

## **Feedback from Teachers**

Teachers and students are the most important stakeholders in the Logifaces project. Therefore, it is crucial to listen to and implement the feedback given by them about using Logifaces in class.

### **TEACHERS WHO ARE EXPERIENCED WITH LOGIFACES**

After defining interviews and questionnaires as the tools needed to collect data, a list of general and detailed questions was developed. Multiple questionnaires were based on the literature topics previously mentioned and a general interview guideline was used for first interviews. The people working with us were asked to take notes on their experiences.

The first two interviews were conducted with teachers in German since this is also the language of the authors of this study. The interviews were conducted using a collection of about 50 questions that were defined beforehand, and following the line of the discussion, an additional around 10 open questions were asked. The questions revolved around inquiring about exercise ideas and past implementations versus new ideas occurring during the school closures. Also the use and usefulness of Logifaces as a manipulative was investigated. Additionally, questions about crossover lessons with other subjects and the possibility of using Logifaces virtually were asked and answered.

Through the interviewed teachers it was revealed that a German interview may work in this manner but English interviews could have difficulties due to the language barrier. To overcome these difficulties, first about 10 test interviews were conducted with teachers who were not part of the Logifaces team to identify good strategies. Secondly, carefully aimed towards the goal of the study, selected questions were sent to teachers in advance in order to allow them to translate the questions and think about their answers before the actual interview. The teachers were also able to answer the questions in written form beforehand. The interview again went through the questions and answers to identify if the study authors and those interviewed understood everything in the same way and that all was understood correctly. In these cases it was also possible to ask questions in more depth about certain interesting points in the answers given.

Moreover, if there was an interesting point that was surprising or unconventional the interviewed people were asked to elaborate. For example, one of the teachers thought beforehand that the students would be distracted by the game during lessons or even thought the game could be too boring due to the simple design. In contrast, the teacher found out later that the children loved it and it was an excellent tool for creating exercises. This was found out by carefully asking what exactly was surprising for the teacher during classes.

The analysis of the interviews, which were also partly recorded, was evaluated using a qualitative approach. The interviews themselves were conducted during the Sars-CoV-2 outbreak and thus were conducted via online video tools, such as Zoom, Whereby, or Google Meetup. Interesting points were selected as anecdotes.

We asked the teachers participating in the project about their opinion of the game. Two male and five female teachers from Serbia, Hungary and Austria provided answers. The teachers' subjects were science, art, maths, and languages.

The aim was to learn about their expectations, their backgrounds and their experiences using the game during their lessons. Our questions revolved around their motivations and their perceptions of the interactions of the children. Interesting recurring statements were collected to give an impression of the mindset of the teachers.

When asked about their motivation to use Logifaces during their lessons the following aspects were brought up. Motivating students to connect maths to the real world and to foster creativity was one straightforward answer we obtained multiple times. Since innovation had high value for some, they said that the combination of art and maths was beneficial. It seemed to provide the possibility to work with other teachers by combining subjects that seemed motivational and inspirational. Also inspiring children to think in a nonlinear way had much value to some teachers.

We then went on to ask about the setting they used the game in. The teachers used it physically in classrooms mostly. They often use it either in small groups or with each student by themselves. The age of the students was mostly between 12 and 18 years.

Here some of the things the teachers said:

*"In my educational practice I am interested in STEM activities and the creative teaching process. Logifaces is an opportunity to satisfy my interests." Could you explain that further? "I like working together with other teachers, we try to do something new. We combine different subjects, for example, with physics or other subjects."*

*"The thinking and perception of contemporary youth operate on the principle of network thinking. Logifaces now provides an opportunity to deepen nonlinear and rhizomatic thinking. I find it very exciting!"*

*"Usually, I use them for my workshops, where students revise content learned in traditional lessons. Logifaces needs a connection to the subject and the topics; you have to adjust the students to the new way of learning, it is a process."*

*"In the 8th grade, we experimented with the topic of Object and Space design. They made objects and practical spaces from their own combinations."*

Afterwards we investigated the experiences of the teachers themselves. Some reported that it was interesting to see that the students were only either very excited or slightly annoyed when using the game, with there being no other opinions. One teacher even expected students to be annoyed but in contrast they were excited. Students in science classes seemed to gain a deeper understanding of processes using the game. Also a general experience was that the simple rules of the game were not always easy to follow.

*INTERVIEWER: "Why did you think they wouldn't like it?" - Interviewee: "It is so simple, maybe they lose interest fast. They even asked for more Logifaces in the lessons!"*

*"The use of Logifaces sets in my biology classes helps students to visualise certain processes and thereby make proper conclusions. The students listen to explanations, but they gain a deeper understanding with the game."*

When asked about the duration of the prepared exercises and what kind of instructions they needed from an exercise book, the teachers often prepared for either 45 or 90 minutes. Some reported that the plan was usually too ambitious and the exercises took longer than that, others said that the planning and the time overlapped nicely. One teacher pointed out that a strict planning process needs to take personal aptitudes, skills, and rhythm into account and that they usually try to let students find their own solutions to a problem. This can make planning obsolete.

*"My activities usually last for 45 minutes, and usually everything goes as planned. 50 minutes in Austria; you need some time for introduction."*

*"The planning of a process is never too strict. It is important to consider individual aptitudes, skills and rhythm. Cooperative group work is therefore beneficial because everyone has more chances of success. Solutions can be of many kinds!"*

Topics were collected that teachers were able to teach using Logifaces. They named topics such as geometry, reflections, translations, volume and area calculations as well as combinatorics. Furthermore they were able to teach about pressure, density, space design and talent management, as well as about filmmaking and perform investigations into culture and traditions and even exhibition planning. Many teachers also used the game within body and mind workshops to improve students' brainpower and to foster thinking out of the box.

### **Questionnaires for future studies**

Another questionnaire was developed in addition to the interview questionnaire. It aims at obtaining feedback from teachers on their experiences with Logifaces as manipulatives in general during their lessons but also on how the exercises developed for the game work in class. It will be conducted as soon as teachers have the possibility to try out examples, which is not happening for the time being due to the Covid situation.

First, we prepared a general questionnaire. We want to collect the teacher's first impressions of the game and their observations when students use Logifaces in class. We are especially interested in the skills that students develop when using the game. The next part of the questionnaire consists of pairs of contrasting attributes that may apply to Logifaces. The circles between the attributes represent gradations between the opposites as is common for a Likert scale. Teachers can express agreement with the attributes by ticking the circle that most closely reflects their impression. Teachers should decide spontaneously and not think too long about their decision to make sure that they convey their original impression. One example is the opposites dull and creative. In the last part of the questionnaire we ask about personal information and the environment in which Logifaces was tested, like class and subjects.

Secondly, we created another questionnaire to test for specific exercises. For each exercise the teachers conduct, they are asked to fill out one of these questionnaires. This will help us get to know what specific environment the exercise was tested in, for example, if it was a school project or a regular lesson. We were also interested in how the exercise was introduced to the students. During the Johannes Kepler University summer workshops we were lucky to have very positive experiences with an introduction of fractals and mathematics in nature to boost student creativity.

## **WORKSHOPS WITH TEACHERS WITHOUT EXPERIENCE WITH LOGIFACES**

Two kinds of workshop were conducted to gain better understanding of teachers' needs and the views and beliefs of teachers related to Logifaces. One was carried out in small groups with five Austrian Steiner Waldorf school teachers in person while a second workshop was conducted online with around 50 teachers from Indonesia at a later point.

### **Workshops with ideas from Steiner Waldorf teaching in Austria**

Five teachers from a Steiner Waldorf school were asked to play with the game to get familiar with it and then brainstorm ideas about when and how the game or the game's content could be used. Two of them teach foreign language, one is a class teacher with a botany focus, another an arts and crafts teacher and then also a class teacher with a focus on mathematics. The teachers were handed both 3D printed versions as well as concrete versions of the game. We collected their impressions on the versions made with both material and also asked them about the augmented reality version as a warm-up and let them play with the game.

Due to the pandemic, not all teachers were always present during the workshops at the same time and we distributed the workshop time among the individual teachers for both data collection as well as due to the legal restrictions of the amount of people in one room during the pandemic.

The warm-up feedback about the material gave us the result that all materials had their benefits and drawbacks. The teachers had varying preferences about the materials, which we believe originates in their way of using the game and current constraints. The teachers were comfortable discussing their thoughts about the use of the game and its advantages and limitations in lessons and gave us ideas how, when and for which purpose they believe the shapes can be inspiring and useful for their students.



**Figure 11:**  
*A language teacher playing with 3D printed Logifaces blocks*

The original version made out of concrete was preferred by one class teacher because, as they explained, the children appreciate the weight and sturdiness of the material. Younger children sometimes use building blocks to create walls or objects and they would be familiar with wood or heavy blocks in the school rather than plastic and virtual objects. They themselves created many prisms out of two blocks on top of each other and then finally a hexagonal shape on top of another hexagonal shape making comments about how this would keep her smartest students busy while they attended to other students.

One of the language teachers, who can be seen playing in Figure 10, clearly favoured the 3D printed versions due to the possibility of marking them and removing stains easily as well as the possibility to disinfect them. Moreover, they were intrigued by the possibility of mixing multiple colours and thought that the game was best used in training already existing knowledge.

The other language teacher also played with a concrete version and she liked the feel of the blocks but for her the game was just too logical. She said that maybe grammar rules could be taught using the game but she felt limited by the rules and might only use the game to keep students occupied, agreeing with the class teacher that liked creating hexagons sitting next to her. Seeing the created hexagons, they stated this had to be a maths game due its complexity.

The arts and crafts teacher played with the concrete as well as the 3D printed version and had the idea to create personalised Logifaces blocks right away. They were reminded of crystalline structures and came up with a variety of ideas that could be used for crafting. After a short while playing, they were talking about how exciting a room would be consisting of triangles or how interesting walking on a floor of Logifaces would be for students. According to them Logifaces could also be used to explain rainbows.

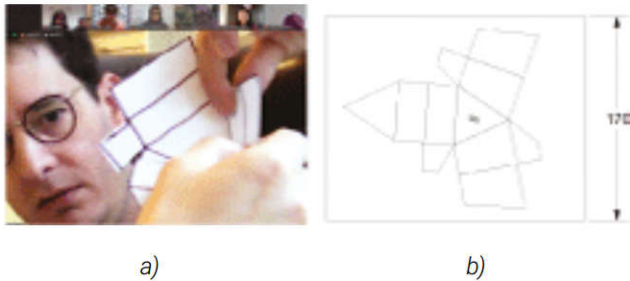
The other class teacher did not prefer any material. It was the shapes they found to be very interesting. They appreciated that due to the various slopes and angles, the game could be used in a great variety of ways to teach mathematics, geography, or even history. After being given the game to play with at home, they had many ideas for exercises for younger students.

The teachers testing the game were given some 3D printed versions to use at the school as a thank you and are happy to improve their lessons using their own exercises. We took the input of the tangible and physical advantages of the Logifaces blocks and, as the next step, investigated how this could be transferred to virtuality to be applicable in distance learning.

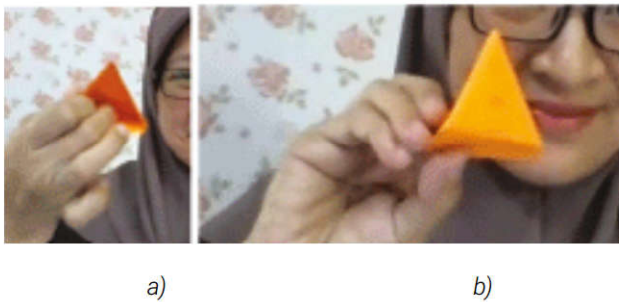
### **Workshop with Asian Teachers**

About 50 teachers from Southeast Asia, mainly Indonesia but also neighbouring countries such as Laos, the Philippines, and Thailand, participated in an online workshop about the Logifaces game and ways to use the game in a distance learning environment.

We first presented the game and the game's rules to the participants. We explained the Logifaces project and introduced the inventor of the game, Daniel Lakos. We later went on to show them how they could use online micro-games from GeoGebra. After the introduction of the platform we asked them to download, print, and fold a prepared Logifaces block folding exercise to make the form of the blocks clearer to the audience as can be seen in Figure 12. The instructions as well as the game's rules were collected in a GeoGebra book that was accessible to the teachers.



**Figure 12:** Paper folding Logifaces blocks with Daniel Lakos (a) presenting the exercise to teachers from Asia using paper folding printouts (b)



**Figure 13:** a teacher from Asia folding Logifaces from paper

The folding of the block helped to convey to the teachers how the game works because they had no 3D printer available to print a small set of the game. They were much more easily able to understand the rules of the game, which were demonstrated by two researchers, Imam Rachmadi and Eva Ulbrich, collaboratively creating shapes, such as a cat, using two sets of Logifaces. While creating the shapes they were constantly interacting with the audience as they posed questions about the game and the researchers explained their thoughts and talked about the difficulties to each other and the teachers.

The teachers also were informed about the basic advantages of the game and that exercises had already been created and collected in the GeoGebra book containing the folding instructions, information about the game and other online resources. One of these resources was a 3D app that provides teachers with the possibility to display a Logifaces block into their environment using Augmented Reality. They were shown that all 3D objects from GeoGebra were able to be used for this purpose or to be 3D printed as well.

We sent a feedback form about the workshop to the participants that they were invited to complete later on. From the 21 completed forms, 16 of the teachers were women and five were men between the ages of 29 and 46. Ten of them teach multiple subjects as class teachers and 11 teach mathematics or other subjects. Two thirds already knew about GeoGebra beforehand.

We asked several questions that allowed the teachers to reply in free text form and some additional questions that required them to choose from a predefined set of answers, such as their previous knowledge about GeoGebra, their gender, their age. They mostly answered in English but sometimes in their own respective languages, which then had to be translated by the authors.

First, we wanted to know whether the teachers used technology or games during their lessons, because we wanted to determine their prior knowledge in these fields (“Do you usually use technology and/or games during your lessons? If not, what is the reason? If yes, how do you use them?”). 14 of them rarely or never use technology in their classes, four of them use technology regularly. The rest use technology only occasionally. The reasons given for not using any technology during lessons included that the teachers lack the knowledge or the schools are not equipped with smartphones or computers. The reasons given by the teachers that use technology were that it is very motivating for students. Games were used by seven teachers regularly, sometimes by two and never by twelve.

*AN EXEMPLARY ANSWER WAS: “I usually use games but not technology. Games make students interested in lessons and are effective so I usually use games described in our teacher’s manual and also my own creations. I can’t use tech in my school because there is no power supply and other modern things like computers.”*

Later we asked about how they thought Logifaces could be implemented in their lessons. Many replied with ideas about which topics or concepts they could teach: volume, patterns, tessellation, areas, edges, crafting, triangles, 3D, counting, geometry, perimeters, volume, measurement, art, shapes, colour, texture, 3D printing, to name a few. Others explained the context of when and how they would use it, for example connections to daily life, as a distraction, with a specific technical operating system environment such as Android or teaching to use gadgets, constructing things, after the lesson, or to have students go from two dimensional pictures to forms.

*ONE TEACHER SAID: “I think I can use Logifaces to teach various topics in maths like net of pattern or shape, tessellations, area, edges and so on.”*

We also gained some insight into teachers’ opinions about how games can be beneficial in teaching situations. The opinions included that Logifaces can help with the development of problem-solving skills and critical thinking, the training of imagination and creativity, inspire motivation, create fun, and develop understanding of mathematical concepts such as geometry, and foster a safe environment that can help to prevent psychological problems, for example.

*“There is a lot besides, it will increase the enthusiasm of students in learning, but it can also help me as a teacher to more easily convey the subject matter to students as well as to make students easily understand the material.”*

*“Because it can cover the 4c’s...collaboration, critical thinking, creativity, and communication ”*

In general, the teachers expressed surprise at how games can support lessons and add fun to topics that might be less known for being entertaining.

*“I think it will be boring idea [sic]. But as the time flew, this boredom was thrown away. So many new things for me are shown here. It’s out of my expectation. Really the best. Actually I’m a type of traditional teacher, didn’t know the new world.”*

This indicates that the teachers’ beliefs changed during the workshop. Other statements support the idea that the benefits of Logifaces can be easily made clear to teachers:

*“This workshop changed my mindset of mathematics, I thought mathematics is only counting and counting, but I got a lot of think [sic] here and change my mindset about mathematics.”*

*“The game as I know that is something that can make us fun [sic], and more games make us lazy. But after I saw the explanation and other interesting games, wow it’s amazing. Of course, the game can be applied in mathematics and science. It’s something new for me.”*



**Figure 14:** Feedback from Asian teachers about the benefits of Logifaces

We conclude that the Logifaces game can have benefits in lessons far beyond teaching mathematics and art and can even be used to change the beliefs of teacher who are usually more traditionally thinking and are initially opposed to games and technology in class.