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WP2A1 - Research Phase Report / Croatia

FOSTERING STEM EDUCATION FOR YOUTH EDUCATIONAL CARTOONS METHODOLOGIES AND E-LEARNING TECHNOLOGIES



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RESEARCH PHASE 1- DETERMINING UNDERACHIEVED SCHOOL SUBJECTS IN STEM FIELD
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1. What is STEM education and why it is important for children - principles and advantages;

STEM education is an approach to learning that focuses on integrating the disciplines of science, technology, engineering, and mathematics. It emphasizes the application of knowledge and skills from these fields to solve real-world problems, foster critical thinking, and promote innovation.

There are many principles and advantages of STEM education for children including:

Integration of disciplines

STEM education should break down the traditional barriers between subjects and encourages a holistic approach to learning. It recognizes that these disciplines are interconnected in the real world and promotes the integration of knowledge and skills across them.

Hands-on and problem or project based learning

STEM education emphasizes active learning through hands-on experiments, projects, and problem-solving activities. It encourages students to ask questions, explore, investigate, and make their own discoveries, fostering a deeper understanding of concepts and promoting a love for learning.

Real-world relevance

STEM education focuses on connecting classroom learning to real-world applications. By solving practical problems and engaging in authentic projects, children understand how STEM concepts are used in various fields and industries, making their learning more meaningful and relevant. More often than not it is the abstract learning that discourages pupils to further explore that subject.

Future job opportunities

The demand for professionals with STEM skills has been increasing in sectors such as information technology, healthcare, engineering, finance. By exposing children to STEM education at an early age, they develop an interest in these fields, gain foundational skills, and are better prepared to pursue higher education and careers in STEM-related fields.

Overall, STEM education is important for children as it nurtures critical skills, fosters a love for learning, and prepares them for the challenges and opportunities of the future. It empowers them to become active participants in a technology-driven society and equips

them with the tools to solve complex problems and make a positive impact in their communities.

2. Analysis of the national situation;

The Croatian education system incorporates STEM (Science, Technology, Engineering, and Mathematics) subjects to provide students with a foundation in these areas from an early age. Here's an overview of how STEM subjects are included:

Science

Science education is an integral part of the primary curriculum in Croatia. Students learn about various scientific disciplines, including biology, chemistry, physics, and environmental science.

Depending on the school they go to, they may engage in hands-on activities, experiments, and observations to develop scientific inquiry skills and an understanding of basic scientific concepts. However this really varies from school to school and the will of that school to develop and evolve their curriculum to include more practical activities rather than everything being learnt from a book.

Science is taught through the following subjects at primary school, the grade listed is when they start learning this subject.

- 1) Nature and Society (includes topics like biology, geography, and history) - Grade 1
- 2) Physics - Grade 7
- 3) Chemistry - Grade 7
- 4) Biology - Grade 7

There may also be science related subjects taught in the following extra curricular activities, which is truly school specific as mentioned earlier:

- 1) Science and Technology Clubs
- 2) Environmental Clubs
- 3) Gardening and Agriculture Clubs
- 4) Astronomy Clubs

Technology

Technology education focuses on introducing students to digital literacy, computer skills, and problem-solving using technology. Students learn how to use computers, software applications, and the internet for research, communication, and creativity. They also gain knowledge about information technology and its applications in society.

The teaching of technology is still pretty basic in Croatia, with the curriculum slow to adapt to real life needs. The teaching of technology is also heavily linked to the availability of equipment and tools, and most schools find it hard to find funding to truly offer their

students the basics. This is changing quickly thanks to external funding, which is why across Croatia the amount of teaching relating to technology varies so much.

Technology is taught through two subjects at primary school - IT and Technology, and most students are then dependent on extra curricular activities or local nonprofits who may run:

- 1) Robotics and Coding
- 2) Science and Technology Clubs

Engineering

Engineering concepts are not explicitly taught at the primary level, problem-solving and critical thinking skills are emphasized throughout the curriculum. Students are encouraged to apply their knowledge of science and mathematics to design and construct simple models or structures, fostering a basic understanding of engineering principles.

It's only in secondary education that students have the opportunity to choose specialized tracks that align with their interests and career aspirations. These tracks often include technical and vocational education programs that offer more in-depth study of engineering principles and applications.

Engineering-related subjects, such as electrical engineering, mechanical engineering, or civil engineering, are typically introduced in vocational or technical high schools. Students who choose these paths can delve into specific engineering disciplines, learning relevant theories, principles, and practical skills.

Mathematics

Mathematics plays a fundamental role in the Croatian primary education system with 4 to 6 hours spent weekly learning the subject. Students learn mathematical concepts and skills, including numbers, operations, geometry, measurement, algebra, and data analysis. Problem-solving and logical reasoning are emphasized to develop analytical thinking abilities.

Just like with most schooling systems, maths is taught through its own subject, and the only other opportunity for pupils to develop similar skill sets might be through school co-operatives or economics focussed classes.

3. Obstacles and challenges at national level – underachieved STEM subjects;

There are three main challenges for STEM in Croatia, as mentioned earlier:

Funding and resources

Adequate funding and resources for STEM education can be a challenge. Schools may face constraints in acquiring modern laboratory equipment, technology tools, and specialized materials needed for effective STEM instruction. Insufficient funding can also limit opportunities for teacher professional development in STEM fields.

Teacher Training

Ensuring that teachers have the necessary qualifications and training to effectively teach STEM subjects is constantly getting harder and harder given the lack of flexibility in teaching training courses. There is also a shortage of qualified teachers in Maths, Science and Tech and therefore often other teachers have to cover the shortfall.

Curriculum Integration

With this lack of resources and knowledge, integrating STEM subjects, especially tech, across the curriculum is not visible. An interdisciplinary approach requires careful curriculum planning and coordination among different educational stakeholders and there is little movement towards this at a national level, however certain schools have looked at how to develop it themselves.

4. Solutions and new approaches;

As a result of our research, we have found that the children in Croatia are not yet aware of the benefits of STEM education or have been properly introduced to the interdisciplinary connections of STEM education. Generally speaking, they find them boring, dry, and uninspiring to learn while in class.

However, with a lot of kids today spending more and more time online, especially on YouTube, they are finding and liking videos that integrate STEM learning. This is valuable information for educators since it proves that STEM education is not a niche interest, and many more students would find themselves more engaged in STEM education if presented in a way they find appealing.

Videos (whether they be real-life action or animated) prove to be an effective tool in grabbing the attention of young minds. This is especially useful in situations of schools not having enough money for experiments. Interesting ways of connecting STEM learning with creative outlets such as drawing and play-acting, as well as role-modeling (which comes naturally to children), should be further examined and used.

5. Proposal of topics to be used for the development phase;

The three hardest STEM subjects for children to understand have been identified as maths, chemistry, and physics. During interviews and focus groups, a lot of complaints about STEM education have been about the lack of connecting lessons from these subjects with real life. By not having students engage in real-world problem-solving, there is a need for new, more ambitious instructional practices in enacting a STEM approach.

Proposed lessons by kids during the focus group have been:

- Linear equations (Maths)
- Pythagorean lesson (Maths)

- Volume (Physics)
- Vectors (Maths)
- Bonds between molecules
- Temperature (Chemistry)
- Compounds of matter (Chemistry)
- Newton's laws (Physics)
- Motion (Physics)
- Light (Physics)

RESEARCH PHASE 2- DETERMINING MOST SOCIALLY EXCLUDED YOUTH TYPE

1. Overview of the national education system: structure and present situation;

The Croatian education system has undergone several reforms in recent years to improve its quality and align with European standards. Efforts have been made to modernize teaching methods, enhance educational resources, and improve the overall quality of education. As mentioned earlier, a large amount of funding is now being channelled to invest in schools especially around STEM and Entrepreneurship education.

Preschool Education

Preschool education is optional and available for children aged 3 to 6. Preschools in Croatia are typically organized as kindergartens or nurseries, both public and private, and there is often a huge demand for public spaces due to the lack of provision. There is no curriculum and kindergartens and nurseries truly range in quality, especially when it comes to preparing the children for primary education.

Primary Education

Primary education is compulsory and provided for children aged 6/7 to 14/15. Parents alongside school staff decide whether their child should start earlier or later. It consists of eight grades and is divided into two stages: lower primary (grades 1 to 4) and upper primary (grades 5 to 8). Weekly testing is normal which puts a lot of stress on children to cram and study. The government is about to test a full day school system with schools around Croatia because currently pupils study during either a morning or afternoon shift. They are also piloting an end of primary education standardised test due to the subjective awarded of grades that currently happens. This subjectivity often leads to unfairness when choosing a secondary school.

Secondary Education

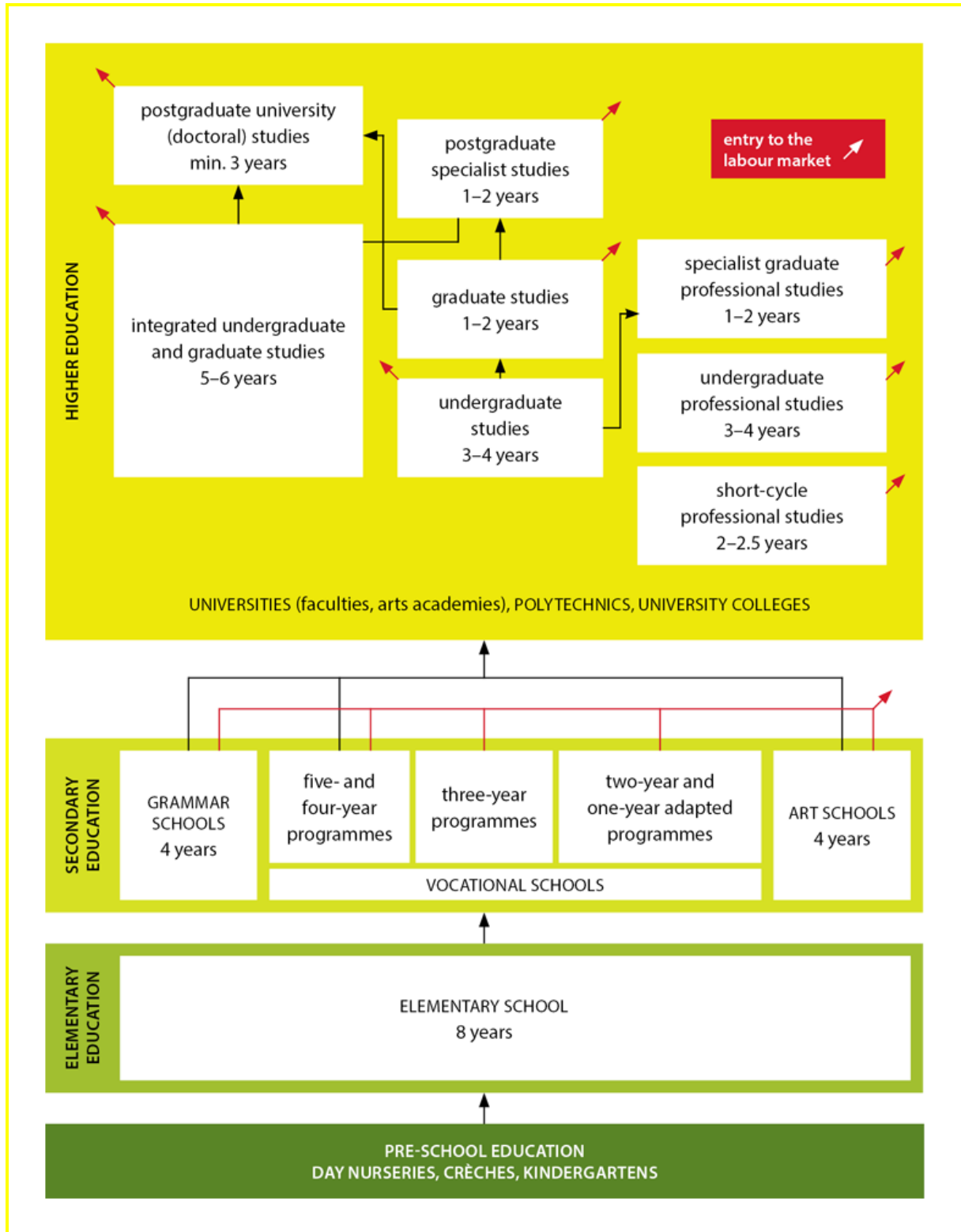
Secondary education in Croatia is compulsory and is typically attended by students aged 15 to 18. It consists of various types of schools:

General Gymnasium (grammar school): These offer a comprehensive general education and prepare students for university. It can be the most demanding to get in to and maintain strong grades, but students are then best prepared for their standardised tests at the end of it.

Vocational Schools: These provide practical education and training for specific professions or trades, and depending on the region you live in, vary in availability and number. For example there is one stonemasonry school in Brač, an island with a long history of stonemasonry. Alongside specific subjects, they continue to study a general curriculum in case they hope to undertake standardised tests at the end and move onto university. Courses can last three to five years depending on what they study.

Some examples of these schools are:

1. Art Schools - focus on artistic education, covering fields like music, visual arts, dance, and drama.
2. Technical Schools - focus on technical and engineering education, preparing students for specific industries.
3. Economics and Trade Schools - focus on education in business, economics, and entrepreneurship.
4. Tourism and agriculture - focus on all themes within working in tourism and/or agriculture



Source: www.croatia.eu

2. Children excluded from the education system: causes, typologies, solution implemented so far;

Croatia has improved over the past decade in offering a more inclusive education system, however there are still large gaps in truly engaging and involving children from all walks of life. There are certain groups that are more excluded than others including:

Children with Disabilities

Children with disabilities often face barriers to accessing quality education due to physical, sensory, or cognitive impairments. This mainly comes down to the lack of appropriate infrastructure, even with something basic like access since many of the schools are old building which have not been adapted for use. The schools have not been renovated for years and unfortunately offer poor conditions for both pupils and teachers. Furthermore there is a severe underfunding of specialized support services, and even trained personnel can contribute to their exclusion from mainstream education.

Schools are now being built with inclusion in mind, some are being retrofitted whenever they are awarded funding. Meanwhile there are specific schools set up for children who are unable to participate in mainstream education.

Roma Children

The Roma community often experiences multiple forms of exclusion within society, and this is then apparent in the educational system where they often face exclusion or abuse. This can be connected to discrimination, language barriers, and cultural differences which can hinder their access to quality education and lead to high dropout rates.

There are a number of outreach programs with the Roma community to try to counteract the social exclusion of Roma children, especially around rights and values to get them better integrated into society at an earlier stage.

Children from Socioeconomically Disadvantaged Backgrounds

Children from low-income families also face huge challenges especially in today's world of high inflation and living costs. Educational resources, such as textbooks and materials are costly, and with a large emphasis being on digital tools, many of them don't have the required resources at home to study.

Private tutoring is the norm too, and very much seen as needed to get good grades, with parents spending hundreds of euros a month on certain subjects for their child. Given the average salary was just 1000 EUR a month in 2021, for many families this is not affordable and their children rapidly drop behind.

There are not too many specific measures aimed at alleviating this by the government, other than the usual access to the welfare state for financial and practical support. Many nonprofits are offering a free homework club to try and cover the lack of private provision, whilst schools also try to offer support for purchasing school materials and offering one on one tuition.

Migrant and Refugee Children

Up until recently Croatia hasn't been a large recipient of migrant and refugee children, however with the war in Ukraine and a shifting demographic due to labour shortage, schools are now seeing more and more migrant children. Due to language barriers, interrupted education, and in some cases cultural differences, it can take a few years for these children to catch up and until then can be excluded as a focus on Croatian language learning separates them from the class.

Croatian schools are now mandated to offer Croatian language courses and provide migrant or refugee children with extra support to ensure they can fully participate in the school education system. Uptake and promotion of this is limited however, and the process can be timely and is rarely seamless the first time a school looks to do it.

Results from our research

When discussing with young people who they thought were most excluded from their peer groups, they also mentioned the socially excluded groups listed above. Further to this they also provided the following groups:

The group shared stories of certain individuals in their class being excluded, more often because that person either lacked social skills, didn't seem to want to be included or had special educational needs. They also talked about times where they had also been or felt excluded for their differences or not fitting in.

People with different religions or beliefs
Serbians / Bosnians / Other Immigrants
People from rural areas
People with Autism Spectrum Disorder
People with mental health issues
LGBT community
People who dress differently
People who are bad at socialising
Outliers

As we delved deeper into the reasons why these people were often excluded there was a consensus that there were three main reasons:

- That person would exclude themselves for certain reasons
- That person would be excluded because of visible or known differences
- That person would either exclude themselves or be excluded due to misunderstandings, miscommunication or a lack of empathy from others.

A large driver behind this was thought to be because Split and the surrounding area is made up of people from a majority traditional Catholic Croatian background which leans less favourable towards people from other countries, beliefs and demographics.

The other drive is purely lack of awareness or the inability to communicate with each other to understand how to include people.

Therefore the focus group wanted to look at how they can show people how to ensure they always have an invite and be included. They wanted to think about how to gain an understanding that some people have different comfort levels when it comes to different activities.

3. Proposal of the most common excluded types of youth from the education national system, to be used as characters of the educational cartoons;

After holding focus groups and interviews with our young participants, one group that was often excluded were those from the neurodivergent community, with specific mentions of those on the autism spectrum.

Many of those interviewed could remember a certain time or event where individuals were excluded either on purpose or accidentally because of them 'being different'.

Those interviewed showed sympathy to these individuals in these moments, but often felt they weren't able to include them for other reasons linked to not knowing what to say, how to act or what to ask.

RESEARCH PHASE 3- SELECTION OF THE EDUCATIONAL CARTOONS METHODOLOGIES AND TECHNIQUES

1. Analysis of the existing educational cartoons methodologies and techniques- overall benefits of these methods;

To create a good cartoon, we need to start with scriptwriting and storyboarding. In this segment, we need to think about the subject matter and characters. It's important to have an interesting protagonist. Storyboarding also informs on how long the video will be.

Storyboarding has several benefits, including:

- Saving time in the making and editing process
- Maintaining the continuity of the story in the editing process
- Making it easy to communicate creative visual ideas to the public

There are several storyboarding software that can be used in this process, for example:

- Storyboarder
- Toon Boom Storyboard Pro
- Adobe Photoshop
- Storyboard Fountain

Further to our research, the kids liked different kind of animation, as presented in the following videos they choose:

[TheOdd1sOut - YouTube](#)

[Tabbes - YouTube](#)

[Haminations - YouTube](#)

[Jaiden Animations - YouTube](#)

[Top 10 Worst Animal Skeletons - YouTube](#)

[TED-Ed - YouTube](#)

[Jake Doubleyoo - YouTube](#)

[SCP-5000 - The Suit \(SCP Animation\) - YouTube](#)

[Kurzgesagt – In a Nutshell - YouTube](#)

[Reimagination of Disney's short film's music: "Paperman" \(2012\) - YouTube](#)

[Zuko Joins Team Avatar: "Hello, Zuko Here" 🙌 Full Scene | Avatar: The Last](#)

[Airbender - YouTube](#)

[Your Body Killed Cancer 5 Minutes Ago - YouTube](#)

[MSA previously My Story Animated - YouTube](#)

After a focus group, the kids choose as top picks the following videos:

[Top 10 Worst Animal Skeletons - YouTube](#)

The way this is made is by combining 2D drawing and animation in a movie editor. The benefits of these kinds of video making are more time spent on the story and less on the animation, making it easier to make for amateurs.

[Norse Mythology Explained \(COMPILATION #1\) - YouTube](#)

The technique here is 2D cutout animation made in Blender. Blender is a free online app making it easily accessible. However, there is a steep learning curve for Blender as opposed to other software.

2. Possible online tools software and generators capable of creating the cartoons and its components;

Further to our research, here's a list of all the cartoon/animation making software preferred by our young people:

Flipclip

Flipclip is a user-friendly mobile app that allows you to create 2D animations on your smartphone or tablet. It offers a wide range of drawing tools and features to bring your ideas to life.

Cartoon Animator 4

Cartoon Animator 4 is a powerful 2D animation software that enables you to create professional-level animations. It provides a comprehensive set of tools for character creation, rigging, and animation.

Moho

Moho is a versatile 2D animation software suitable for both beginners and professionals. It offers advanced features like bone rigging, motion tracking, and particle effects.

Toon Boom Harmony

Toon Boom Harmony is a widely-used professional 2D animation software. It provides a robust toolset for traditional frame-by-frame animation, cut-out animation, and special effects, making it a popular choice for studios and animators.

Synfig Studio

Synfig Studio is a free and open-source 2D animation software. It allows you to create complex animations using vector graphics and offers features like skeletal animation, tweening, and particle effects.

Animaker

Animaker is an online platform that simplifies the process of creating animated videos. It provides pre-built templates, characters, and a user-friendly interface, making it accessible for beginners to create engaging animations.

Procreate

Procreate is a popular digital painting app available exclusively for iPad. Although primarily a drawing and painting tool, it offers animation features, allowing you to create frame-by-frame animations with ease.

Blender

Blender is a powerful and free 3D animation software. While known for its 3D capabilities, it also includes a comprehensive set of 2D animation tools, making it a versatile option for creating various types of animations.

Pencil2D

Pencil2D is a free and open-source 2D animation software. It provides a simple and intuitive interface for creating hand-drawn animations, making it suitable for beginners and casual animators.

Toonz

Toonz is a professional 2D animation software used by many studios and production houses. It offers a wide range of features for traditional and digital animation, including scanning, colouring, and compositing.

PowToon

PowToon is an online platform that simplifies the creation of animated videos and presentations. It offers a user-friendly interface with drag-and-drop functionality, allowing users to create engaging animations without prior animation experience.

Autodesk Sketchbook

Sketchbook is an award-winning sketching, painting, and drawing app for anyone who loves to draw. Artists and illustrators love Sketchbook for its professional-grade feature set and highly customizable tools.

DaVinci Resolve

DaVinci Resolve is a tough video editor to beat. Not only for the vast number of features it comes with, from high-end video editing capabilities to a powerful node-based special effects system, extensive colour correction features, and professional-level audio tools, but the whole thing is available for free.

3. Proposal of educational cartoons methodologies and techniques;

1. Storyboarding

For storyboarding, we will be using [The Sketchbook app](#). This will be used for generating images. Images will be developed based on a script for the video. We will animate videos mostly as a series of comics that will sometimes contain small animations. This will allow the kids to be creative when developing their cartoons without burdening them with time-consuming software for professional animations. Other sketching apps can be used here, as we will likely use [Procreate](#) as well. Sketching can be done either on mobile phones, laptops or tablets.

2. Audio

[Audacity](#) will be used for recording and audio editing.

3. Movie editing

In this step, students will combine the images and audio into a movie editing program. The key is that students need to time the audio to the images that have been created. There are a lot of choices for movie editing software to choose from. One of the best free ones is [DaVinci Resolve](#).

[Here](#) you can watch an example of a video made in this way.