Video Education for Kindergarten Mathematics

Ideas and Principles of ViduKids

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Content

Welcome

A warm welcome to this guide about creative video in early childhood mathematics education! We appreciate your interest in our project and hope this publication will help you understand our overall ideas about Video Education in Kindergarten Mathematics – ViduKids. It is a European project that contributes to mathematics learning in early childhood through innovative media methods, especially producing creative videos with young children. As a pedagogue in a kindergarten[1], you are the primary contact for reaching children. You will be equipped with engaging content and methods in form and didactics for yourself and the children in your kindergarten. We hope that good pedagogical frameworks, best practice examples and practical, tried-out classroom activities will interest you and inspire you to take video production onboard yourself within your early mathematics teaching practice.

This guide supplements what we have already published online on our website **ViduKids.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.

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 get in touch with us with your ideas, comments and contributions.

Many greetings from the ViduKids team!

Introduction

Goals of the ViduKids project

Early childhood mathematics is in the international spotlight. The recent release of the PISA study has forced many countries to reconsider their curricula and pedagogical approaches as results have either stagnated or declined. This leads to an international systematisation in education, a global standards movement with a shift in policy focus from educational inputs to learning outcomes. An increase in educational measurement may result in early childhood education's 'schoolification' and move away from play-based pedagogies. Pedagogues meet this tendency with scepticism. They prefer a play-based approach rooted in children's everyday life experiences.

ViduKids contributes to this discussion with innovative pedagogical methods from the ideas within the rich technology ecosystem surrounding video production. Video is a very motivating tool bringing in many different experiencesThe moving images can help illustrate mathematical concepts like space, numbers, and shapes and easily connect them with the real world. But currently video production by kindergarten children is a new approach to early childhood mathematics.

The core idea of ViduKids is that children themselves become an active part of the video production process. Using creative thinking, mathematical content will be reworked and visualised during this process. In this approach:

- Children will playfully discover mathematical concepts like space, numbers and shapes
- Children will document their ideas and discoveries themselves on video
- Other children will be engaged as viewers of the videos
- Children will be given ample opportunities for self-reflection
- Pedagogues will support the children appropriately; in particular, provide ideas, examples and technical support
- The ideas will be developed further with pedagogues from other EU countries

Pedagogues will be the interface for reaching the learners, and the project will take great care to address and include them appropriately.

Benefits of applying ViduKids in the classroom

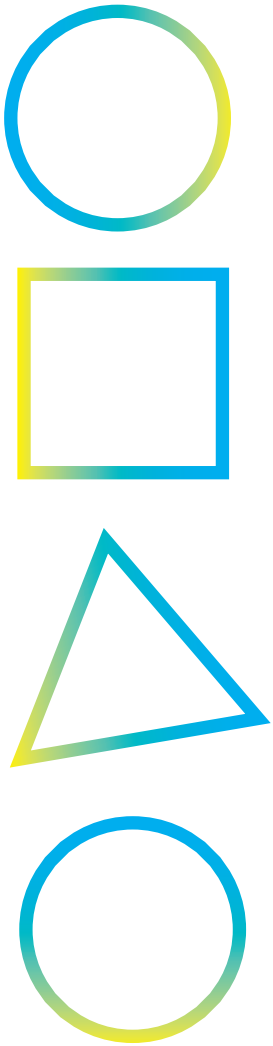
ViduKids fosters problem-based and independent learning. The project develops teaching methods that are video-based and play-based. The use of multimedia encourages children's intuition

and helps them to reconstruct new knowledge by themselves. If video is used collaboratively and reflectively, it is a powerful tool to support both media and mathematics competencies.

ViduKids puts its primary emphasis on visual communication, which is ideal for exchange across Europe with the possibility of subtitles in a multitude of languages. The project motivates preschools and kindergartens to form tandems: two institutions cooperating and exchanging and discussing outcomes and ideas. To protect children's privacy, videos concentrate on not showing the children themselves.

ViduKids promotes content produced by the children themselves. Videos created by kindergarten children are rare. ViduKids provides creative concepts based on exploration, storytelling, and problem solving embedded in a pedagogical framework in which pedagogues can facilitate children to develop their own media. The proposed ideas of video pedagogy are child-centred and include a broad range of ideas on how mathematics can be visualised. Playful concepts support children to engage naturally with mathematics, helping them understand core concepts before they start compulsory school.

ViduKids



Children create shapes and record their work on video

Pedagogical background

Early childhood education

A kindergarten child is naturally curious, inquisitive, and highly internally motivated to explore and learn. So if we follow these insights, we quickly realise that the important role of the adult in this period of child development is actually in promoting early learning with appropriate stimlui in all areas of early childhood education, including mathematics. One of the pedagogical approaches can also be early learning of mathematics using modern technology and film design (Stop Motion Studio), as we tested in the ViduKids project.

Kindergarten children love to learn new things, but only if they have fun, so the concept of play should be particularly discussed in preschool education. Play helps children express themselves and contributes to their development in all aspects. Traditionally, play in the kindergarten period has meant children's actions and their own creation of meaning.[2] Play has often been seen as the child's work and the child's natural way of acting in the world around them.[3]

Play has been the subject of several different studies. Thus, play characteristics have been analysed, leading to different definitions of play. Relaxation and constructive functions are often emphasised, as well as play's creative and problem-solving aspects.[4] Other researchers emphasise the fact that play is a central part of children's culture and that the world of play in which children live has intrinsic value.[5] Today, the perspective is changing, and play and learning are seen as two interrelated phenomena.[6] Play is emphasised as an important part of the learning process. The kindergarten curriculum emphasises the importance of play in children's development and learning. It is also stressed that play and joyful learning foster multiple skills such as imagination, empathy, communication, symbolic thinking, cooperation and problem-solving. In play, children experience and create a world of meaning on their own terms and with their own specific values. In play, children share their life worlds with other children.[7] In play, children learn about the perspectives of others and gradually learn to understand them and develop communicative competence, which is fundamental to children's learning and creativity.[8]

There is a very important segment which should not be neglected in early learning in kindergarten. Developing a cooperative, partnership relationship between kindergarten and families is necessary in institutional kindergarten education. If we approach the content involved in the activities that take place in the kindergarten daily in this way and involve parents as equal partners, then there is less chance of a communication gap or lack of accurate information. Parents could be afraid that their child will be overwhelmed if they are unfamiliar with the content, method and course of early learning mathematics using modern technology. Thus we presented to parents our expectations of children regarding the acquisition of mathematical concepts through video techniques before the start of the ViduKids project - that the purpose of teaching is not to achieve some specific learning goals such as in school but to learn

new approaches to learning mathematics. Above all, it is essential for a child to experience the first mathematical concepts as a positive experience and will have a pleasant feeling with each re-encountering of mathematics later in life, which we see as the foundation for quality and active learning. As with other activities in the kindergarten period, it is crucial in early teaching that professionals are aware that the process of the activity itself is more important than the final product.

As with other activities carried out in organised kindergarten education, appropriate motivation is also essential in teaching mathematics. The child is likely to prefer to follow a positive-minded pedagogue who has a positive self-image and is not afraid of new challenges but takes them as an opportunity for new successes. The whole pedagogical process of early learning should take place in laughter, fun, play and dance because kindergarten children should experience each content holistically, with all the senses, with the whole body, to learn actively.

Early mathematics education

In recent years, early childhood mathematics has moved into the international spotlight. Many studies[9] show that early childhood mathematics achievement strongly predicts success in future school mathematics, other subjects, and life in general. Furthermore, early childhood mathematics education is not only crucial for future achievement but has value for children in the present.[10] Mathematics provides opportunities for challenge, investigation, discovery and sustained shared thinking.[11] It stimulates creative and innovative thinking in both young children and pedagogues[12] and develops thinking and reasoning for children's present and future.[13] This should encourage pedagogues to engage with their children in mathematics learning and consider how they might experience mathematics in their early childhood years.

The mathematical content

To structure the mathematics content, we use Alan Bishop's six fundamental mathematical activities: locating, designing, counting, measuring, explaining and playing.[14]

Locating is exploring one's spatial environment, conceptualising and symbolising that environment with models, diagrams, drawings, words or other means. It includes spatial relations (e.g. left, right, front, rear, top, bottom, in front, behind, outwards, inwards, through, up, down, outside, inside) and spatial imagination (to visualise how parts will fit together).

Designing is creating a shape or design for an object or any part of one's spatial environment. It may involve making the object as a 'mental template', or symbolising it in some conventionalised way. It is about shapes (e.g. circle, triangle, rectangle, square) and their properties (e.g. round, pointed, oblong, symmetrical, corner, side).

Counting is a systematic way to compare and order discrete phenomena. It may involve tallying, using objects to record, compare and order discrete phenomena, and using number words or names (five wooden sticks, four cars, three stones, two animals).

Measuring is quantifying qualities for the purposes of comparison and ordering (longer, shorter, as long as, twice as long as), using objects, tokens or body parts as measuring devices with associated units (fingerbreadth, span, foot) or 'measure-words' (long, short, high, low, wide, narrow).

Explaining is finding ways to account for the existence of phenomena, be they religious, animistic, scientific or mathematical (Why are wheels round? How can four ducks share twenty coins?)

Playing is devising and engaging in games and pastimes, with more or less formalised rules that all players must abide by. Children experience models, rules, procedures, strategies, hypothetical reasoning and prediction in play.[15]

Bishop found these activities through his ethnological studies. He analysed mathematics as a cultural pursuit and developed his theory of mathematical enculturation.[16] He argues that these six mathematical activities 'are both universal, in that they appear to be carried out by every cultural group ever studied, and also necessary and sufficient for the development of mathematical knowledge. […] Mathematics, as cultural knowledge, derives from humans engaging in these six universal activities in a sustained, and conscious manner. The activities can either be performed in a mutually exclusive way or, perhaps more significantly, by interacting together, as in "playing with numbers".'[17]

Bishop's activities are related to the mathematical content areas of space, numbers and shapes as well as mathematical skills like reasoning, exploring and problem-solving. Locating is about space; counting about numbers; designing about shapes; and measuring requires knowledge about both space, numbers and shapes. Explaining and playing develop mathematical skills that can be applied to every content.

Three approaches

Adults often think mathematics is mainly about numbers and solving tasks with given methods.[18] That is not the case for both younger children and professional mathematicians. For them, the focus is on exploring and discovering patterns, structures, and connections and solving problems in real and fictional worlds. Non-mathematicians often find mathematics difficult because it is abstract. Piaget assumed that children are not capable of abstract logical reasoning before they reach the formal operational stage, around the age of 7 years. Recent research[19] shows that abstract thinking begins much earlier. Playing is crucial in transitioning from concrete to abstract thinking.[20] Otsuka and Jay[21] found three properties of play situations that promote the transition from concrete to abstract thinking:

1. The children share their thinking with other children and adults.

2. The children chose to pause to reflect on their experiences.

3. The children demonstrate satisfaction with the result of their self-directed play.

Our experiences with the ViduKids project show that video production creates play situations with these properties. That is true for all three approaches we have used: exploration, storytelling, and problem-solving. Video production helps the children to share their thinking. Video production slows down the process, which provides time for reflection. Finally, video production produces a product – the video – that satisfies the children.

Exploration

The insight that we learn better by experiencing the world around us than by memorising facts and procedures is not a new one. It was already expressed by Jean-Jacques Rousseau and John Locke and is supported by the theories of Dewey, Bruner, Piaget, and Vygotsky.[22] Children have to explore the world to construct their own concepts. Even though mathematical concepts are abstract, they are often related to structures of the physical world, which children can explore. When it comes to mathematical concepts, we must distinguish between the (abstract) concept, the mathematical sign or symbol, and the object or reference context. To explore the number three, for example, does not mean to search for the numeral 3 in our environment but to look for sets with three elements. The signs and symbols do not have a meaning of their own. The learners must produce sense in their heads by establishing relations to suitable reference contexts. The epistemological triangle (see Figure 1) represents the interrelationship between the symbols, the reference, and the mathematical knowledge (the abstract concept). The child's exploration influences the relationship between sign and reference context and the construction of new, more general mathematical knowledge. Therefore, none of the triangle's corners is more important than the others. The three aspects 'mathematical concept', 'mathematical sign/symbol' and 'object/reference context' form a balanced, reciprocally supported system. This system, however, is not independent of the learner. The reciprocal actions between the corners of the triangle, such as the symbols (for example, number words or numerals) and the reference context (for example, sets, see Figure 2) have to be actively produced by the child in interaction with others while exploring the world.[23]

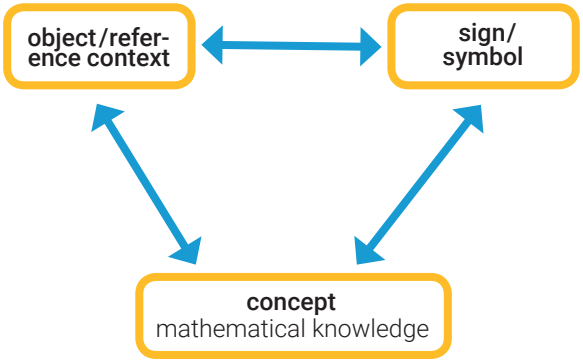


Figure 1: The epistemological triangle.[24]

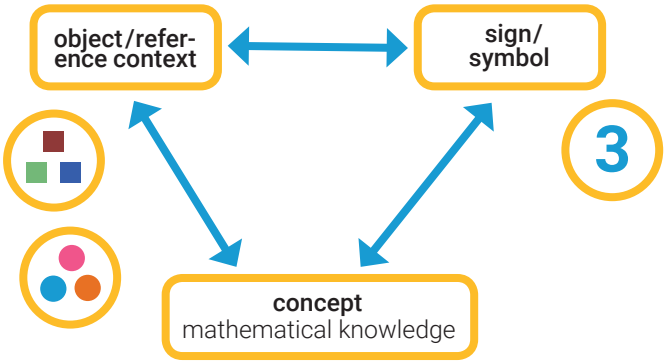


Figure 2: The epistemological triangle of the number three.[25]

Here are some examples of mathematical concepts that kindergarten children can explore: small, large, round, pointy, triangle, square, rectangle, cube, prism, pyramid, and the natural numbers one, two, three, and so on. During the exploration process, video production helps the children document their discoveries. After the exploration, the children can use the videos to share their findings with other children, parents, and pedagogues. Additionally, the videos have three more benefits. They help the children:

1. focus on their discovery by watching it through the camera,

2. reflect on their exploration when watching the videos, and

3. visualise dynamic concepts, for example, the increase/decrease schema[26] or the construction of a geometrical shape.

Storytelling

We mentioned above that playing is a mathematical activity. Play supports children in engaging naturally with mathematics. When they play with mathematical objects before they solve problems with them, they are more successful and more creative.[27] However, the potential for playing to contribute to children's mathematical learning is only realised if the mathematics is noticed, explored and talked about.[28] One way to engage children in mathematical play is to start with a story. It can be a traditional fairytale (for example 'Goldilocks and the three bears'),[29] a modern children's book[30], or a narrative that the children create by themselves.[31] Usually, children engage with a story by integrating it into their pretend play. The pedagogue can enrich the children's play with mathematical ideas and activities and help them to notice the mathematical concepts by talking about them.

Video production adds a new dimension. Here, the children shall retell the story visually by using digital video. The preferred video technique is stop-motion animation. It may be a short activity if the children can use the toys at hand. Or it may be a project that lasts over several weeks if the children do handicrafts to create the scenery and props. Letnes points out three key points to remember:

- When children play with different ideas in their creation of an animated film, they create their world in the moment. The animation is the children's product, whilst the practitioners' role is to help and guide the children in translating their story into film.

- By creating an animated film, the children receive experience and knowledge in animation production and processes. This knowledge involves media experience, playing with form and content and developing aesthetic awareness.

- In this, the children are beginning to build their own digital literacy, and finally the children, through the distribution of the animated film, get what might be called subject-in-the-world knowledge.[32]

In addition, the children engage with the mathematical concepts and build a deeper mathematical understanding. That is true for the mathematical ideas in the story as well as the mathematical concepts related to the production of animated videos, temporal order, frames per second, time, speed, perspective, locating and arranging the props and much more.

Problem-solving

Problem-solving is not only an important goal of mathematics lessons but also one of the most important methods of learning mathematics. Even small children learn in kindergarten that mathematics helps solve problems of all kinds. Whether a situation is perceived as a problem or a task depends on the learners' previous experiences. To solve a task, the learner must just apply a known method correctly. For a problem, it is essential that you do not have any memorised or prescribed methods to solve it. The famous mathematician George Pólya[33] has outlined four steps for problem-solving:

1. Understanding the problem,

2. Devising a plan for how to solve the problem,

3. Carrying out the plan, and

4. Looking back, evaluating if the problem is solved, reflecting the process

In our previous project **vidumath** with children in primary school, we found that these four steps correspond with the steps of the video production process. Making a storyboard for video production helped the students plan how to solve the problem. Then they took a one-shot video that showed how they carried out the plan. The final video allowed them to look back and reflect on the process.

For younger children, the situation is different. The children must solve the problem first before they can produce a video about their solution. Video production plays an essential role in step 4, the reflection of the process. This step is crucial but often neglected.

Pedagogues create a mandala and try out stop motion

Creativity and aesthetic expression

The digital opportunity space

Digital technology has become part of most kindergarten children's everyday life today, but research shows that children mostly use technology for entertainment.[34] To a large extentthis also applies to use in the kindergarten. When children create art and cultural expressions through video and digital media, it helps them become producers rather than merely consumers of new technology. It gives the children a space of opportunity where they can express themselves, communicate and be seen by the outside world.

Making a video in the kindergarten will most often take place as a group activity, where the children and the pedagogue together experience creative processes in the form of idea development, dialogue and interaction with each other and the media and the material used. Working with digital technology in the form of creating a video will be able to include also many non-digital activities, such as drawing and painting, composing a story, creating soundscapes, etc., and shows how rooted the media and materials of the art subjects are in such creative processes. Research shows how practical artwork in combination with digital tools provides a synergy of ideas – simply more combination possibilities in creative processes.[35]

By using digital technology, the children experience new possibilities of expression, a form of digital aesthetics.[36] This can also be described as a form of multimodality: that isseveral sign systems (for example verbal language, music, drawings, etc.) put together to create different cultural expressions, such as a film. Children themselves are great consumers of multimodal cultural expressions, such as picture books with text, animations, computer games, etc. The fact that they themselves can take part in creating similar cultural expressions helps expand children's opportunities for expression.

Creative problem solving versus creativity

Creative problem solving is often linked to that part of creative processes, where the goal is often to solve a defined problem area in the form of, for example, building a new bridge or resolving a conflict. Making a video in the kindergarten can also be seen as creative problem solving. This will then mainly be linked to the more practical challenges of making a video, rather than the artistic challenges in the form of personal expression and preferences. Creativity has in many ways been a somewhat mythical term, where many believe that it is a quality reserved for a few, or special types of people. This may have a connection with the fact that creativity can be understood as an expression and a product created by brilliant people.[37] However, in order to gain a broader understanding of the term, it is equally important to link it to everyday situations and the children's creative productions.[38] Creativity is a quality that all people possess to a greater or lesser extent. It is like a muscle, it just needs to be trained and maintained. Through artistic activities, we get to train this 'muscle', as in the process of making a video.

It has often been heard that creative people have the ability to think independently of external frameworks, or'outside the box'. The recently deceased English professor Sir Ken Robinson defines creativity as 'the process of having original ideas that have values.'[39] This perspective is as much linked to the children's ability to come up with an original idea as it is to the adult genius. As long as the ideas have value for them, they will be creative, according to Robinson. More importantly, Robinson believes children have no fear of making mistakes; an important skill to have in creative processes. As he said in one of his TED-lectures, 'If you're not prepared to be wrong, you'll never come up with anything original. And by the time they get to be adults, most kids have lost that capacity.'[40]

It is important to highlight the children's creative processes. The fact that the children get to share their thoughts along the way, through dialogue about their own experiences, is important and contributes to a meaningful process. Likewise, it is important that the children's aesthetic expression in the form of artistic products is also highlighted. Communicating what you have created is, after all, an important part of a creative process.[41] Digital expressions in the form of a video can quickly be perceived as not accessible to children, despite the fact that the threshold for sharing them is low. Pedagogues have a responsibility here,both to make these available, but also to use them with the children. Showing off what they have made gives the children the opportunity to put into words and tell about the creative process to friends and family, and will be an important dimension to their creative processes with digital tools.[42]

When the children contribute to the creation process of an animated film, it is not only about the technological and practical solutions in the form of the use of video, but also aesthetic and artistic activities and problem solving. For example, this could be modeling figures in clay, painting scenography, designing props in arts and crafts. Dramatic challenges can be the narrative/story itself, while musical tools can be songs or soundscapes that the children create. Through working with artistic tools the children acquire experience and knowledge about expressing themselves. What tools do I want to use to create a scary number three in a 'horror movie', or a happy square who has just fallen in love?

A model for understanding children's creative processes

Experiencing and expressing oneself is an important part of being human. When children go through such processes, it often happens through play. Play can be compared to a creative activity.

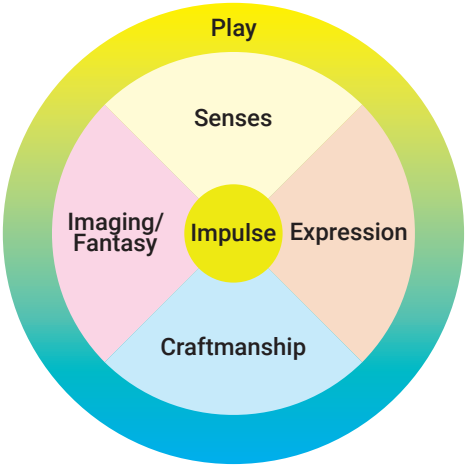


Figure 3: A model to explain children's creative processes[43]

The model in figure 3 explains which elements are in children's creative processes. The outermost circle of the model, which encircles the creative process, Ross calls **play**, or the potential space, which is also described as the free space of possibilities, (descriptions inspired by the psychologist Donald Winnicott). At the core of the model lies the **impulse**, which is the driving force in all creative activity, and can be seen as a basic need to express, create and realise oneself. The **impulse** can come from both inside and outside. Here it is important that the pedagogue is responsive to the child's needs, wishes and curiosity, by asking questions, listening and observing signs of impulses. Between **play** and **impulse** lie the four competencies, which Ross believes are the basis for children's expression:

In creative work, the **senses** are fundamental, as there is a direct connection between perception and attention to thoughts and emotional impressions in everyday life. Children need to explore, trust their own ability to perceive, and learn to appreciate sensory impressions.

Expression means all different forms of artistic expression such as painting, drawing, and music. By giving the child the opportunity to investigate, experiment and experience different media and possibilities of expression, the basis for being creative is developed. The child gains experience and knowledge about the media's form of expression.

Craftsmanship is an essential part of creating. The child needs to learn to handle different tools and techniques. Here, the pedagogue must be central in the form of being supportive in the use of tools, materials and technology with a focus on the process.

The last competence is the development of **imagination**. Imagination is the ability to get ideas and form ideas. The ability to imagine is activated when the child processes various experiences by clarifying and evoking inner images. Here, the responsive adult will be able to play an important role in the form of wondering together with the child, and asking good questions: What colour goes with a ball? Which is heaviest, a triangle or a square?

Sensory experiences not only contribute to knowledge, but also feed children's imagination. Vygotsky believed this was essential in children's creative activity. Creativity depends on the imagination.[44]

Media education

At this point of this booklet, it has hopefully become clear what ViduKids is about – bringing mathematics learning and media learning together. We have already established core media ideas of ViduKids in the area of documentation and reflection. In this chapter, we would like to expand the media learning aspect of the project.

Early childhood mathematics is more and more in the international focus, this also applies to the

integration of media education in kindergarten. There is an increasing number of media projects implemented with early-learners. ViduKids is also the first full-scale video education project of Kulturring since the start of the media education department in 1994. The interest in early media education overlaps with the fact that young children have more and more access to media technology and content and that this young group will also need pedagogical support in how to critically engage with it.[45]

At the same time, there has been an ongoing concern that young children should rather be protected from any media within kindergarten. To be clear, the goal of ViduKids is not to ensure that young children spend even more time with media. It is about helping these children to become more media competent – becoming aware of the nature of media, experiencing new content, being able to distance themselves and actively using media for their own messages.

What is media education?

The concept of media education is not new. It has grown out of film education which began in France in the 1920s already and became popular in the 1990s with an increasing amount of different possible approaches.[46] Media education is not about learning and teaching through the media but teaching and learning about the media. It is based on critical thinking - becoming aware of media messages and reflecting on their potential meaning.

An accessible framework of what this could look like is offered by Hobbs with the AACRA model: access, analyse, create, reflect, and act.[47] To make this useful for young children, it could be, in the context of ViduKids, adapted to:

- Access and share media messages through technologies together in small groups
- Engage together by actively discussing texts, visuals and sounds leaving space for individual experiences
- Creating your own media texts including photos and videos
- Reflecting together what has been created, what is missing, discussing individual responses
- Applying the knowledge to the wider world of media, finding connections between what media was produced and what media is consumed outside of kindergarten

Media education in this sense can be a helpful approach for very young children. It doesn't need to be a complicated study but can be done in a playful fashion with a focus on a limited number of questions.

Media education is a much-needed concept to be included in any curriculum. It is on the basis that 'our' world is becoming more a media world and a need for a curriculum that needs to be relevant to the children's world outside of school.[48] Media education needs to be integrated into the curriculum of every subject across all age groups up to

senior learners. Media content is used in all areas of learning, and it is not possible any more to isolate this from the school subject itself.

Towards a pedagogy of production

ViduKids is based on video education which relies on core ideas of media education with a focus on active video production by the learners. It is the outcome of a cumulative experience of a wide range of teachers and educators from different countries and the collective experience from European video education projects in the late nineties. It is an approach which has created interest for learners of all ages relating to different subjects such as history, languages, politics, art but also subjects where you might not see an immediate link – maths and sports.

This kind of video education gives space to the learners – space to be active and creative producers. Children plan, produce and reflect on their own video messages. They are guided to construct their own understanding where new information is linked with prior experience and knowledge.[49] The activities are in the previously described tradition of media education and done as an exploration with a critical enquiry.[50]

Video education is not vocational training in video production. Support with the different production levels is given but the focus is on the content. Children are given lots of space for their own ideas. They can experiment with still and moving images, they can learn how to write visual stories where 'the camera can become a pen'. They will become aware of camera framing and movement. They will understand stop-motion projects in the context of space and timing of moving images. At the same time, they will develop their reading skills of visual stories. First examples from the piloting show that even very young children come up with creative and interesting ideas. They have presented themselves as independent learners working on their own stop-motion videos.

The following pages will give more insight into how you can get into video education with your young learners yourself and how this kind of video education will foster the media competence of kindergarten children.


Children create their own digital story

Implementation of ViduKids

Getting into ViduKids

ViduKids helps children visualise and reflect on abstract mathematical concepts to support learning and understanding. We provide task sheets, video examples, and video tutorials to give a clear picture of how you can use the project in kindergartens and preschools.

It is crucial to start with elementary exercises, especially when there is little experience with video education. These can include simple photos or video clips connected with mathematics content. Basic practices can be implemented in a single activity or be a part of a larger project. See our matrix document below for examples.

The key idea is to use video to help support mathematics understanding – the quality of the video is not essential. The children do not need to produce professional-looking videos, as it is the process that matters. You can use available technology that records video, such as smartphones or tablets, camcorders or a digital camera with a video function. There is no need to buy technology primarily for the project.

Assessment, privacy and copyright

ViduKids is based on children's teamwork. Media work is teamwork and collaborating leads to meaningful discussions about the approach to the mathematics content and a reflection on the moving images created. The assessment of video mathematics projects will need to look into these project processes. It is not enough to appraise the final video outcome.

Before any video project starts, educators have to get written permission for children to be seen and/or heard in a video. If this is an issue, there are ways around it, e.g. concentrating on just showing the hands or only objects and not including any sound. You will find many examples of such an approach in the ViduKids pilot videos.

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

The ViduKids guide

The ViduKids 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 but rather on media skills. There is a range of production levels from beginners to more 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 gained with the intermediate task can be applied to the advanced task.

2. The second dimension is the mathematical content areas. We provide examples for the areas of **space**, **numbers**, and **shapes**. These are not levels of difficulty, but the underlying concepts build on each other. For example, the number line is a spatial object, and different shapes have a different number of corners (the triangle has 3, the square 4, …)

	Space	**Numbers**	**Shapes**
Entry Task One-shot video or Photo slideshow			
Intermediate Task Stop-motion			
Advanced Task Creative explorations			

Entry task

One-shot video

- Production: Recording video in one-shot – without any video editing or taking pictures and let the smartphone software automatically create a slideshow
- Possible mathematics content: This can include anything that takes place in everyday life, play, or mathematical activities: It could be short excerpts of a mathematical situation or show a child's mathematical idea or expression. It can be used for pedagogical documentation (a learning story).

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

Examples:

- **Space**: a still image of a child sitting under a table; a video of a child on a seesaw going up and down
- **Numbers**: still images of numerals on traffic signs in the neighbourhood; a video of a child counting a number of apples
- **Shapes**: still images, which show where shapes are featured in the preschool; a video of a child building a tower of wooden bricks

Entry tasks do not include video editing. The recorded material is used as it is.

Intermediate task

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 change. The photos 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 shapes; changing amounts, solving problems, …

The intermediate task introduces video production. The critical difference is that still and moving images (and optional audio) are edited. We have chosen stop-motion as the key intermediate example since it is a playful activity that can be done easily without the children appearing in the video or hearing their voices (which is a concern in some preschools 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 25 still images per second, our brains transform them into a moving image.

Examples:

- **Space**: a video that shows how a caterpillar (made of plasticine) eats through an apple
- **Numbers**: a video that illustrates a solution to the problem 'Ducks divide money'
- **Shapes**: a video that visualises how six squares come together to form a cube

Advanced 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 mathematical activities; music and drama mathematics displays, …

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

Examples:

- **Space**: a video about a treasure hunt in the woods
- **Numbers**: a video that shows how four children solve the problem of fairly sharing three apples
- **Shapes**: a video that explores what different shadows a cube can cast in sunlight (from the smallest, a square, to the largest, a hexagon)

Children solve a mathematical problem

Step-by-Step guide

We are using a model by Selander and Kress[51] to describe the learning sequence (see Figure 3). In the following, we will discuss what is specific to a ViduKids project on each step.

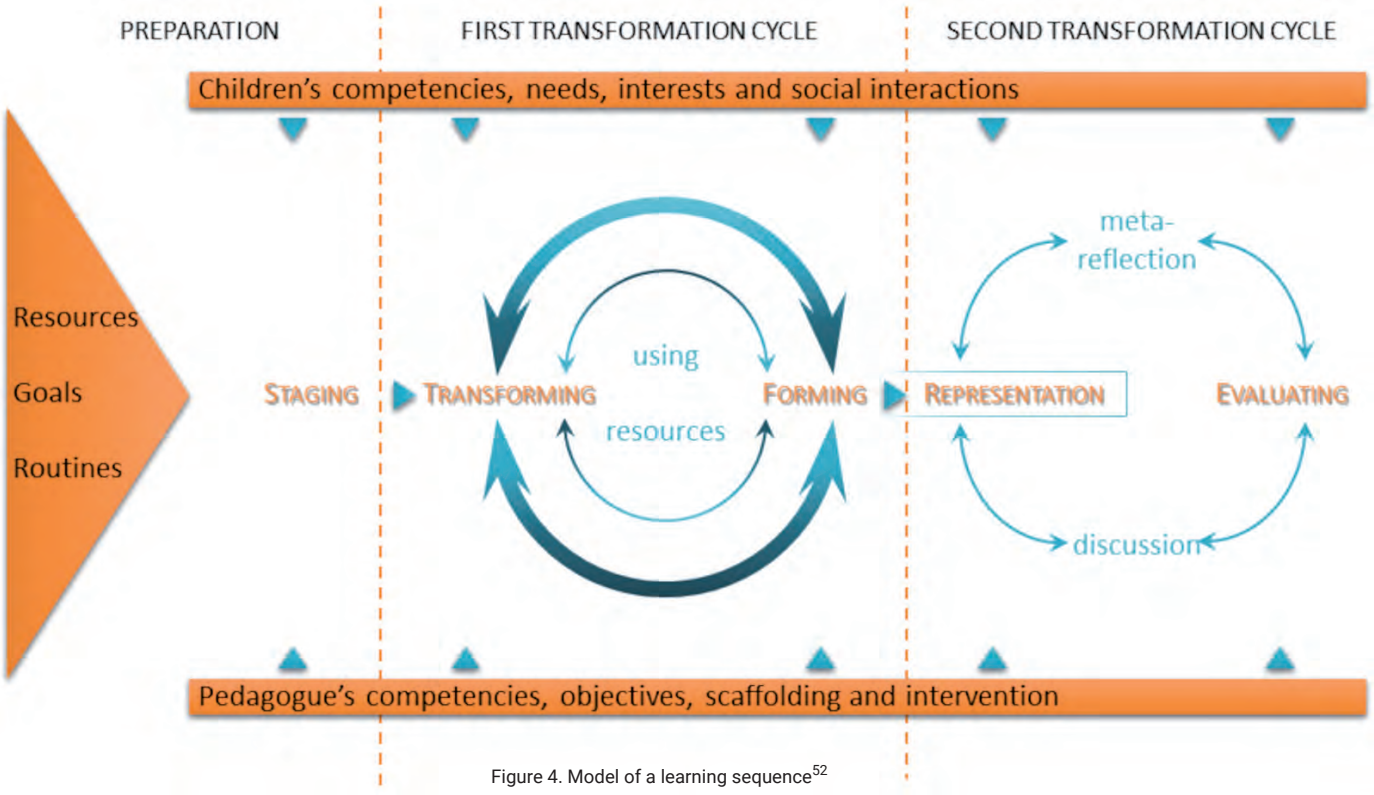


Figure 4. Model of a learning sequence[52]

Preparation

Read this booklet and watch some completed videos before starting the project. Your preparation and scaffolding are an integral part of the project. When planning a learning sequence, the pedagogue must identify the learners' needs and set achievable goals and objectives to meet these needs. Part of this is the selection of the mathematical content. What content you choose may depend on external requirements (the curriculum or a given progress plan) and the children's interests or needs. In addition to

the mathematical content, you must choose the pedagogical approach (exploration, storytelling, or problem-solving). This decision may depend on the children's competencies, needs and interests, as well as your pedagogical objectives. Finally, and specific to a ViduKids project, you must select a suitable video technique regarding the children's proficiency and the chosen mathematical content and pedagogical approach. The ViduKids matrix will help you with that.

When working with digital tools, the children must first become familiar with these tools. In accordance with findings by Bird and colleagues, our experiences show that learning to use cameras involves children in establishing important understandings about the cameras during epistemic play. The children need to learn how to hold the cameras, how to orientate the viewfinder so that it frames what they intended to record, and how to coordinate pressing the release button with the image in the viewfinder to take a picture or record a film. After these aspects of camera use are mastered, the children are able to generate intentional and controlled footage.[53]

Staging

Staging is a term from the theatre. It means the act of putting on a play. Here, it means a promt that catches the children's attention and starts a learning process. If the children are to go on an explorer mission the task has to be interesting and meaningful for them. If the children are to make a digital story, a book, a play or a film may function as a prompt. When the pedagogue produces a stop-motion video while telling a story, the children become curious and want to find out how they can do the same. We have observed several times that the film that the pedagogue or another child made motivated other children to create their own films. If the children are to make a video about a mathematical problem, the problem itself must catch their attention.

The first transformation cycle

The first transformation cycle comprises choosing, processing and combining information by using the given resources. It is not a linear process but consists of many small activities of transforming given knowledge and forming new knowledge. The aim is to create a representation of the new knowledge. If this representation shall be a film, three steps may be part of this cycle: pre-production, filming and post-production.

Pre-production

If the children want to create a digital story, it is a good idea to outline the content before filming begins. This might include the solving of a mathematical problem if that was the prompt. The children have many mathematical experiences already during the pre-production. They learn about the temporal order of events when creating a 'storyboard'.[54] And they experience spatial relations, shapes and numbers when making props and scenery.[55]

Filming

This is often the most enjoyable part of the project. The children work autonomously on their videos. When using stop-motion, the app does a lot of the work. We fixed the camera with a tripod. Thus, the challenge was not to orientate the viewfinder so that it framed what they intended to record but to place the scenery and objects in the area that is framed by the camera. The children take pictures, and the app puts them in the correct order, one after the other. The children choose what they want to take a picture of and place and move the objects. The pedagogue scaffolds if needed. You must help the children understand that they should move things only slightly from one image to the next. Unexpected obstacles may occur.

The purpose of this step is not only to enhance children's motivation and enjoyment. The medium helps children transfer their mathematical ideas and concepts to reality. That deepens their mathematical understanding. While the children make the video, they again think through the mathematical problem. Especially when obstacles occur, the cognitive conflict will lead to deeper insight.

Along the way, the children can check what the video looks like. Are they happy, or do they have to change something? They might be surprised to see that it takes so much less time to watch the video than to make it. What happens to the length when they take more pictures? If the children already have experience with stop-motion, they can experiment with the settings in the app. What happens to the video if we change the frames per second? It is common for each image to be displayed for 0.1 seconds, that is ten frames per second. In addition to the mathematical content, children have experiences with the mathematical aspects of how video works.

Post-production

How much post-production is needed depends on the chosen video technique. Even if no post-production is required, it is fun and will strengthen the video's message.

A **one-shot video** does not require post-production, but with the right equipment, it is possible to add music, sound effects, a title, captions or more. Without post-production, a **stop-motion video** is a silent movie. Therefore, the stop-motion app provides an easy way to add a soundtrack. The children can add dialogues, spoken comments, sound effects or music. Adding titles and captions is also supported by the app. **Creative explorations** are open to any form of video post-production.

The second transformation cycle

During the first transformation cycle, the children produce their videos that are representations of their mathematical ideas, concepts and knowledge. Watching the finished videos with the whole group starts the second transformation cycle. It is more abstract than the first cycle because it is not about creating a film but about discussing and reflecting on the results as well as the process. The children are proud to present their work and share

their ideas and results with the other children. The group appreciates and admires each child's work. Then, the pedagogue leads the children into a reflection on the videos. The children may reflect on the following questions:

- What artistic effects does the video use?
- What mathematics do you notice in the video?
- How does the video communicate the story?
- How does the video visualise mathematics?
- How is the story related to mathematics?
- How do the videos present the same mathematics in different ways?
- How do the videos present solutions to the same problem in various ways?
- How can one problem have multiple solutions?

The reflection leads to a deeper understanding of both filmmaking and mathematics. Watching the videos will often inspire the other children to create their own videos on similar topics.

Evaluating

Ongoing evaluation is an essential part of every project. During the whole project period, the pedagogue will evaluate how the project is going and what has been achieved so far. After the project is finished, a final evaluation will provide insights into the children's achievements and how future projects may be improved. On the ViduKids website, we provide a logbook[56] and a post-activity questionnaire[57] that you can use.

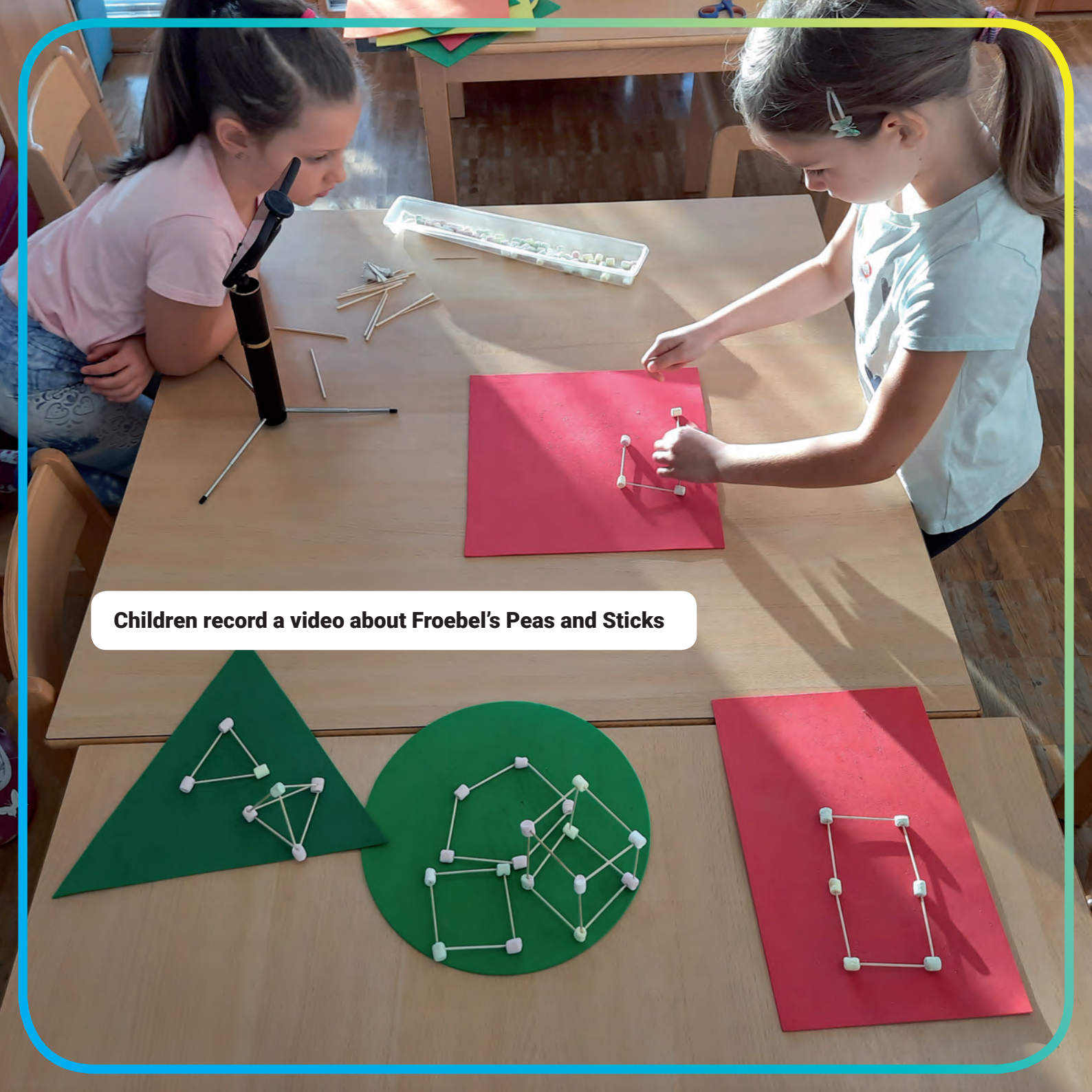
According to Kirkpatrick's multilevel model, there are four levels to consider: Reaction, Learning, Behaviour and Results.[58]

- **Reactions** - This level is about the children's satisfaction. The children express their satisfaction with the process and the results during all steps of the project, especially during the viewing.

- **Learning** - The videos as well as the children's reflection on the videos, give insights into what the children have learnt during the project. This refers to mathematical concepts, skills and insights as well as media skills and knowledge about video production.

- **Behaviour** - What the children have learnt changes their habits and behaviour. The pedagogue can observe those changes. Do the children use the concepts and skills they have learnt in their daily life? Do they transfer their insights to new situations to solve problems?

- **Results** - This does not refer to the products (i.e. the videos) but the project's impact on a higher level. Did the children get a deeper understanding of mathematics and media that will help them to master future challenges? It will take some time before such results become apparent.



Children record a video about Froebel's Peas and Sticks

Technical support

This section provides technical and filmmaking information for your **ViduKids** projects. It is all about getting you started. There are many free online video tutorials that cover all the different aspects of taking photos, producing stop-motion or editing videos if you want to take this further.

Alltypes of media production have become easier over the years. Modern technologies produce good-looking images with little technical involvement by the user. Very young children can often take photos already. As the teacher or educator, you need to understand that you do not need to be a media production expert. Your role is to be in charge of the pedagogical concept of the project.

Using the technology you have

We have already mentioned that the production quality is not the critical parameter of a ViduKids project. It is therefore a good idea, especially for first projects, to keep the production simple and use whatever immediately available technology you have. It is more important to understand and learn how to create and reflect on the media produced.

Mobile technologies such as smartphones and tablets are convenient options for media work in kindergarten. Especially tablets are easy to handle and offer a nice size screen which is helpful when children work in groups. Modern phones and tablets are highly integrated multi-tools with good cameras (including camera apps), post-production software (including stop-motion apps) and the ability to upload videos straight away. This speeds up the production process. Both of these are the best option for looking at recorded material straight away without copying files to another device.

But **any other photo or video camera** can be used for taking photos or recording video. For the entry task, children can use digital compact cameras, which normally record both photos and videos. They are often still around in homes and not used so much anymore. Digital cameras with interchangeable lenses produce good quality images but are not needed for what ViduKids is about. Older-style video cameras are still an option for video work. They are easy to handle, but the material will need to be transferred to a computer afterwards in order to view and edit it (more information below).

For work on the intermediate (stop-motion) and advanced task **desktop and notebook can be used for the editing**. There is a range of free software around, but the whole process of using a camera and computer is more time-consuming and less playful. Ideas of how to use computers are mentioned below.

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

Last but not least: make sure that the battery or batteries are charged, that there is enough memory to record photos and videos, that phones and tablets are protected with covers and camera straps are used to protect more expensive cameras.

Using your camera creatively (entry task and advanced task)

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. Taking photos and recording is a very creative process which employs different camera positions, camera framings and camera movements. Encourage your children to explore as much as possible and find out how and what changes.

Different **camera positions** create different images. It is common practice to put a camera in front of your eyes wherever you stand. But things change when put the camera on a

- **higher position** to look down on the object: standing on a chair or table, looking down from a window,

- **lower position** to look up to the object: hold the camera as low as possible, place the camera on the floor

You can also experiment by taking photos or videos of the same object from different angles – from both sides and behind. What changes can you observe then?

The **camera framing** determines how much you choose to show and not show. You can compare yourself with a painter who will need to decide what to include in the painting. The frame is determined by your camera. It is a rectangular frame – have you got any creative ideas of how to change this and make it round?

Working on your framing is an active process, not something you just do. You will need to decide how much you want to include in your image. You can show as much as possible, but you might want to concentrate on one important thing by going closer. You can do this by moving your camera closer to the object or "zooming in" with your camera lens. When you zoom in, you might realise with some cameras that your object gets isolated by making the background more out-of-focus. With some cameras, you might be able to go very close, you will then create a "macro" shot. This can be useful for small objects or details of objects you might normally not see.

Different foregrounds or backgrounds can also change your image. You might want to isolate objects by placing them in front of a plain material such as coloured cardboard or cloth. Or you want to rather show the object in its original setting. Again – whatever change you do to the camera framing, there will be different messages with your photo or video clip.

Camera movements add another creative dimension when you record video. 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 or walk closer to or further away from an object. Camera movements are there to support your message, not to distract from the message. A walk to "something small" for example can be a helpful message to support the process of finding small things in the classroom or playground.

Also, be aware that too much camera shaking can become hard work for the viewer. A tripod can help for certain shots.

Stop-motion production (intermediate task)

Stop-motion has been the most popular ViduKids task and was mainly done with tablets or smartphones. The easiest solution is to use a stop-motion app such as Stop Motion Studio. Within this app you take the photos, check up on the order and timing and create your final video file which you can share. Many ViduKids projects show that even young children can operate a mobile device with a stop-motion app independently. The easy interface of the stop-motion apps allows children to watch what they have recorded straight away.

The production steps for a stop-motion project are:

- Set up your stop-motion studio: look for a place where you can set up your animation (make sure there is enough lighting), set up your background, arrange your objects
- Set up your tablet or smartphone on a tripod or another solution where the device is fixed on something (for example an open box on top of your objects)
- Open your app and start taking photos (take a photo after each small change of the objects, keep the change small to get a smooth animation)
- Preview your animation and decide if any of the photos need to be deleted or added
- Add titles, sound, music (optional)
- Export your animation – create a video file which is ready to be shared or uploaded

As mentioned before – you can also create stop-motion videos with digital cameras and computers. You can set up a digital photo camera on a tripod, take as many photos as needed and transfer these to a computer afterwards. You can then work with stop-motion software or built-in software such as "photos" (Windows 10) or "iMovie" (macOS). The key for both is to keep the duration of the photos very short (a fraction of a second).

Post-production/video editing (advanced task)

Video editing is the creative process of selecting and arranging photos, video clips, graphics, music, sounds and titles and bringing them together to make a video. It is a similar process which we described already in the stop-motion section above. If you feel confident with the first two ViduKids tasks you might want to explore video editing as an option to include for example sound recordings with your maths videos. Since it is a more technical process it might be something you do together with your children. Video editing is an option for both mobile devices and computers. Free software includes FilmoraGo (Android), Filmora (Win 10), and iMovie (both iOS/macOS).

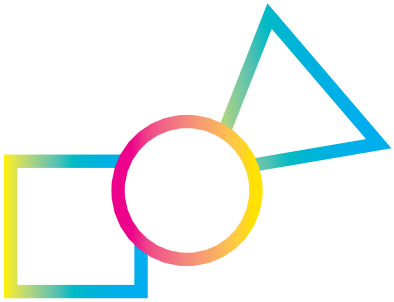
Every video editing project has three steps:

- Importing
- Editing
- Exporting

1. Importing: Copy all source files into one folder (photos, video clips, graphics, sounds/audio). If you used a camera, you should connect the camera to the computer (normally with a USB lead) or put the camera memory card into the card reader of your computer or external card reader. If you have recorded photos and videos with a mobile device you will have everything ready without any additional work. You might only need to find out where your device has stored your recordings.

2. Editing: Look through all your photo and video material and think of a plan for your video. Lay out the videos and photos on the timeline. Continually watch the development of your video; trim photos/video clips to make them shorter or change the order of the clips. Add music and sounds and re-adjust your images. Add titles for the beginning and credits for the end. Consider adding subtitles. Be aware of the copyright of visuals and music. If you have access to musicians that can compose music clips this is by far the best option. Under no circumstance can commercial material be used. If you do you will risk legal consequences.

3. Export: Once all work is done and checked you have to export it. This is a process called 'rendering' in which a new video file is made. All software packages offer pre-sets where you can choose the quality and format of your video. Often there is a 'recommend' option. The higher the compression, the lower the file size but also the lower the visual quality. Choose an option which fits with what you want. Common file formats are based on MP4 (**M**oving **P**icture Experts **G**roup's standard no. 4).
You can show the file to your class, upload it to your school website or social media channels or you can share it directly. We would be happy to include your videos on our online channels.



Children watch and reflect on a video

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58 See https://www.kirkpatrickpartners.com/the-kirkpatrick-model/

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