut), each student gets one random piece and they have to find other pieces of the pictures. Once they have found their picture, the group is formed. It is necessary to ensure that students are not grouping by themselves to avoid the situation when some students are left aside because they are not popular among the classmates
- When students have to work in groups on the activity, the teacher has to make sure that everyone is involved because sometimes there are active leaders who wish to do everything by themselves not letting others to do anything. It can be solved in a way where teacher divides the roles in the group and the roles has to be changed from time to time

Tips

3. Robotics activity

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4. Mid-activity check

Teacher checks the status of tasks

Teacher gives supporting information if needed

Discussions with students about mistakes

After 15-20 minutes of work teacher has to check the situation with the progress of task and has to be sure that everyone is involved. Sometimes it could happen that students are stuck in the task, and they do not know the way how to solve the situation. Teacher should give some hints where the additional information can be found

Sometimes the roles in the group are divided in a way when one or two students are involved in programming, but others should do some creative activities, for example build the parking space, or develop the design for the robotics solution. Although these are activities which are important for the development of the robot, those students will not gain particular knowledge about programming, about sensors, actuators etc. Teacher should ensure that roles are changed from time to time

It is suggested that the mistakes are discussed openly to let students learn not only from their mistakes but also from the mistakes of other students. When evaluating the students' work the way how they search for information to solve the mistake can be one of the most important criterions to evaluate their motivation

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4. **Mid-activity check**

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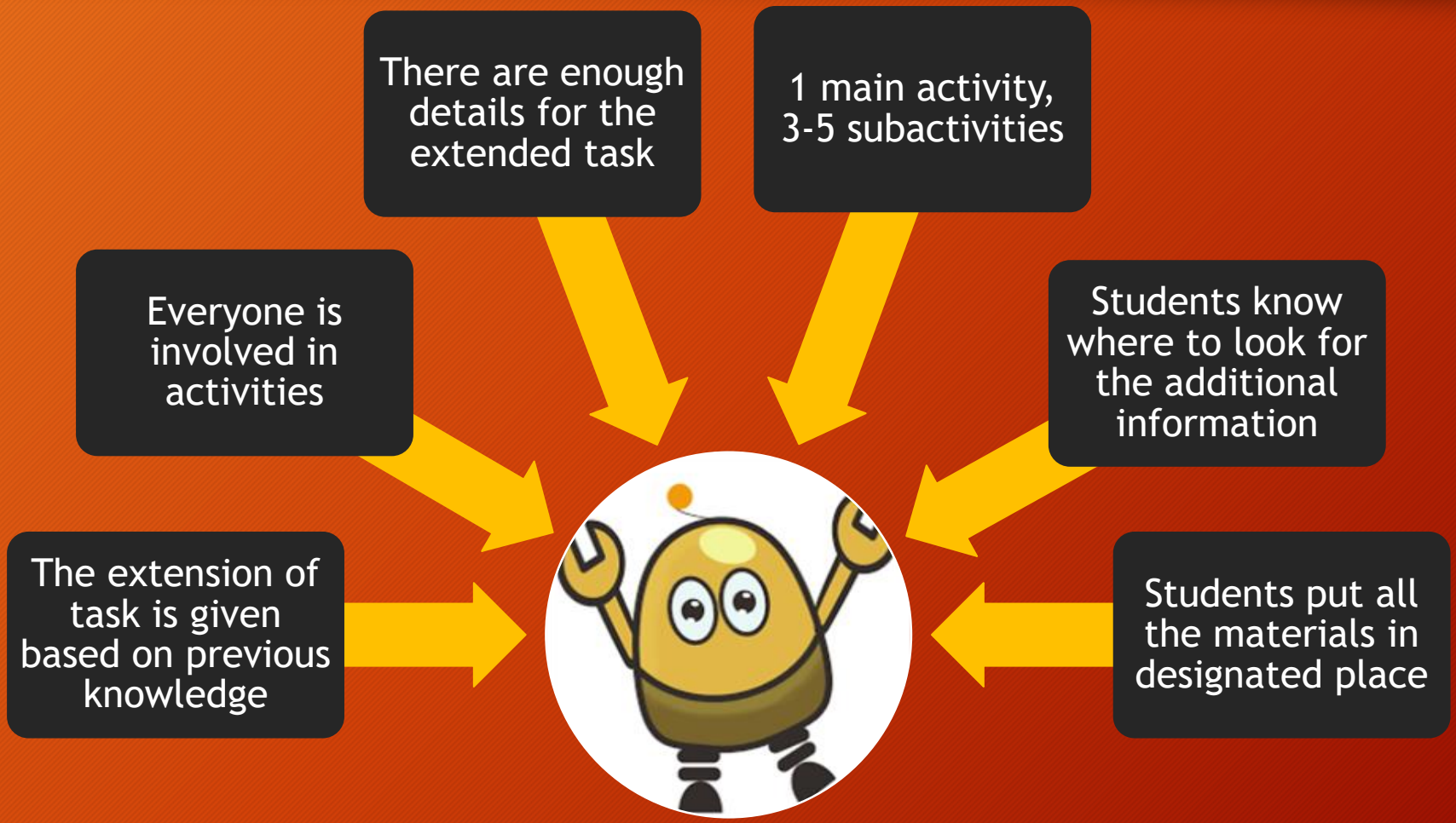
5. Robotics activity (part 2)



After the mid-evaluation of the progress, there can be given extra assignments to let students extend their knowledge or to ensure that the knowledge gained in the previous steps of the activity is used in the different context.
If there are extra assignments given and extra details are needed teacher ensures that there are enough details available. If there is not enough the same kind of details available, then there can be assigned different tasks for each group

The teacher has to be aware about the situation where students do not understand particular concepts and if this information is too much for them, they lose the interest and can develop avoidance motivation or vice versa students have learnt something very well and if no new challenges are given for their cognitive load, then they can get bored. It is up to the teacher to carefully monitor the processes and if necessary additional help is provided or new challenging tasks are given

The teacher must follow that at the end of the activity students put all the details in designated places, robotics block, tablets are connected to charger. These rules should be explained at the beginning of the activity and reminded at the end of the activity and teacher keeps an eye on the process

Tips

5. Robotics activity

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6. Discussion

About the new knowledge learned

About the mistakes and solutions found

About the difficulties faced

- At the beginning of robotics activities the teacher should explain the culture of discussions. Later on when it is a routine procedure it shouldn’t be reminded unless there are some problems occuring
- The discussion should be led by the teacher by asking particular questions. Teacher should ensure that each student/each group has the possibility to tell others what happened, what kind of mistakes or problems they faced and how these problems were solved
- Sometimes it could happen that there are very talkative children who would like to talk every time they have such a possibility. In such a cases the teacher allows them to talk but follows the strict timeline to keep them focused.
  In cases there are introverted students, the teacher shouldn’t insist that they speak in the front of the class. Such students can be encouraged but they can’t be forced. Introvert students can learn everything very well but they are getting stressed if they have to present something. Sometimes it can be fake signals – like they can be seen as lazy, not interested, or even shameless because they will reject the teacher’s invitation to speak

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6. Discussion

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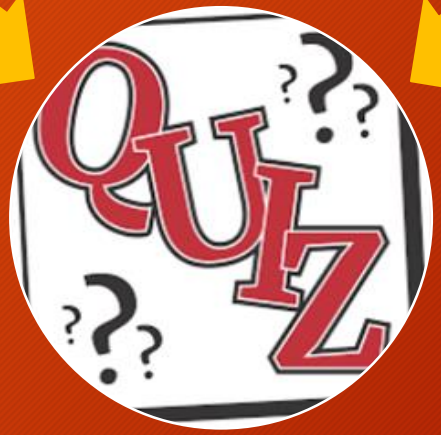
7. Quiz

Some simple questions (1-2)

Some questions about the new knowledge learned

1-2 open questions (not mandatory)



It is advisable that after each activity students have a short quiz which consists of 5-8 questions.
1-2 questions should be very simple to give the opportunity for all students to answer them correctly. It is needed to let them keep motivated because sometimes new knowledge is not very well acquired yet and if there are only questions about the new knowledge students can feel distracted, they can feel stressed and they can feel that haven't learnt anything. Those simple questions will help to avoid such situations

There should be 2-4 questions about the new information students learnt during the activity. It will help them recall the information recently learned and used from their memory and it supports that this knowledge will be stored in a long term memory. Such questions are also serving as the motivator because not all the students have well developed intrinsic motivation.
At the starting period of new activities there should be smaller amount of questions about the new information but later the amount of questions can be increased but it is advisable not ask more than 8 questions here

There can be 1-2 opened questions where students can freely express their feelings, their thoughts about the activity. Sometimes these spaces will be left blank, but such an option can help students who are too shy, or introverts express their opinion

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7. Quiz

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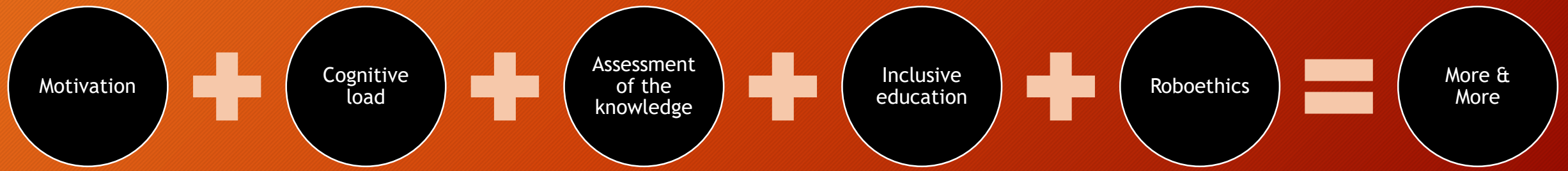
What else we have to think about?

What else we have to think about



Motivation

There can be several aims of the motivation:

1) To improve skills and knowledge – students are interested in the topic and wish to improve their knowledge

2) To use the acquired skills and knowledge – if they are interested and understand the topic, they wish to use the knowledge gained

3) The avoidance, which is explained as a desire to avoid the use of the knowledge and skills, so that individual does not look more incompetent than others – such kind of motivation develops if students do not understand the topic because of the lack of previous knowledge, because of sense of failure, because of attitude of others

There can be several ways how to support the motivation:

1) Experience of success – teachers have to provide the opportunity to experience the success. That is why sometimes very easy questions are needed

2) Possibility to observe those who are good performers – it can help, but if the student has developed the avoidance motivation, the success of others can develop even stronger avoidance motivation. In such a cases teacher should never use others as an example

3) People who are emotionally/socially close convince that child is able to reach the aim – in the learning setting teacher should develop trustful relationship with students to convince students to learn

4) Emotional and physiological aspects (people are afraid that they will not be successful are in stress and it influences ability to learn) – previous learning experience should be taken in mind

Cognitive load

- Intrinsic cognitive load

is the inherent level of difficulty associated with a specific instructional topic. It means that students must be somehow familiar with the topic or new information. Teacher must provide the new information in line with the explanation how it fits in the schema of previous knowledge. For example when we start talking about sensors, we can explain that human body also have several sensors

•Extraneous cognitive load

is a term for this unnecessary (artificially induced) cognitive load. It means that teachers should avoid giving students much unnecessary information or when showing presentations, add there many pictures which attracts student's attention. There should be only most important information included

- Germane cognitive load

it is information which helps to build the new schema of knowledge and it is suggested to avoid unnecessary information which causes extraneous cognitive load and prevents learning something new

Assessment

- Assessment of the knowledge growth – it can be measured with quantitative indicators, for example: improvement of knowledge, widening of understanding, deeper understanding of some concepts, more facts and concepts learnt, new ideas developed etc.

- Knowledge acquisition – here we can assess the way how and where students are searching for extra information, for new knowledge. It can be evaluated if students are using different sources of information, if they are using respectable sources etc.

- Knowledge accumulation – here we can evaluate how the knowledge is accumulated. There can be two perspectives – 1) the cognitive: how the knowledge is accumulated in students' brains, in their schemas of knowledge? Do they develop new thinking schemas? 2) the technological: do students know how to use different technological solutions to store their newly developed solutions? Do they know how to combine different technological solutions for their particular needs?

- Knowledge access – also here can be two perspectives – 1) the cognitive: how students can use their knowledge in the new contexts, how they can use their cognitive processes to access the knowledge they have stored in their memory? 2) the technological: do students know where they can access the knowledge, in which platforms, in which shared learning spaces, or which technological tools can be used to reach the knowledge?

Inclusive aspects

- Special needs – teachers should be aware about different special needs of students when organizing robotics activities. The list of possible special needs can be quite long, but for example students with vision problems can not be able to see tiny details, or colorblind students will not be able to see color differences between details, there can be students who can't work with tiny details because of hypotonia, or students with autism spectrum disorder can be sensitive to the noise robots can make
- Socio economic status (SES) - There can be hidden aspects, where access to education is formally provided but includes only the possibility to learn. Learning materials, support materials, and the possibility of participating in non formal activities should be financed by the student's family. In countries where the quality of education differs in public and private educational institutions, access to education is provided, but quality of education still is an actor that plays a significant role. If educational robotics is not used in compulsory education, then families with low SES will not have the possibility to provide these innovative learning activities for their children
- Cultural diversity - In this dimension can be included children of nomadic families, first-generation migrant families, Roma children, Muslim girls, and so forth. Religious beliefs about innovation, about the involvement of girls in science, and so on can play an important role.

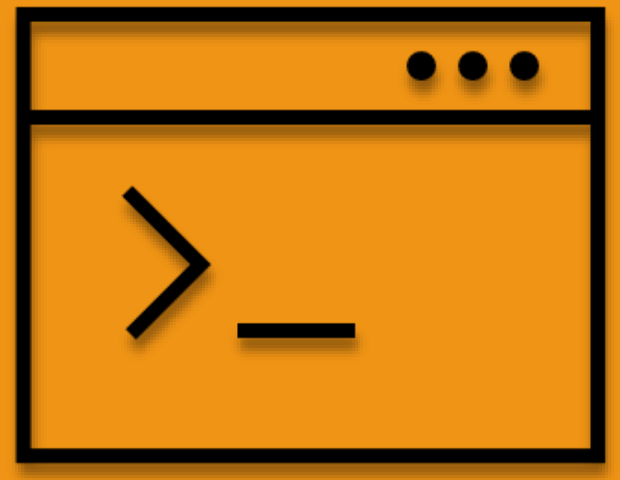
Roboethics

- In 1942, novelist Isaac Asimov formulated, the Three Laws of Robotics:

1. A robot may not injure a human being, or through inaction, allow a human being to come to harm.
2. A robot must obey the orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law Later on Asimov added the Fourth Law (known as Law Zero):
4. No robot may harm humanity or, through inaction, allow humanity to come to harm

- Psychological risks - stress, embarrassment, anxiety, addiction, discomfort, deception, humiliation, being disregarded. For children with special needs there might be additional ethical implications: such as the lack of considerations

- Data protection – the teacher has to talk about data protection as the robots can collect a lot of data and people should be protected from any privacy breaches committed by a robot



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ROBOSCIENTISTS PROJECT

Motivating secondary school students towards STEM careers through robotic artefact making

Erasmus+ KA2 2018-1PL01-KA201-051129

Creators

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Declaration

This report has been prepared in the context of the ROBOSCIENTISTS project. Where other published and unpublished source materials have been used, these have been acknowledged.

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