



– creative video for mathematics



Erasmus+

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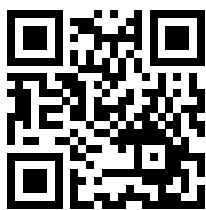
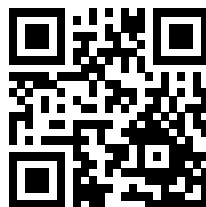


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A warm welcome to this guide about creative video in mathematics education! We appreciate your interest in our project and hope that this publication will help you understand our overall ideas about video education in mathematics – [vidumath](#). This is a European project that contributes to mathematics learning through innovative media methods, especially producing creative videos with the children. You as a teacher are the primary avenue to reach children. You will be equipped with content and methods that are attractive in form and didactics for yourself and your pupils. We hope that good pedagogical frameworks, best practice examples and realistic, tried-out classroom tasks will interest you and will inspire you to take video production on board yourself, within your mathematics teaching practice.

This guide supplements what we have already published online on our [vidumath](#) website <http://vidumath.eu>. We will give an insight into what video in mathematics education means for us, how it is not about a technical approach and how it combines with our ideas of a creative and innovative mathematics classroom where children explore, discover and discuss their mathematical ideas to develop a deeper understanding, and to experience mathematics as an exciting and joyful activity.



As a European project we love to share your students work with other schools and students across Europe. The project has created a “wikispaces” that is very simple to use at <http://vidumath.wikispaces.com/>. We would be happy if you register on this site and send an email (through the “contact us”-form on the website) with your details and the name of your school or class. We will then make a page for your group and send you a link so you can edit the page. You will need to register on the wiki and you will be given editing rights, after we have checked you are a bone fide teacher.

We have tried to keep the online links in this guide to a minimum, but please go online if you want more concrete examples, if you want to watch the videos mentioned or if you want to access further tutorials. You will also find information about current and future courses (online and face-to-face) in the field of video in mathematics education.

Please contact us with your ideas, comments and contributions.

Many greetings from the [vidumath](#) team!

## Goals of the vidumath project

Mathematics education has received a lot of attention across Europe in recent years. Researchers and teachers look into new teaching methods that challenge, especially, the lack of motivation for learning.

**vidumath** is contributing to this discussion with innovative teaching methods that are taken from the ideas within the rich technology ecosystem that surrounds video production. Today video is a very common form of communication that most young people enjoy. Video is a very motivating tool and adds many different facets compared to a conventional textbook. The moving image can help to illustrate more complex structures and can more easily connect with the real world.

The core idea of **vidumath** is that children themselves become the active part of the video production process. In this process, using systematic but creative thinking, mathematical content will be re-worked and visualised. Mathematics is a science that is defined by rules, patterns, abstractions, and proofs that can be applied in a large number of settings including ones that are practical, philosophical or playful. In this approach:

- ☞ Children will playfully discover learning for mathematics
- ☞ Children will document this process themselves on video
- ☞ Other children will be engaged as learners and viewers of the videos
- ☞ Children will be given ample opportunities for self-reflection from this, 'learning-by-teaching' approach
- ☞ Teachers will support the children appropriately; in particular provide ideas and examples
- ☞ The ideas will be developed further with other EU teachers

Teachers will be the interface to reach the learners and the project will take great care to address and include them appropriately.

## Benefits of applying vidumath in the classroom

**vidumath** fosters problem-based and independent learning. The use of multimedia encourages student intuition and helps them to reconstruct the problem themselves. The project develops video-based teaching methods. If video

is used in a collaborative and reflective way it is a powerful tool to support both media and mathematics competences.

There is a need to work across Europe and [vidumath](#) puts its major emphasis on visual communication which is ideal for exchange across Europe with the possibility of subtitles in a multitude of languages. To protect children's privacy, videos concentrate on not showing the children themselves. The project motivates schools to form tandems: two schools cooperating in classes and exchanging and discussing outcomes and ideas.

[vidumath](#) promotes content produced by the learners themselves. Videos created by learners are less common and are often of poor quality – not just in terms of video production but also concerning mathematical content. [vidumath](#) provides creative concepts based on problem solving embedded in pedagogical frameworks in which teachers can facilitate learners to develop their own media. The proposed ideas of video pedagogy are learner-centred and include a broad range of ideas of how mathematics can be visualised. Playful concepts support children to engage naturally with math, helping them to understand core concepts before they arrive in secondary school.



## Getting into vidumath

Although classroom time and resources are limited, **vidumath** will help you to reach your educational objectives because difficult mathematical concepts will be more easily absorbed by the children. **vidumath** provides task sheets, video examples and video tutorials to give a clear picture of how you can use the project inside and outside the classroom.

It is important to start with very simple exercises, especially when there is little experience with video education. This can include simple photos or video clips connected with mathematics content. Basic exercises can be implemented in one class lesson, or they can be a first homework, especially for older students who can easily work themselves.

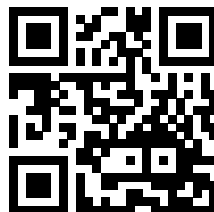
The key idea is to use video as a help to support mathematics learning – the quality of the video is not important, they don't need to produce professionally-looking videos, as it is the process that matters. Available technology which records video such as smart phones or tablets, camcorders or digital cameras with a video function can be used. There is no need to buy technology especially for the project.

## Assessment, privacy and copyright

**vidumath** is based on the teamwork of the students. Media work is teamwork and collaborating leads to important discussions about the approach to the math content and also to a reflection on the images created.

The assessment of video mathematics projects will need to look into these project processes. It is not enough to just grade a final video outcome. Students are asked to present a plan / sketch / storyboard of what they plan to do before they start recording. As a conclusion of the project, they have to report about the challenges they have faced.

Before any video projects start, teachers have to get a written permission that children are allowed to be seen and / or heard, in a video. If this is an issue, there are ways around by concentrating on just showing the hands or only objects and not including any sound. Many examples of such an approach can be seen with the **vidumath** pilot videos – <http://vidumath.eu/video-home/>









And finally: Copyright needs to be observed. Commercial images, video clips or music which is copied or downloaded cannot be included in the student's work.

## Experiences from the pilot study

### Experiences from Sofia / Bulgaria

About 150 children from a school in Sofia took part in the pilot study in Bulgaria. The children came from first year (seven-year-old), second year (eight-year-old), and fourth year (ten-year-old). Each age class was divided into smaller groups with a mentor in charge, who acquainted them with the concept of the project and how to make stop-motion videos. Firstly, the teachers showed videos on the topics of symmetry, geometric shapes and equations. Then the teachers demonstrated how to make stop-motion, how to import the photos into Windows Movie Maker, and how effects and music were added. Each of the groups made a pilot video in the classroom. This was so motivating for the children that they all went further and created their own videos in their free time, as well.

The children took pleasure in doing the activities, enjoyed discussing ideas and working in groups autonomously while accomplishing the given tasks. Their active engagement in creating short video films on the basis of their knowledge of mathematics leads to understanding of its relationship to everyday life.

-  *Maths is entertaining and easy // child*
-  *Maths is creative // teacher*
-  *I am proud to know that the videos created by us will be watched and used by our peers throughout the world // child*
-  *Maths, presented by means of video films, is a challenge and a new way of dealing with the subject // teacher*
-  *I am not scared of Maths. I enjoy sharing my idea // child*
-  *vidumath enables us to deviate from the conventional way of teaching. It is a new idea of project-based education // teacher*

About 100 children from two schools in Trondheim took part in the pilot study in Norway. The children came from fifth year (ten-year-old), sixth year (eleven-year-old), and seventh year (twelve-year-old). The children were divided in groups, two or three in each group. Almost all children could choose their group autonomously, but the teacher assigned a few to make sure that the members of each group had the same level of mathematics competence and enthusiasm for the work. Some low achieving students who needed more support worked together and received additional guidance.

The session started in the morning with a short introduction about the project, the mathematical topic and how to make stop-motion videos. The topics chosen by the teachers were equivalent fractions, commutativity of multiplication and the equal sign. The children planned their videos for about 45 minutes. The production of the video took 60 to 120 minutes. After a long lunchbreak, the children had 30 minutes to find music, create a title and the credits and complete the video. The final 30 minutes were used for a talk about experiences and the learning process. The children enjoyed the activity, were engaged and highly motivated to complete. They required minimal support from the teacher and worked autonomously in groups.

One of the teachers said about the project: "All groups gained a deeper understanding of equivalent fractions. The groups talked about the topic of equivalent fractions so they could animate them. Two or three pupils didn't know what equivalent fractions are when they started. The experience resulted in understanding."

"Since we know that fractions is one of the most challenging topics in mathematics for children of age nine to twelve years, we need to spend a lot of time on this topic. To highlight the topic from different perspectives helps the pupils to develop the concepts. I experienced that the use of animation provides good opportunities for learning and in-depth treatment of the topic fractions. I will use this approach again in my mathematics teaching."

"I guess, this approach could be successfully used in special needs education, too. To be challenged to explain to others provides excellent opportunities for learning. I think this would be a good way to conduct tests and exams: For the pupils to produce a stop-motion video shows me that they have different, specific skills in a (mathematical) topic."








Two schools took part in two workshops. The first **vidumath** workshop was completed with a grade four primary school class (twenty-five mainly nine year old children). As their command of English was not high, all the communications were translated from English to Portuguese. Children worked in teams of about four at their own group table.

Each group worked on a one shot video on the theme of probability. Working with coloured plasticine balls they had to figure out what was the colour of the balls hidden in a bag. You can read more details about this task on page 16.

All the teams went through four phases: (1) Preparation phase: The children discussed how to visualise the maths task, prepared props and backgrounds and decided how they would document the results. (2) Recording phase: They recorded one video clip that filmed how they solved the mathematical problem. The video was 3 and 5 minutes long. (3) Post-production phase: In a video editing software, the students speeded up the video clip to make it more watchable, and they added titles and music. (4) Presentation phase: Each group presented their video and gave a short summary about the process they followed.

Children were only allowed to start Phase 2 Recording, after their ideas were checked by a teacher. The children were enthusiastic about the workshop, interested in working with the **vidumath** team. They put a lot of effort into their projects.

The second **vidumath** workshop took place at a vocational school of cookery with twelve teenage students who wanted more support with applied math-

-  *I learned to be confident to develop incredible activities  
// child*
-  *We should say thank you but instead we say that we want more // teacher*
-  *I felt very proud when I saw the video // child*
-  *What an interesting activity to promote students motivation and involvement for learning maths // teacher*
-  *I learned that it is important to collaborate in the group to develop an activity. I also learned that it is also important to be patient and persistent to achieve a good result // child*

ematics. After a longer discussion it was decided that the students would produce a short video presentation for younger children on proportionality and fractions in the area of changing the ingredients of a recipe. You can read more about this task on page [23](#).

Students worked on the script and storyboards and prepared for filming in front of the camera. They recorded about 10 different shots which were edited into a rough draft at the end of the 3 hour session. Students needed a longer time to find a good and visual way to introduce fractions. The workshop was also a lot more demanding in terms of production but the students clearly understood and followed what was needed.

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### Experiences from Bielefeld and Leipzig/Germany

Just over fifty teachers and student teachers attended two vidumath workshops at Bielefeld University of Applied Sciences and at Leipzig University. The vidumath team presented the core ideas of the project and then worked with the participants on practical exercises on how to implement the vidumath methodology in their classrooms, including how to create and run the project. During these parts of the workshop and in the concluding section afterwards, there was ample time for the participants to comment on how the vidumath ideas could be used with their own students.

The participants appreciated the novel ideas of vidumath, the methodology of the approach and the combination of video production with mathematical content. They commented that, there needs to be a good balance between the introduction and implementation, that the technical requirements need to be shown clearly, and time awareness is important.



We analysed the children's motivation and perception of learning while participating in a **vidumath** activity about equivalent fractions in Norway. A short questionnaire with open questions about implementation of the activity and perception of effort was used as well as the *Task Evaluation Questionnaire*, a version of the *Intrinsic Motivation Inventory* (IMI).

Some children answered that there was no difficult part. Others considered the filming difficult, or wrote that to arrange the movement of the pieces was the major obstacle. To get an idea and film was a big challenge for a few.

The **vidumath** activity was perceived as very interesting. The children also considered that they were able to develop the activity well and that they had some autonomy to develop it, but they scored their perceived choice at a medium level. They have shown a lower level of tension and pressure while developing the activity. Children also answered that they put in a high level of effort to develop the activity.

The item "This activity is useful for learning equivalent fractions" was scored very highly. The answers to the open questions "What did you learn from this activity?" were analysed through content analysis. Learning about mathematics was the most frequent subcategory: Children answered more frequently that they learned about equivalent fractions and learned math in a fun way while developing the activity.

We found a strong correlation between children's interest while developing the **vidumath** activity and their perception of learning equivalent fractions.

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## Summary

Our experiences with the project make it clear how mathematics teaching can be more creative and motivating. The technical and organisational effort for a video project in the mathematics classroom is manageable and can be performed by any teacher. Financial costs are not an issue, since only existing material is used. Time must be invested – both preparation and teaching time. But even that is kept within reasonable limits and is justified when one is rewarded with motivated students who have gained a deeper understanding of the mathematical content.

12 Naturally, **vidumath** is not a method that can be used in every lesson. But there are many opportunities where it makes sense to combine video production and mathematics:

- ❏ **Introduction:** When a new topic is introduced, the children can create videos to familiarise themselves with the topic or to present their prior knowledge on the subject.
- ❏ **Problem solving:** While working on a topic, the children can solve an open-ended complex mathematical problem that is open to multiple methods, pathways, and representations. The children present their different solutions in the videos.
- ❏ **Consolidation:** When a topic is completed, the children can show in the videos what they have learned. Thus the teacher can check whether all the mathematical concepts have been understood correctly.



## The vidumath matrix

The matrix provides an overview. It has two dimensions.

1. The first dimension is the **video production level**. We provide [entry](#), [intermediate](#) and [advanced](#) video production examples. These levels are not based on mathematics levels. There is a range of production levels from beginners to advanced video producers. The levels also build on each other. The knowledge acquired with the entry task can be applied to the intermediate task, and the knowledge acquired with the intermediate task can be applied to the advanced task.
2. The second dimension is the mathematics **learning opportunity**. We provide examples for introduction, problem solving and consolidation. These are not levels of difficulty but parts of the learning process. As mentioned on page [12](#), [vidumath](#) can be used either when introducing a new topic or when students solve a mathematical problem or to examine or consolidate students understanding.

	Introduction	Problem solving	Consolidation
<b>Entry task</b> One-shot video	page <a href="#">14</a>	page <a href="#">16</a>	page <a href="#">17</a>
<b>Intermediate task</b> Stop-motion	page <a href="#">18</a>	page <a href="#">19</a>	page <a href="#">20</a>
<b>Advanced task</b> Creative explorations	page <a href="#">21</a>	page <a href="#">22</a>	page <a href="#">23</a>



**Screen recording / one-shot video**

- **Production:** Recording video in one-shot – without any video editing.
- **Possible mathematics content:** This can include anything that takes place in a mathematics classroom or even the documentation: It could be short excerpts of a mathematics situation; It will show one short idea / expression; ...

The entry task offers a low barrier to entry so that motivation and confidence is raised to try video education. If you have no experience then it is vital to start with very basic exercises. Entry tasks require very little technology understanding. They can include still and moving images.

A very first introduction could be:

- The production of still images which show where shapes or numerals are featuring in the school or in the immediate neighbourhood – for example numerals on signs or numbered objects.
- Or on a higher level it could include a one-shot video of a mathematical expression with students acting out or pointing at graphics or objects.

Entry tasks don't include video editing. The recorded material is used as it is.

**Introduction**

According to constructivist learning theory it is best for learners to discover facts and relationships by themselves. Students are more likely to remember concepts and knowledge discovered on their own than facts they have only heard or read. [vidumath](#) provides an engaging way for the learner to draw on



*Every time we teach a child something,  
we keep him from inventing it himself.*

*On the other hand, that which we allow him to discover for  
himself will remain with him visible for the rest of his life.*

— Jean Piaget

his or her own past experience and existing knowledge to discover facts and relationships and new truths. To do so, we introduce a new topic by giving a discovery task to the students. Students will then produce videos that show how they interact with the world by exploring and manipulating objects, wrestling with questions and controversies, or performing experiments.

The entry task can be used to introduce a wide range of mathematics topics. It starts in [kindergarten](#) with for example the topic two-dimensional geometric shapes. The children get the task to explore their neighbourhood and take still images which show where shapes are featuring for example on furniture, buildings, and traffic signs. Another topic is numbers. The children take still images which either show numerals, e.g. numerals on signs or numbered objects, or they take pictures of sets with a given amount of elements.

In [primary school](#) the introduction of mathematical operations like addition and subtraction is important. When introducing addition, for example, the students can use the task to find an additive situation and then produce a one-shot video about it. Other topics that suits primary school are quantity of liquids and weight. Students could make a one-shot video that shows how they measure quantity or weight while they prepare a meal.

In [lower secondary school](#) fractions are an important and difficult topic. To introduce the topic, students can use the task to discover how fractions are used in everyday live and produce a one-shot video that shows what they found. Probability is a difficult topic, too. It helps students to discover what it is about when they produce a video of playing a game of chance, such as snakes and ladders and the rolling of dice.





*We only think when we are confronted with problems.*

— John Dewey

Problem solving plays an important role in mathematics, and hence in mathematics education, too. As Principles and Standards (NCTM, 2000, p. 52) state: “Solving problems is not only a goal of learning mathematics but also a major means of doing so.” What is considered a real problem and not only a task depends on the students’ knowledge and skills. For a problem it is essential that the students don’t have any memorised or prescribed methods how to solve it. The famous mathematician George Pólya has outlined four steps for problem solving:

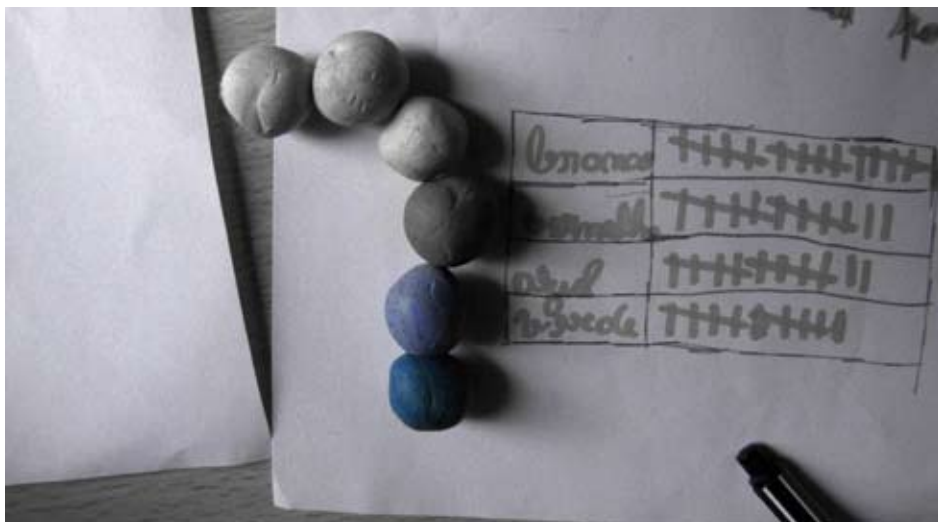
1. Understanding the problem
2. Devising a plan how to solve the problem
3. Carrying out the plan
4. Looking back, evaluating if the problem is really solved, reflecting the process

These steps correspond very well with the steps of a [vidumath](#) project (see the Step-by-Step guide on page [24](#)): Making a storyboard for video production helps the students to plan how to solve the problem. Then they take a one-shot video that shows how they carry out the plan. The final video allows them to look back and reflect on the process.

The one-shot video technique is suitable for all problems that can be solved either in a straight forward way, or by trial and error, and do not require an advanced dynamic visualisation. We tried the following problem with grade 4 children in Coimbra (see page [9](#)):

*You have a bag with six balls inside. The balls have four different colours. Find out what colours and how many balls of each colour are in your bag. It is not allowed to look inside the bag or to take out more than one ball at a time. You can take out one and put it back into the bag as often as you want.*





## Consolidation

Mathematics is a subject where new knowledge, to a large degree, builds on previous knowledge. If a student forgets parts of the concepts, algorithms, procedures or conclusions learned previously, he or she has no way to build on the learning. Insisting that students consolidate their learning provides critical scaffolding to help them internalise knowledge and skills, enabling them to extend, build on, transfer and apply that understanding. Students have to process the material provided thus far and make sense of it. Otherwise, students are left trying to learn the teacher's thinking instead of making the learning their own. Taking the time to have students summarise and synthesise is the key to teaching for transfer.

The entry task is especially appropriate for summarisation. Summarisation is the restating of the main ideas one has learned. It can be done in writing or orally, but as well through drama, art or music – exactly what [vidumath](#) offers. Summarising is a very powerful learning strategy because it requires understanding the material in order to summarise it. The students have to repeat the content to refresh their understanding of the main points. When making the storyboard, students have to distinguish between the fundamental ideas that must be included in the video and which parts can be omitted. And they have to find their own pictures to visualise the mathematical concepts and procedures. That works for almost every mathematical topic.

### Stop-motion (animation)

- **Production:** Stop-motion is a basic type of video animation where still images are put together in a software app or video editing software. Objects are moved slightly and a still image is taken after each motion. The images are put on a video timeline with a short duration between each – and they will start to move automatically. The video is like a cartoon. Stop-motion is a wonderful introduction to the idea of “moving” images.
- **Possible mathematics content:** Stop-motion is especially suited for mathematics content where animation works well: showing symmetry; explaining fractions; explaining shapes; ...

The intermediate task introduces video production. The key difference is that still and moving images and audio are edited. We have chosen stop-motion as the key intermediate example since it is a playful activity but also an activity which can be done nicely without the children appearing in the video or hearing their voices (which is a concern in some schools across Europe).

Stop-motion also helps to understand how all videos and moving images are produced. They are a sequence of still images. A “moving” image does not actually exist; it is created in our brains. When we see roughly twenty-five still images per second, our brains transform them into a moving image.


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### Introduction

When we learn something new, we don’t start as blank slates. Children always have some experience already, ideas and concepts related to the new topic. In order to build new knowledge from prior knowledge the teacher has to find out what the students already know and belief about the new topic. [vidumath](#) provides an engaging way to do this.

As long as a concept is directly related to a real life situation, we are able to capture it in a one-shot video. Unfortunately, most mathematical concepts are abstract. They exist only in our minds and have an indirect relation to the real world. Fortunately, stop-motion is a powerful way to visualise abstract ideas. We tried [vidumath](#) with many different abstract mathematical concepts: the equal sign (equations), symmetry (both mirror and rotational symmetry), the commutative property of addition and multiplication, proportionality, the sum





of angles (in a triangle), equivalent fractions, measurement of area, and there are many more.

 *Science, my lad, is made up of mistakes, but they are mistakes which it is useful to make, because they lead little by little to the truth.*

— Jules Verne

While the students plan and produce their video, the teacher can observe not only how much the children already know about the new topic, but as well what kind of misconceptions they have. A misconception is a conclusion that's wrong because it's based on faulty thinking or facts that are wrong. Misconceptions are normal for someone who yet doesn't know all the facts. To become aware of one's own misconceptions is a necessary step in the learning process. This happens sometimes already while planning or filming the video, but for sure when reflecting on the videos.

Here are some misconceptions and mistakes that we have observed during the try-outs:

-  *The equal sign means: "Act out the left hand side and write the result on the right hand side!" (Typical answers to the equation  $8 + 4 = \square + 5$  are 12 or 17.)*
-  *An equation is something that can only be solved by applying the correct algorithm. It is not related to reality.*
-  *The whole is not divided into equal-sized parts.*
-  *When comparing fractions, children do not convert them to a common denominator.*

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## Problem solving

A problem is defined as a task we don't have any memorised or prescribed methods how to solve. However, there are a lot of general strategies that can be applied when we have to solve a problem. The webpage <https://www.une.edu.au/about-une/academic-schools/bcss/news-and-events/psychology-community-activities/over-fifty-problem-solving-strategies-explained> lists and explains more than fifty problem solving strategies. Powerful strategies both to understand the problem and to explain the solution are

- ☐ Visualise the problem or a relevant process or situation
- ☐ Draw a picture or diagram of the problem or a relevant process or situation
- ☐ Create a model of the problem or a relevant process
- ☐ Imagine being the problem, a key process, or the solution
- ☐ Simulate or act out a key element of the problem
- ☐ Consider a specific example

**vidumath** enables students to do this in a creative way. The following problem can be solved by trial and error, but to really understand the solution, a stop-motion visualisation is very helpful. We tried the following problem with a 13 year old boy.






*You have a pancake. You want to cut it by knife cuts in as many pieces as possible. The pieces don't need to have the same size. What is the maximum number of pieces that a pancake can be cut into by four straight cuts?*

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### Consolidation

When taking the video technique one step further from the entry to the intermediate task, we can do the same with student's technique of consolidating their knowledge: We go from summarising to synthesising. Instead of just restating the important ideas, synthesising involves combining ideas and allowing an evolving understanding of the mathematical concepts. It means to put pieces together to see them in a new way. It is crucial for conceptual understanding that students make connections between apparently separate mathematical ideas. For example, fractions, decimals, percentages, and proportions are sometimes taught as separate topics, but in fact they are only different representations of the same fundamental mathematical idea.

Synthesising requires students to process and interact with the ideas rather than simply copying and pasting information. Students are actively engaged with the material when they categorise, analyse, combine, extract details, reassess the value of the learned concepts and procedures, look for bias, omissions, etc. All of this happens when they plan a video about the content they have learned. Finally, they relate their new understanding to their prior knowledge and experiences and develop new meaning. This higher-order thinking skill is challenging for children and needs explicit scaffolding by the teacher. Tasks that help students to learn synthesising their mathematical ideas are:

-  *Use different representations to solve a mathematical task and show how they are related to each other, e.g. illustrate the solution for  $103 - 28$  using an empty number line, a base-ten model, and a notational representation.*
-  *Show how the new mathematical concept is related to other mathematical concepts, e.g. show how multiplication is related to area, grouping, addition, and counting.*
-  *Show how the new mathematical concept is related to everyday life, e.g. show an example how knowledge about fractions helps you to solve a real life problem. (Students can for example animate dolls. If privacy isn't an issue, it can be done with real persons as a one-shot video, too, and even better with advanced video techniques.)*

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## Intermediate task

### Creative explorations

- **Production:** This is open for different video production ideas but is based on “proper” video production including camera work and video editing
- **Possible mathematics content:** All mathematics content can be included here: documentation of mathematics classes / events; any classroom content; music and drama mathematics displays; ...

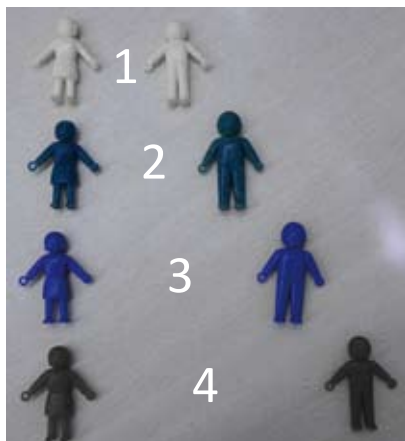
The advanced task is advisable only once entry or intermediate tasks have been completed and the students possess an adequate knowledge of video production. It is totally open to any form of video production and any kind of mathematics tasks.

If the students already know how to produce advanced videos, this can be used to introduce any topic you want. It is very suitable for discovery tasks like finding everyday situations related to the mathematical operation or object you want to introduce. As an example, we produced a video about shapes and numbers in the German city Potsdam: [https://youtu.be/\\_dYrnP6pf-Q](https://youtu.be/_dYrnP6pf-Q)



### Problem solving

Any kind of problem can be chosen here. There are lots of different heuristic strategies how to solve problems and the possibilities to visualise both the solving process and the solutions and even more. We tried the following problem with prospective teachers at the University of Ljubljana, but it would be suitable for primary and secondary school, too:



You have 8 places in a row. 8 persons shall be placed in that row. But the problem is: People with the same colour don't like each other. There has to be

- 1 place between the yellow people,
- 2 places between the green people,
- 3 places between the blue people, and
- 4 places between the red people.



### Consolidation

If students consolidate or show their knowledge about a mathematical concept that is closely related to real life problems, it is better to visualise it with real people acting and not just stop-motion animation. An example of this was produced during our try-outs by students from a hotel and tourism vocational school in Coimbra. The students were asked to show their knowledge about proportionality, as it is needed for preparing meals in a hotel or restaurant. They choose to explain how a chef can scale a recipe that is designed for ten people to a group of twenty two people: <https://youtu.be/GtvRq7Mm-fA>



It takes six steps to conduct a [vidumath](#) project in your classroom: Preparation, introduction, planning, filming, post-production and reflection. Here is an overview and on the pages after a more detailed description of the steps.

<div>Step 1:</div> <div>Preparation by the teacher</div> <div>T</div>	<div>Understand the project: read guides, watch videos</div> <div>Decide on mathematics topic</div> <div>Decide which video technique to use</div> <div>Regard class dynamics when deciding on groups</div> <div>Set project timetable</div>
<div>Step 2:</div> <div>Introduction to the students</div> <div>T▶S</div>	<div>Introduce the project</div> <div>Show some existing videos</div> <div>Introduce the mathematical topic, task or problem</div> <div>Explain the video technique to be used</div> <div>Explain a storyboard, show examples</div> <div>Arrange groups</div>
<div>Step 3:</div> <div>Planning by the students</div> <div>S▶T</div>	<div>Students prepare a mathematics example, work on task or solve problem</div> <div>Students create a Storyboard, teacher acknowledges</div> <div>Students set up and rehearse the video scene (lighting, camera, framing)</div>
<div>Step 4:</div> <div>Filming</div> <div>S◀T</div>	<div>Students take pictures, film their video</div> <div>Teacher scaffolds</div> <div>Students check video and film again, if necessary</div>
<div>Step 5:</div> <div>Post-production</div> <div>S</div>	<div>Students transfer pictures or video for editing, if necessary</div> <div>Students edit</div> <div>Students add audio</div> <div>Students check and upload video</div>
<div>Step 6:</div> <div>Reflection</div> <div>S◀▶S</div>	<div>Students watch the final videos in the classroom</div> <div>Students appreciate each other's videos</div> <div>Students reflect on their experiences and learning</div>



## T

*Understand the project: read guides, watch videos**Decide on mathematics topic**Decide which video technique to use**Regard class dynamics when deciding on groups**Set project timetable*

It is advised that you read this booklet and watch some completed videos, before starting the project. In addition, your evaluation and scaffolding is an integral part of the project, although, we have experienced significant student autonomous and collaborative work in the piloting stages. We recommend a light touch!


It is also important to understand that although the mathematics in the project is pre-eminent, the motivation for the children, is making their own video. The mathematics learning happens because the students have to spend time thinking about the mathematics they want to present and viewing the mathematics from alternative perspectives to those they have in the normal classroom. Most especially, children need first to understand deeply the mathematical concepts in order to make the video correctly.

There are some points teachers should prepare before starting the project:

- ☐ *What mathematics subject do you want to reinforce in the class? There are different possibilities as to when to use video in the learning process (see page 12 and the [vidumath](#) matrix). Experience has shown that the chosen topic should be something that the students find quite difficult.*
- ☐ *Which video filming technique do you want to use? There are three different possibilities: one-shot, stop-motion or creative exploration (see the [vidumath](#) matrix, page 13). The choice should initially depend on your experience but do consider that the students are often ahead of you.*
- ☐ *How do you want to divide the participating class into groups of two to four children? Experience has shown that homogenous groups work best, i.e. students who are together in a group have the same level of mathematics competence and enthusiasm for the work.*

- How much time do you want to use for the project? Experience has shown that planning takes about 45 minutes. More time for the planning may be needed if the students have to solve a mathematical problem. That depends on how difficult the problem is. Only a little planning is needed if the children are given a discovery task. Filming takes between 30 and 120 minutes. A one-shot video is produced very quickly; stop-motion takes more time. Time needed for creative explorations depends on how advanced it is. Post-production takes about 30 minutes. How much time is needed for reflection depends on how many videos there are and how complex the mathematics is.
- You have to ensure that materials are available – both normal, class project, materials and some of the following for the mathematical visualisation: coloured paper, coloured markers and pencils, paper clips, adhesives, scissors, rulers, beads, Dienes' blocks, Math Link Cubes, play dough, interlocking plastic bricks, etc. If it is permitted in your school, it is very motivating for the children to use sweets, e.g. chocolate beans, jelly beans, gummi bears. Some projects may require things from everyday life, such as plates, cups, forks, etc.

## Step 2: Introduction


 20' – 40'	Introduce the project
	Show some existing videos
	Present the mathematical topic, task or problem
	Explain the video technique to be used
	Explain a storyboard, show examples
	Arrange groups

There are some things you have to tell your students before they can start working.

- First, you should introduce the project in general: **vidumath** means **video education in mathematics**, i.e. the students are going to produce videos that are related to mathematics. It is a European project that means children from different countries work on the same project. You will show videos that were made by children in other countries and your students' videos will be shown in other countries. If your school already has a tandem partner school, you can introduce this school. You can also use the Student guide available as a PowerPoint presentation or online as a Flipbook <https://www.flipsnack.com/AEAED958B7A/vidumath-student-guide.html>

- ❏ Show some existing **vidumath** student videos to the class. The examples should show the technique you want the students to use. They shouldn't show the same mathematics topic otherwise they can stifle children's creativity.
- ❏ Present the mathematical topic, task or problem. If you use **vidumath** to introduce a new topic, it is useful to present the topic one or more days before the work on the videos actually starts. Then children can collect some ideas in advance.
- ❏ Explain the video filming technique that the children will use. Experience has shown that this doesn't take much time. Most children of age between 9 and 12 years have already had experience with video filming, some even with stop-motion.
- ❏ It is very important that you explain what a storyboard is. You can find a lot of examples and templates on the internet.
- ❏ Divide the class into groups of two to four children as you have decided beforehand.


### Step 3: Planning


	<p>Students prepare a mathematics example, work on task or solve problem</p> <p>Students create a storyboard, teacher approves</p> <p>Students set up and rehearse the video scene (lighting, camera, framing)</p>
-----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

This step is primarily student work. Let the students work autonomously, offer help only if asked and scaffold only if you see that students are on a wrong track.

We have to distinguish three different cases (see the **vidumath** matrix, page 13):


- ❏ **Introduction:** If the children have been assigned a discovery task, such as finding numbers in the neighbourhood, there will not be a long planning phase in the classroom. They have to go on an expedition. The group discussion will happen on the expedition. **Only in this case, the storyboard can be skipped and the project continues with step 4.**

 **Problem solving:** If the children have to solve a mathematical problem, the group will do this first. Working on a storyboard can help to solve the problem, but normally, students will discuss how to visualise the solution, after they have solved the problem.

 **Consolidation:** If the children visualise a mathematical concept, idea or procedure, the group will collect ideas and very quickly start working on their storyboard.

The group discussion between the students is the key part of the project. This is when most of the mathematics learning occurs. The storyboard plays an important role in this process. It provides a powerful and new way to bring out mathematical thought. If you observe during the process that the students have made a mistake or are on a wrong track, first give them some moments to find it themselves. Sometimes a little hint is enough. Mistakes are an important part of the learning process.

Mistakes are opportunities for learning, as students consider the mistakes and correct them. But they are more than that. Recent neurological research found that when you make a mistake your brain is activated two times. The first time is an increased electrical activity when your brain experiences a conflict between a correct response and a mistake. This brain activity occurs even if you don't know that your response was wrong. The second activity happens when you notice that you made a mistake and think about it.

 *The brain sparks and grows  
when we make a mistake,  
even if we are not aware of it,  
because it is a time of struggle;  
the brain is challenged  
and the challenge results in growth.*

— Jo Boaler

In order to free students to contribute ideas without the fear of being wrong, it is important that you create a mistake friendly environment. That means that you value mistakes, value all of the students' thinking and help them to know that mistakes improve their brains. However, in order to prevent later frustration during filming and reflection, students should discover mistakes while planning the video, not later. Therefore the teachers' evaluation of the storyboard is crucial. ***No group should receive permission to start filming before a teacher has approved the storyboard!*** You have to ensure that the solutions

and concepts are mathematically correct and complete, and the plans are not too ambitious. To judge how ambitious the plans are can be difficult as the students are usually more familiar with video work than adults.

The last part of this step is the practical preparations for filming. A steady camera is often the hardest part, where teachers in the piloting have had to help physically. If camera tripods are not available, you may have to suggest building a platform to hold the camera steady in the same position. In previous piloting, students have used large open books or piles of books, chairs, and tables. Sticky tape can help as well. A steady camera is particularly important if you want to film a stop-motion video.

The children have to setup a film set and prepare props. It could be as simple as a coloured piece of paper acting as a backdrop. Sometimes, students want to build a whole set. You will need to provide limited oversight to ensure that their creative ideas can be completed and built within the time limitations.

One-shot videos often show how students manipulate objects to solve the mathematical problem or visualise the mathematical concept. If privacy is an issue, you have to ensure that the set is arranged in a way that the video will not show children's faces. Showing hands is fine, everywhere.

The students have to find solutions for lighting and framing, too. Too little light is sometimes a problem. Trial and error is the best way to arrive at a good result.



S ◀ T

30' - 120'

*Students take pictures, film their video**Teacher scaffolds**Students check video**and film again, if necessary*

This is the most enjoyable part of the project. The children work autonomously on their videos. The teacher can scaffold if asked by students for help. Experience has shown that unexpected obstacles may occur. Not all students will precisely follow their storyboard, and some good looking storyboards turn out to be difficult to implement.

The purpose of this step isn't only to enhance students' motivation and enjoyment. Students have to transfer their mathematical ideas and concepts from the storyboard to reality. That deepens their understanding of the mathematical relationships. Especially when obstacles occur, the cognitive conflict will lead to deeper insight.

You will find more information about how to make videos in the technical support section (see page 33).

### Step 5: Post-production

S

30'

*Students transfer pictures or video for editing, if necessary**Students edit**Students add audio**Students check and upload video*

Post-production is different for one-shot videos, stop-motion and creative explorations (see the [vidumath](#) matrix, page 13):



A **one-shot video** needs no post-production at all. Even if not needed, it is possible to make some editing for fun, if the students want, are able and you have enough time (see below)

☞ A **stop-motion video** needs to be edited to become a video.

*o If the children are using a stop-motion app on a smartphone or tablet computer, this app can be used for post-production. The app's user guide will tell you how to do it.*

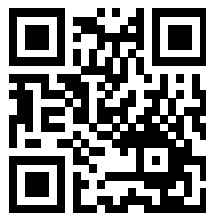
*o If students use a digital camera, the post-production will be done in the video editing software on the computer. First, the children have to transfer the pictures from the camera to a computer. The teacher has to ensure in advance that this will work. On the computer the pictures will be copied into the video editing software. You will find more detailed information in the technical support section (see page 33). Most children will manage this work autonomously with little or no help.*

☞ When doing **creative explorations**, everything is possible. The only limit for post-production is set by the students' video editing skills and the given timeframe.

After the visual part of the core video is finished, the fun part starts. This is not a requirement but students enjoy it. If there is not enough time for this during the mathematics lessons, this could be part of arts or music lessons or done at home. Usually the students want to add an opening title, end credits and audio to the video. By audio we mean music and sound effects. Please ensure that only audio with an open license is used to avoid problems. We recommend providing a limited set of audio files. Searching the internet for suitable music takes much too long.

When the final video is finished, it has to be saved as a video file! We recommend mp4 format. Finally, all video files have to be transferred to the device that is used to show videos in the classroom.

The very last step is to share the videos with the tandem school (if applicable) or with the world by uploading them to the internet, e.g. YouTube. The videos, and something about your class and school, should be uploaded on to the project wiki, <http://vidumath.wikispaces.com/>. If you haven't done yet, you will need to register and let the project know the name of your school so we can add your own page, for you. This can be done after the lesson is finished.





45'

*Students watch the final videos in the classroom*  
*Students appreciate each other's videos*  
*Students reflect on their experiences and learning*

It is a very important stage for the students to have their videos shown to the class. This can be taken further by sending the links of the uploaded videos to the parents, or adding them to the school website. This strengthens the students' self-esteem and contributes to the sustainability and effectiveness of the project.

Each group presents their video. The students act as teachers for the rest of the class. Please ensure that every video will be appreciated and complimented on by the class. The first time a video is shown no negative comments should be allowed. Afterwards, suggestions for improvement can be made, but the following rule should be observed: You have to say at least two positive comments before you can express one criticism.

It is a beneficial part of the mathematics learning process to reflect on the videos. How do my classmates understand the video? Was that what I had intended? Why do they interpret things differently? Reflecting on different perspectives, different visualisations, different ways of solving a problem and different solutions to one and the same problem deepens the understanding and often leads to new insights.



*We do not learn from experience  
 [...] we learn from reflecting on experience.*

*— John Dewey*





This section will provide more technical and filmmaking background information for your [vidumath](#) projects. It is all about getting you started. There are many tutorials on YouTube which cover all the different aspects of video editing with various software but also creative film making if you want to take this further.







Video production has become easier over the years – but at the same time it is easier to get carried away with the technology and its features. Also students have become quite savvy with video production. It is important for you to understand that you, as the teacher, don't need to be the video production expert. Your role is to be in charge of the pedagogical concept of the project.

## Using the technology you have in your reach

We have already mentioned that the production quality is not the key parameter of a [vidumath](#) project. It is a good idea especially for first projects to keep the production simple and use the technology which is immediately available. If students are interested they can develop the quality of their production output with further projects. [vidumath](#) is not about becoming a professional videographer – it is more important to understand and learn how to create and reflect, on the video productions.

**Mobile technologies such as smartphones and tablets** are becoming more and more integrated multi-tools with good cameras, post-production software (including stop-motion apps) and the ability to upload videos straight away. This speeds up the production process. But the traditional approach of a **separate photo or video camera with a computer for post-production** still works well – offering more possibilities but also being more time consuming.

There is a range of cameras which can be used for filming:

-  *Smartphone camera*
-  *Tablet camera*
-  *Web camera of the computer*
-  *Compact photo camera with video function*
-  *Digital SLR with video function (photo camera where you can change the lens)*
-  *Video camera (classic style camera)*

The cameras of **smartphones** and **tablets** are generally of good quality but depend of course on the specific model. All recent models from the mid-price range up are good enough for video projects. Your school might have a policy for the use of smartphones in the classroom; find out if you are allowed to use them. **Web cameras** are built into notebooks or added to a desktop computer. They are normally of a lower image quality and not very flexible within different locations.

Current **photo cameras** offer a good quality, video function. The video quality can normally be adjusted – it is best to go for the highest quality. **Digital SLR cameras** are good for video projects where you would like to have a good image quality like the ideas proposed for creative explorations. Traditional **video cameras** are easy to use, have good video quality and are easy to handle.

All cameras offer the option to record **sound (audio)**. Most of the time the quality is not too good but it is usable for **vidumath** projects. If sound is very important for your project you should either explore a separate microphone which can be connected to some cameras or record sound separately during the recording or in post-production stage.

Last but not least: make sure that the battery or batteries are charged, that the memory card is inserted and that camera straps are used for protection for more expensive cameras.

## Filming creatively

The camera is more than just a technical tool to record whatever is in front of it. It can be used in different ways and through that different messages are produced. Filming is a very creative process of using different camera position, camera framings and camera movements. Encourage your students to explore these and become more aware of the power of the moving image.

Different **camera positions** create different images. It is a common practise to just put a camera in front of your eyes wherever you stand. But what happens when you place your camera on the floor or stand on a table to look down on what you want to record? What happens when you record a drama sequence from different angles – from both sides and also from behind?

The **camera framing** determines how much you choose to show and not show. This might be less of an issue if you work on a stop motion where the framing is tightly fixed at the stage where you work on your animation. Finding good framing is not about showing as much as possible. It is about concentrating on what is most important in each shot. If you think of Hollywood movies then you might be aware of the many close-up shots they use – just a face or hand or an object. Also explore how a foreground or background can support what you want to show.

Camera movements add another creative dimension. This can include pans (going from left to right or vice versa), tilts (going up or down) but also a zoom where you change the lens and your object gets closer or further away. As with the framing – it is tiresome to endlessly zoom in and out. Concentrate on what is most important. Camera movements are there to support your message, not to distract from the message. Also be aware that camera shaking can become hard work for the viewer. Better cameras have an image stabiliser which minimises this. The use of a tripod is generally useful especially for stop-motion productions. If you want to use smartphones or tablets you will need to build something as mentioned before or look for an adaptor which can be put on a tripod.





## Post-production / Editing

Post-production is the second half of the creative process in a video project. It is there where the final message is decided – where images are selected, the order of video clips is changed and also titles and music is added. Post production needs editing software. Free and easy options include *MovieMaker* for Windows and *iMovie* for macOS. *OpenShot* and the forthcoming freeware *VideoLAN Movie Creator* are both free and available for Windows, macOS as

well as Linux. All of these entry solutions are adequate for [vidumath](#) projects. There is a range of free or very cheap apps available to be used with smartphones and tablets.

Every post-production has three steps:

 *Importing*

 *Editing*

 *Exporting*

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## Importing

The importing means that all material is collected and put into the video software. If a camera is used then all photos and videos are copied to the computer. You can either connect the camera through a USB cable or take the memory card out of the camera and insert it into the memory card slot of your computer (or an attached card reader). Then copy all video and photo files and add sound files (music or sound effects) into the same project folder. Once all material is collected use the “import” command and insert all files into the collection of your editing software.

If post production is done on a smartphone or tablet you will only need to find the location of your videos and photos and insert them into the editing app.

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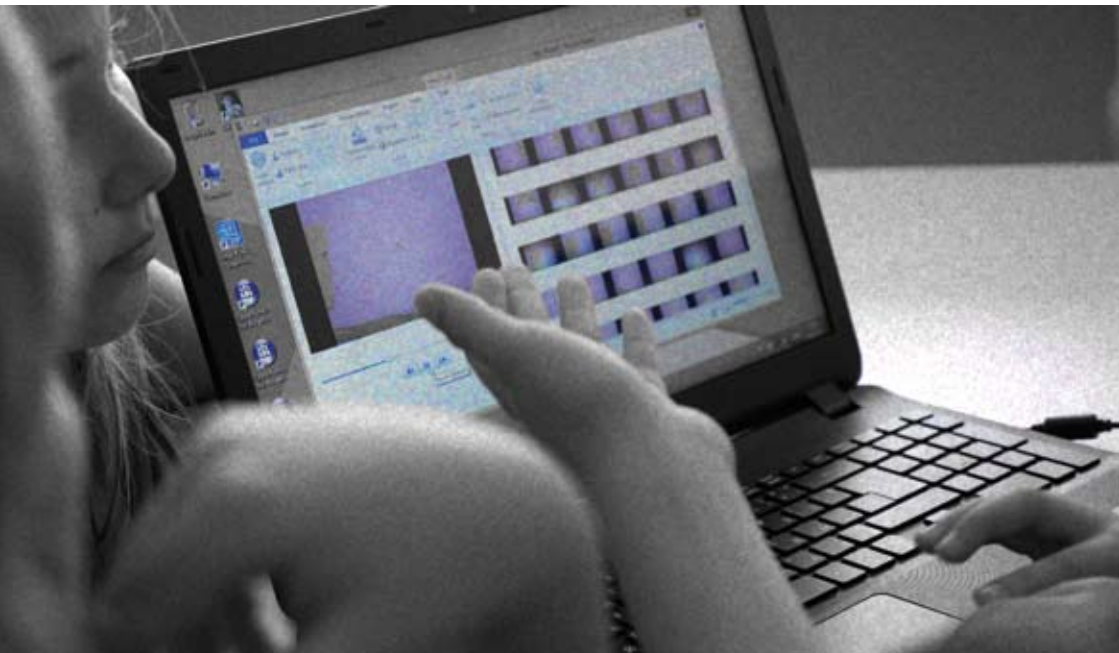
## Editing

Now the actual post production or video editing can start. Go back to your storyboard and lay out the video clips and photos in the same order as they were planned there. Look through your first video draft and decide if there are any changes you would like to make. Also where you would like to “trim” the videos – take seconds at the beginning or end, off because the action was not ready or the content is not really interesting enough.

Once the first edit looks good, titles and music can be added. Titles can be put on as a full screen but they can also be put on top of existing video footage. Subtitles can be added if more content needs to be added or if they are there to support another language. Also credits can be put at the end of the video (be aware of privacy issues such as not including the full names for children). Music is a powerful addition to create interest and change the mood. Again caution is needed with what music is used – commercial and copyright protected music cannot be used. Music with a free license can, for example, be found on <http://freemusicarchive.org>. It is required to include the name of the composer and musician in the video credits.

Once all is done and all students from the team are happy then the video can be exported. This means that a new file is created which then can be shared. This is sometimes confused with saving the project file. The project file is not a video but the internal file for the editing software which records the information of what has been included in the timeline.

All software offers presets which make this process very easy (we normally use mp4 files). Better-quality videos are larger in file size. According to the speed of the computer and the length of the video the exporting can take a few minutes. Only share the video if copyright and privacy have been cleared.



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