# Mathematics EduLarp Starflyer

# Guide for teachers

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## About edularps

An edularp is an educational game using role-playing in a real environment. The role-play format promotes the development of soft skills (in particular, cooperation, communication, assertiveness or empathy), intrinsic motivation and can help to anchor or change attitudes. The present methodology deals with naming the important elements of an edularp and elaborates on the initial workshop and the final reflection. The edularp Starflyer, the story and rules of which can be found in the manual, is a game aimed at the acquisition and validation of mathematical knowledge. Solving morally ambiguous situations and dilemmas is also an important part of the game. The basic elements of an edularp are:

- **Story**: the game is set in a specific environment and in a story that has its own twists and turns. This is one of the most important elements for promoting intrinsic motivation of players and creating flow. The setting of the story (whether it is the Universe, the Prehistoric World or the Wizarding World) needs to be supported by changing the school room, which will help to develop the imagination of the pupils. To intensify the atmosphere, furniture can be rearranged, light can be changed (darkening the room, using coloured ice-strips), music or sounds can be played, videos can be projected or fog machines can be used, amongst other options.

- **Role-playing**: each participant receives a completely new role that takes them out of their everyday life and, even in a group where they are outsiders normally, they can become, for example, the leader of a team that has to destroy an approaching asteroid. In order to benefit from this element, students need to actually leave their normal roles at least partially and put themselves more into new roles. The division and creation of roles is provided in an introductory workshop. The roles can be emphasised with costumes. However! An edularp differs from a regular educational game in that players should have the room to make their own decisions during the game and their behaviour should have an impact on the flow of the game.
    - **NPC (non-player character)**: non-player characters (lecturers, educators) also assume their roles and have a mainly motivational and educational function. They can also bring unexpected twists and turns to the game, or act as advisors to the players in case they get "stuck" in the story.

- **Mechanics of edularps**: game mechanics (quests) are embedded in the story to make an edularp educational.

- **Schedule of an edularp**: Each edularp is preceded by an introductory workshop. The introductory workshop includes icebreaker activities (to relax the participants) or activities to promote acting. We also explain the principles of edularps and the rules of the game

itself to the participants. Last comes the imagination session, which brings the participants into the story and starts the game itself. Edularps are succeeded by a final workshop during which the students abandon their roles and reflect on the game.

An edularp has many advantages and students are unlikely to forget this unusual experience, but only if done correctly. The disadvantage of an edularp is that it is demanding to prepare and execute. An educator should be motivated and open to new experiences. In case one really devotes their energy and time to staging the story, the rules, playing with the space and adapting it to the spaceship, motivating the students to play their roles, one can enjoy all the benefits mentioned in the first paragraph and, above all, everyone, the teacher and the students, will have fun.

## 1.    Introductory workshop

The initial workshop can be divided into several phases for clarity. An edularp is very different from regular teaching and it is therefore advisable to start with icebreakers or activities to get students relaxed and fired up. Icebreakers are also good for introductions when the group of students is newly formed or not very close-knit, or when the teacher is an external teacher rather than a class teacher. This is followed by an explanation of the concept of edularps and then an introduction to the story, setting and rules of the game. At the end, students practise assuming the roles, a common agreement is created and group rules introduced. The last part of the introductory workshop is the imagination, followed by the game itself.

### 1.1 Icebreakers (20 min.)

Place the pupils in a circle made of chairs (or they can sit on the carpet). Make sure that we, as teachers, sit among the students. Here we attach some activities that you can use during this phase, including their time requirements:

**In order...** (approx. 5 min.)

Ask the students to introduce themselves one by one clockwise by first name. We may never forget that as instructors we are part of these icebreakers and actively participate. We then ask the participants to reposition themselves clockwise, e.g. alphabetically (Andrea, Damian, ... Zoe) or according to random criteria (hair length, birth month...). For a group where the pupils know each other we can use more demanding criteria, for an unknown group it is ideal to use alphabetical ordering by name.

Students should take away from the activity:

- That there is no hierarchy nor judgement;
- How to reduce physical barriers;

- That they have freedom of movement.

   **My name** (approx. 5 min.)

Participants will be given a sticker on which to write the name they want to use in the game. Disclose to the students that this will be a game that will take place in the Universe (or another setting depending on the game being played). Therefore, they should choose their "space name". Once everyone has finished, we go around the circle again and the participants say, "My Earth name is [real name]. My space name is [fictitious name]." The player must add a space gesture, pose or movement to their name and the group then applauds.

Students should take away from the activity:

- That they have freedom of bodily expression;
- That within context, their character can shift.

   **Roles and counter-roles** (approx. 10 min.)

This is an activity focused on improvisation. Divide the group in two and put them in two parallel lines facing each other. One of the pairs facing each other is always the *captain of the* spaceship and the other is the spaceship'*s clerk*. The clerk always has to come up with a suggestion. The captain is then tasked with responding with one of these three options:

1) NO: The official comes up with a suggestion (e.g. "Captain [space name], we need to fix the ship, how about we use this tool?") and the captain is asked to answer "no" and add a justification (e.g. "No, official [space name], we tried this tool last time and it didn't work.").

2) YES, BUT...: The official comes up with a suggestion (e.g. "Captain [space name], we need to repair the ship, how about we use this tool?") and the captain is tasked with answering "yes, but..." (e.g. "Yes, official [space name], but you need to check with the chief of engineering before using it.").

3) YES AND...: The clerk comes up with a suggestion (e.g. "Captain [space name], we need to fix the ship, how about we use this tool?") and the captain is tasked with answering "yes" and adding some value of his own (e.g. "Yes, clerk [space name], and we can also add this accelerator tool.").

After each round, the role of the captain and clerks are switched so that students can try out both roles. During each round it can be discussed with the participants the idea that if the player accepts their role and adds their part, the story will develop in a more interesting and entertaining way than if the players just mechanically answer "yes" or "no".

Students should take away that:

- being an active player who develops the story is better than playing mechanically;
- creativity is stimulated through scenarios;
- the player has their responsibility;
- great events can be created.

### 1.2 What is an edularp? (5 min.)

During this phase, settle the players back into the circle. Students are explained what the acronym "edularp" stands for – educational live action role playing. It is possible to compare an edularp to improvisational theatre or a computer game, but in a real environment. We also highlight what players have experienced in icebreaker activities:

- It is a safe space to explore, where we do not judge or ridicule anyone, but rather collaborate.
- Larp is a space of free creation, imagination and fantasy.
- Stay in character and be inclusive (accept everyone). Continue to address each other by cosmic names.
- Be responsible for your role and play actively.

### 1.3 Rules of the game (18 min.)

Through a presentation, the lecturer gradually introduces:

- the game world (future, space travel, etc.);
- Story;
- rules (game mechanics).

Afterwards, participants can ask questions about anything that was not clear to them.

### 1.4 Division and training of roles, joint contract (15 min.)

Players can complete their character during the initial workshop. For example, in the Starflyer edularp this option is voluntary (see manual). It depends on the collective, their experience with similar activities and their passion for the cause. The class teacher can assess whether the students will have too much trouble understanding the rules and grasping their basic role or whether they would appreciate more elaborate characterisations of their characters. Creating a character can be done by filling out a questionnaire, drawing from a variety of characters, or making a selection. After creating a character, they stand up one by one, introducing themselves by their (space or other) name, characteristic, gesture, or specific voice. The others applaud.

All players then form a social contract (moral code) on which they must agree. If necessary, some of the rules of the game are repeated and the magic circle is defined –the game is an action directed at

a character, not a real person! The beginning and end of the game are defined. A safe word can be chosen that the player uses when they need help, to step out of role, are uncomfortable, etc.

### 1.5 Imagination (2 min.)

Imagination can look however you see fit. The aim is to get participants out of the role of students and into the fantasy world of the edularp. This is an example of what such an imagination can look like. Players dress up in costumes and place chairs around each station, then sit on them and close their eyes. One of the lecturers takes care of setting the atmosphere, while the other lecturer narrates the imagination. As part of the atmosphere, the windows can be blacked out, the prepared ice-strips can be lit and the space can be fogged – as if the spaceship is about to take off. The lecturer tells how the individual crew members (players) got on board the ship and how challenging and exciting the task ahead of them is. The lecturer ends the imagery by saying that the players are on board, opening their eyes and have to get to work.

Younger players don't like to close their eyes, so more active imagination can be used by turning off the lights and the players can be told to walk like astronauts. As they walk, they are told what is around them, that they are entering a spaceship, and as soon as the light comes on, the game begins.

## 2.    Final workshop

An edularp is an activity full of emotions and extraordinary experiences. That is why not only an introductory workshop should be held, where it is clear to everyone through the explanation of the rules that it must take place, but also a final workshop. Students need to have space to shake off the role, return to the real reality and process the events they have experienced. If the game drags on and the time window shrinks, we better improvise and shorten the game, but don't cut out the space for reflection.

### 2.1 Deroling (getting off the roll) (10 min.)

After the edularp comes applause and expressions of enthusiasm (high fives with the players) to release the tension in the characters. Then, together with the players, the props are gathered and a circle of chairs is prepared (or, after more individual work, the group can be divided into two smaller subgroups, i.e. create two circles of chairs).

Players can prepare a final message for their character and recite it. It should look something like this, *"My name is [real name] and I want to say goodbye to [space name] with this last [message]."* Some players may be uncomfortable reading the message aloud in front of all their classmates, either because of their general shyness or because of the emotional experience. Their wish to keep the report to themselves should be respected. Just writing the report may be enough to shake the role.

After the deroling, a short break can be included to separate the game reality from the real one and to get the students in the mood that the following programme will be in a different spirit.

## 2.2 Discussion and reflection (40 min.)

The discussion can take place in different ways, depending on the players and their activity. Ideally, we come up with questions and topics and let the discussion flow freely (students volunteer) and keep boundaries. If the collective is quiet, passive, then answering around the circle or passing the floor to specific classmates who have not yet had it can be used.

First, teachers can focus on the **emotional impact of the game** and the **moral dilemmas** inherent in the game. Teachers can ask the questions:

*How are you feeling now?* As teachers, we would like to hear from the students about specific emotions and feelings that are going on inside them. We would like them to convey their individual experience - what was going on inside them during the play and at the end of the play?

*What happened?* We're analysing the course of the game. What were the consequences of their decisions? How did they work with their mistakes? How did they feel in that moment?

*How do you connect the game to reality*? Students work with abstraction, perceiving the themes of the play in a broader context and looking for a link to real reality.

We can then look at **linking mathematics to morality** by asking "*What if...*?" (exploring hypotheses). And specific practice with math problems: *which examples were easiest/most challenging for you? If you were to calculate similar examples now at school, do you feel you are sufficiently prepared for them?*

Students are not always talkative and able to put their experience into words. Thus, we can also monitor the fulfilment of objectives through observation. Specific goals that can be observed:

- Decision making, problem solving and justifying solutions (mathematics/morality);
- Cooperation and dynamic group management versus individuality (math/morality);
- critical, careful and creative thinking.

## 2.3 Conclusion (10 min.)

If the group has been divided into two subgroups, both are gathered in one place and asked questions to conclude the experience. An important question to summarise what has been said can be: '*What have you learned?* " or "*What are you taking away?*". In that moment, synthesis, generalisation and learning take place. The learners may also have made an ill-considered decision at some point, or may

now wish to change their decision for whatever reason. So we ask: "*How could we do things differently next time*?" We give them the space to close the process and learn through their "mistakes".

# -MANUAL-

## 3. Basic information about Starflyer edularp

| |
|---|
| Estimated programme length: approx. 270 min. (4.5 hours) |
| Optimal number of participants: 20 |
| Maximum number of participants: 30 |
| Minimum number of participants: 10 |
| Recommended level of education: secondary school with the possibility of modification for primary school (mathematical problems must be modified) |
| Optimal number of lecturers/teachers: 3 |
| Minimum number of lecturers/teachers: 2 |
| Space requirements: normal school classroom with the possibility of adjusting the arrangement of desks |

## 4. Story

The story is a fundamental element of an edularp. It allows players to break out of their everyday roles as students, children, friends, etc. and become, in this case, the crew of a spacecraft. The story promotes the intrinsic motivation of the participants and, thanks to emotionally charged experiences, fosters better retention of the learned or validated material. In the initial workshop, the instructor should try to give the participants an introduction to the story with passion. The introduction to the story is presented through the first slides of the interactive presentation.

Participants represent the crew of the Starflyer spacecraft, which serves the United Solar System's Alliance of Planets. After the invention of hyperspace travel, it was possible to colonise suitable planets for life. Many more or less inhabited planets were created.

Space travel is made possible by harnessing dark matter energy. This substance can be extracted by giant accelerators and store immeasurable amounts of energy in its form, but the production and storage of dark matter is so expensive and challenging that it is only possible on Earth where the infrastructure exists. Dark matter storage is possible thanks to new physical discoveries. In the context of the game, dark matter represents fuel or currency. The Starflyer carries small amounts of dark matter in the form of "containers", which players use to move around the galaxy or solve problems on individual planets. Dark matter is a game mechanic, a science fiction element that is not based on actual physics, and we will communicate this information directly to the players. We don't attempt to play the role of lecturers to explain how dark matter works or what the physics behind it is. What is important to the game is that it is a form of energy storage, fuel or interplanetary exchange.

Earth will not allow any machines or components to be exported to other planetary systems to build giant accelerators and produce dark matter. It therefore has a monopoly on the sale of dark matter. At the same time, Earth will impose sanctions on any system that attempts to build giant particle accelerators. So Earth remains the most powerful planetary system.

Recently, however, scientists have come up with a theory, backed by "rumours" circulating the Milky Way from traders, that there is a brand new element in the depths of the galaxy that can be used to extract dark matter without the help of particle accelerators. Such a discovery would completely change the face of interstellar flight and its position in the galaxy. Earth is therefore sending out several ships to search for the element, looking for any hints of what form it might take and where it might be found.

Starflyer is one of several such ships. Some ships go to the centre of the galaxy to conduct research. The Starflyer flies to investigate several planets and stations where there has been information that this element could be explored more.

There is no exact assignment as to where the ship should go, it is a reconnaissance mission. Players can be given different perspectives on what the discovery of a source of dark matter outside of Earth might mean, e.g. Earth will be invaded by other planets; an influx of refugees from planets where conditions are not suitable for life can be expected if they can afford to travel as they wish; the solar system may become impoverished and no longer safe when accelerators are no longer needed, etc.

*The following description of the story is intended for teachers/lecturers who teach the edularp to players, for a more comprehensive overview of the game. Players will discover the rest of the story as the game progresses.*

The crew of the Starflyer gradually visits a total of 5 locations - planets, where they search for the source of dark matter. They also visit the sixth location of the research station, where they solve an ethical dilemma (the problem with the unknown egg). The game's story is strictly linear; the players' choices have no significant influence on the story's development. They do, however, influence the story of each planet. Players always make a choice, which is presented through a response option in an interactive presentation. They then learn immediately after the choice has been made what effect that choice had on the story of the planet and its inhabitants.

Through the dilemmas on each planet, players discover the implications of democratizing the dark matter resource. It is clear from some of the stories that the discovery of a dark matter source would mean a significant destabilization of the current system. At the end of the game, therefore, an important ethical question for the players is whether it is right to spread knowledge of dark matter production throughout the galaxy and destabilize Earth's position, or to destroy an important scientific discovery and preserve the status quo.

On the first planet, Ronus, the Starflyer can resupply, encounter Earth loyalists, and get alerted to a separatist movement that perhaps has and is exploring dark matter. The second planet, Pauper Stellae, is afflicted by poor conditions and the inhabitants want to acquire dark matter to solve their problems. The players' altruistic choice is unkindly commented on by Earth.

Players then discover a science base where, as Earth's emissaries, they help solve an ambiguous ethical problem involving an unknown alien egg.

On the next planet, Bellum Nebula, there are two different continents at war with each other, each wanting to buy dark matter from the Starflyer to win over the other continent. There are several solutions to the problem, and the ship's crew can decide based on the counter-offer of both continents (exchange dark matter for information), or exercise Earth's authority to calm the conflict.

Another planetary system, Inexpectat, consists of two planets around which a meteorite is moving in an erratic trajectory. Neither planet has enough resources to deflect it away from itself, which would mean guiding it to the other planet. The crew is asked to solve the problem. The simple solution is to destroy one of the planets. In return for resolving the situation, the crew is given information about a nebula where some hidden dark matter research should be taking place.

On the flight to this nebula, the crew picks up a cry for help. They discover a separatist research station where an accident occurred during dark matter experiments, but the results of the research were salvaged. The Separatists explain the significance of the discovery and confirm that there is a new element allowing dark matter to form outside of Earth. At this point, the crew is faced with the dilemma of whether to rescue the scientists from the base and spread their discovery throughout the galaxy, or leave the base in the lurch and thus keep the information about the new element quiet. The game ends after the crew's final decision.

## 5. Role

The unified role of the participants in the edularp is the crew of the spacecraft. However, each crew member can be characterised by his or her character trait and also by the "profession" he or she holds on the ship. The crew member has the opportunity to hone his/her skills and abilities by rotating between the stations where the different professions work. There is also a role for tutors/teachers, a description of which can be found below.

### 5.1 Player Characters

It can be challenging for a first-time player just to understand the rules of the game and learn the skills needed for their profession, so characters are more of a supplement that you can use in the game, but you can do without them. If you develop the game further and play it repeatedly, you can add characters later (it makes the game more interesting and can be a motivating factor). There are four characters in total:

| Nature | Brief description |
|---|---|
| **Ambitious builder** | Your name is [space name], you are an ambitious, determined, impulsive, hard-working person. You like to work in groups, but when it comes to action, you think a daring heroic task is more effective than working in a group. Some people criticize you for being too individualistic. However, you firmly believe that your quick ideas, solutions, and suggestions for solving problems are the best and right ones, even if they differ from the group's. |
| **Analytical researcher** | Your name is [cosmic name], you have a very wise, practical and analytical mind, and you are a very thoughtful, cautious and reflective person. You enjoy working in groups, but when it comes to action, you need to evaluate every detail and possibility so that you can respond in the most planned and responsible way, even when time is running out and the group disagrees. |
| **Cheerful socialiser** | Your name is [space name], you are a funny, cheerful, extroverted and talkative active person. You enjoy working in groups, but when it comes to action, you are a bit clumsy and like to encourage the group to keep their spirits up and have fun, even when the work is demanding and things are tense. |
| **A kind peacemaker** | Your name is [cosmic name], you are an enthusiastic, sincere, kind and lovable person. You firmly believe that the group is more important than the individual. You enjoy working in groups and when it comes to action, you support it with peaceful leadership. You care that the thoughts and feelings of all crew members are taken into consideration. But you are also a very particular person, and in the end the democratic way is the best and the right way for you. |

Characters are distributed to the players during the initial workshop. Each character has their own story that they come to the mission with, which they can use to spice up the game.

## 5.2 Starflyer Crew Call (habitat)

The crew of the Starflyer (i.e. all the students involved) share equally in the operation and repair of the ship. This forms the main focus of the five stations where players solve a variety of mathematical problems. Correctly solving the problems determines the continuation of the Starflyer's flight. At some stations, players will know straight away whether they have solved the problem. At the explorer

station, they do not learn this information directly, but only relay the result to the shooter station. In each round, one station is occupied by one group of players. After the next jump, the players swap stations so that successively (over five game rounds) all players visit all stations. The table gives an overview of the stations:

| Habitat | Task | Non-Player Character (NPC) |
|---|---|---|
| Navigators | The navigators are calculating the hyperjump vector to the next planet. | The NPC tells the players if they have counted correctly. If there is an error, the group of navigators must recalculate, or pay for the error with dark matter. |
| Explorers | Explorers are mapping the area around the ship to see if there are dangerous meteorites or resources around. | The NPC will not tell the players if they have calculated the examples correctly. The result is passed directly to the shooters. |
| Shooters | Defending the ship from dangerous meteorites and acquiring resources of material value for the ship. | The NPC will not tell the players if they have calculated the examples correctly. Players will learn the result through an animation in an interactive presentation. |
| Repairers | After each hyperjump, the repairmen have to put the ship back in order. | The NPC tells the players if they have counted correctly. If they make a mistake, the players must recalculate or pay for the mistake with dark matter. |
| Engineers | After each jump, the engineers optimise the ship's reactor to provide energy for the next jump. | The NPC tells the players if they have counted correctly. If they make a mistake, the players must recalculate or pay for the mistake with dark matter. |

A more detailed description of the specific mathematical examples at each station is given in the tutorials of each station (see appendices).

5.3 NPCs (non-player characters) and their position in the edularp

The instructors in the edularp take the role of **androids**, which are robots that are present on the ship. The androids assist players when needed, but do not influence player decision-making. They check the correctness of the calculated examples at each station, supply the necessary props to the stations, and change the assignment of the examples. To add to the atmosphere, the android can wear a robot costume, move around and speak in choppy tones. It is more of a helper here, but if necessary, the android can take on the role of educator or even motivator if the circumstances require it.

Other non-player characters can be found on many of the planets visited. These roles do not have to be portrayed by tutors, they are artificial characters for presentation. The texts of the characters need to be read. In order for players to better distinguish between the lecturer, who is an android at the moment, and then reading the non-player characters from the presentation, it is useful to change the position of the voice (the android can speak robotically, the character from the presentation human-like). Also, on some planets there are multiple characters, so it is appropriate to have one character read by one lecturer and another character read by another lecturer. Characters from the presentation bring new information and dilemmas to the game.

## 6. Game mechanics and principles of the game

6.1 Basic rules

Players are familiarised with the rules to players during the initial workshop. Edularps in general are games where player activity is desirable and their own contribution should be valued, but even edularps have limits and there are ground rules. Adherence to the rules is a requirement for participation in the game. These rules are:

1. Respect for the information on printed materials and emphasis on fair play. Players respect the information they learn from NPCs.
2. Increased attention to safety, especially when moving around the room.
3. No physical contact between players within the game. No physical competition is allowed.

6.2 Presentation

The classroom shows the inside of the Starflyer spacecraft, while the presentation projected on the interactive whiteboard shows the view from the ship. Through the presentation, players can virtually visit various other planets besides Earth and meet its inhabitants. The presentation depicts the journey through the Universe, the various dilemmas on the planets that the crew solves and as a result the presentation presents the story that the players experience.

## 6.3 Controlling the ship

The ship is controlled by five stations where players are located. The stations are spread around the room (spacecraft) so that the different groups cannot see each other. Player contact during math problem solving is not prohibited, but groups should not mix.

Before each game round (hyperjump), tutors (NPCs in the role of androids) distribute tasks to solve at each station. The correctness of the solution is verified by the tutors and androids after calculating the problems. For some stations, the players are immediately told whether they have solved the problem correctly, for others they are not. The procedure before each hyperjump is as follows:

1. The crew decides which solar system to move to via hyperjump.
2. Navigators must correctly calculate the hyperjump vector to the next selected system. If they solve the task incorrectly, the android prompts them to correct it.
3. In every star system, there is always an unknown object moving near the ship. Explorers must determine what the object is and communicate this information to the gunners. The NPC at this checkpoint never communicates whether it is resolved correctly or not. Players will only find out through a video of an interactive presentation.
4. For each stop, the shooters have to calculate several examples corresponding to alternative scenarios (an asteroid approaching the ship or a resource that can be mined). After learning from the scouts what the object is, they report to the officers whether they have decided to fire a missile at the object and destroy it - or send a drone to intercept it. Also, at this checkpoint, the androids do not tell the players whether the example is solved correctly.
5. After each hyperjump, the repairers have to decide which part of the ship to send the repair robot to. If they do not solve their task correctly, the game cannot progress further. In case of failure to solve the task, the players are immediately asked by the instructor to correct it.
6. Engineers at their station are tasked with optimising the ship's reactor each round. If they fail, the NPCs are immediately called upon to correct the task; the ship cannot continue to fly without a properly rotated solar sail.

In case the scouts or shooters make a mistake, they are not explicitly told. Then, if a task is solved incorrectly at any station, the NPC will trigger a video sequence in the interactive presentation indicating the failure. The ship is hit by an asteroid or crashes into an asteroid itself. At this point, the trainer tells which station made the mistake. If both habitats are successful and have managed to destroy the asteroid or attract a resource to the ship, the animator triggers the success sequence. If unsuccessful, the "fixer" station is told that the example was unsuccessful and the Starflyer crew loses a unit of dark matter.

The animation of success or failure is triggered very easily by the lecturer by clicking on the right part of the button in the interactive presentation. Participants of the edularp have no way of knowing that the interactive tile is actually split in half. The right half of each tile refers to the failure animation, while the left half refers to the success animation.



Interactive presentation with the choice of getting the object or destroying the object. Each tile is composed of two buttons, which are not visible on the presentation. Clicking on the left half of the tile triggers a success animation, the right half a failure animation. The selection of success or failure is the same for each solar system (5 in total).

## 6.4 Other interactive screens

In the interactive presentation, hidden buttons are used in case of a dilemma with an unknown creature. This is a snapshot of a scientist at an egg problem where groups must agree on one of five possible solutions. To scroll the interactive presentation to the chosen option, the trainer selects the hidden buttons located in each corner of the slide and in the middle at the top of the slide (5 buttons in total). It is advisable to try out the hidden button mechanism before the game. The buttons are arranged as follows:

1) option to destroy the egg - top left

2) the possibility to breed the creature in laboratory conditions - top centre

3) the possibility to breed the creature in captivity - top right

4) the ability to release a creature on a suitable planet - bottom left

5) option to release the creature - bottom right.

## 6.5 Mathematical solutions of individual habitats

For each station there are 5 mathematical problems and a tutorial - i.e. instructions for solving them. The instructions for solving the stations are left from the beginning only at the navigators' station. All other stations will only receive the math problem instructions. The players' task is to figure out the solution to the problem without further help. If the group cannot figure out the solution to the problem for an extended period of time or fails, they may choose to ask the androids for help. This step requires the use of dark matter as the ship's energy. For one unit of dark matter per round, the group may receive a tutorial on the task or a calculator. At the end of the round, the group returns the tutorials and calculators. An alternative to using a calculator is a cell phone.

The mathematical tasks will not be discussed in detail in the manual. They may vary based on the country of the game (Italy, Czech Republic, Spain) or may be modified before the game based on the school's requirements. All problems are presented in the appendices, including tutorials, which should provide sufficient information for the tutors to become familiar with the nature of the problems and their solutions.

## 6.6 Movement of Starflyer through the solar system

When looking at the map of the star system that forms the assignment for the group of navigators, it is obvious that players can get to different solar systems in hyperjumps. This mechanism gives players the illusion of non-linearity in the game. In reality, it is completely indifferent which solar system the Starflyer goes to. In each solar system, Starflyer visits a planet. The last location "NGC-71 nebula" is also in some (initially unspecified) solar system. However, the order of the planets is determined by the order of the slides in the presentation and is completely linear. The players do not know this information. It is indifferent where on the star system map the Starflyer is located and what other solar system the players choose for the next hyper jump. The information about the specific location of the Starflyer is only handled at the end of the game, when players are asked to find out where the NGC-71 nebula is located in the "Inexpectat" location. At this point, we simply find out where the ship is currently located and select the nearest star system that the ship can reach (see the navigators tutorial and navigator problem solving) and communicate through the mouth of the android that this location has been received by the inhabitants of the Inexpectat system.

## 6.7 Dark Matter

As mentioned, dark matter is the fuel of the Starflyer and a representation of a resource that players can use at various points in the story. Physically, dark matter can be represented in a number of ways - by tokens, board numbers, cards, etc. The Starflyer has a total of 10 units (we can call them containers, for example) of dark matter at the start. We physically prepare 10 tokens that are easily visible to all participants (e.g. on a table in the middle of the room, a number on a clearly visible board,

etc.). At each hyperjump to the next solar system, we take one dark matter token from the players. If the interactive presentation shows that the Starflyer is donating or receiving dark matter, we can add/remove tokens to the group. If a group decides they want to receive a math problem tutorial or calculator in exchange for dark matter, the trainer will remove the dark matter token from the group. Token acquisition is possible through resource acquisition (explorer and shooter stations). If both groups calculate their assignments correctly and it turns out that the crew should acquire dark matter, the tokens are added. If the crew is running low on dark matter (e.g. due to frequent use of tutorials), the crew can improvisationally replenish dark matter, preferably at the moment they acquire a resource or acquire dark matter within the story. In such a scenario, we give the crew more units of dark matter to keep the game going. However, it is also possible to let the ship's crew completely run out of dark matter and not artificially increase the amount. In this case, the Starflyer cannot prepare for the next hyperjump, and the alternative endings may be different. The crew can perish in space, be rescued by a random spaceship over an extended period of time, etc.

## 6.8 Decision-making system

There is no commander on the Starflyer, the entire crew should be able to handle all jobs and be interchangeable. It is therefore democratic. However, the work teams remain the same, and the players have to solve many moral dilemmas during the flight. Each working group will devise their own decision-making system to follow in the event of dilemmas during the initial workshop. We encounter, for example, democratic, totalitarian or random decision-making systems (coin toss, rock-paper-scissors). During the game, players can change their decision system once. Thus, the Android asks each team separately for their decision and the resulting decision is democratic (e.g., two groups vote for option A, three groups vote for option B, option B wins).

## 7. Equipment and preparation of the game area

The Edularp Starflyer is played indoors and one larger school classroom is sufficient. The equipment needed to run this game:

- a computer with a data projector on which we will run a presentation with the view from the spacecraft;
- six benches on which we will place the game stations and storage for NPCs;
- chairs (according to the number of players + lecturers) arranged in a circle (during the workshop, afterwards it is possible to arrange the chairs to the individual stations or move them to the side);
- a set of printed assignments, tutorials, writing materials and support materials for each station;

As mentioned in the introduction, it is also important to create an atmosphere within the edularp in order to promote intrinsic motivation of the players and to encourage them to remember more of the learned or validated material through emotional experience. Therefore, it is advisable to take care when preparing the game of:

- a set of costumes for students and lecturers;
- the sound system of the game room;
- Atmospheric lighting of the play area using LED strips or coloured bulbs (or darken the room with roller blinds, dark fabric or opaque plastic film);
- You can also create a variety of backdrops or use a fog machine (e.g. to signal the failure of a spaceship when it collides with an asteroid).

A school classroom represents the inside of a spaceship. Before the game, it is therefore necessary to set up five game locations (benches) for each profession. There needs to be space around each bench for players to sit or stand. It is also advisable to place a bench somewhere in the space with materials for the lecturers. The computer bench is for the lecturer who controls the projection of the view from the ship. The PC is therefore needed to run the interactive presentation.

Each site needs to be permanently placed:

- writing utensils and note papers for players;
- special materials for individual sites.

## 8. The course of the game

The Edularp has three phases. The first one is an introductory workshop, during which students learn about the concept of edularp and the rules of the game. This is followed by the edularp itself, which takes place on board a spaceship and lands on each planet. After the edularp, there is a final workshop in which the pupils step out of their assigned roles and share their experiences together, summarising the knowledge and skills they have acquired. In the table below we give an approximate time estimate for each phase of the game, but this may vary for different groups of players.

| Planet | Stages | Time (min.) | |
|---|---|---|---|
| Country | Introductory workshop | 60 | 60 |
| Ronus (A) | Work on the stations | 20 | 30 |
| | Contact with the planet - discussion and choice | 10 | |
| Pauper Stellae (B) | Work on the stations | 20 | 30 |
| | Contact with the planet - discussion and choice | 10 | |
| Research station | The problem with the egg | 15 | 15 |
| Bellum Nebulae (C) | Work on the stations | 20 | 30 |
| | Landing on the planet - discussion and choice | 10 | |
| Stellae Inecpecta (D) | Work on the stations | 20 | 30 |
| | Landing on the planet - discussion and choice | 10 | |
| Arcanus System (E) | Work on the stations | 20 | 30 |
| | Landing on the planet - discussion and choice | 10 | |
| Country | Final workshop | 60 | 60 |

Twenty minutes at the station should be the time it takes students to solve the problems. Often they need to get used to the situation in the first game round, so it can be longer. More skilful groups can do the arithmetic in 10-15 min. We have found it useful to remind players of the time, e.g. 10 min to go and 5 min to go. Primarily, students are to count independently at their workstations, but if they come up with the initiative to help each other, we as tutors encourage them to work together (the assignments change with each planet, so it will be a new example for everyone). Landing on a planet always varies in time - every decision is different, but see the 10 min. limit as a maximum (more often we are around 5 min.).

The length of the opening and closing workshops may also vary. If you include the characters in the edularp, the introduction will take longer than without them. Some groups will be interested in a discussion, others will be satisfied with simple answers and instead of an hour, the conclusion will be 30 min. The edularp can thus be completed in at least about 3.5 hours and the longest can be 4.5-5 hours.

Ideally, you should tell the players how breaks will be arranged - either they can have a snack and go to the toilet at any time during the game, or you should include a uniform break somewhere in the middle of the game. The break should ideally be integrated into the story of the game so that players don't fall out of role unnecessarily. For example, the Android can say that the instruments are reporting a possible power drain on the crew. Food sources need to be replenished.

The game starts on board a spaceship (where the whole story takes place), which is flying from the planet Earth to the solar system, where the planet Ronus is located. On each planet we give background information, a problem to solve, options, non-player characters present, moral dilemmas, and materials needed. As part of the presentation, you will always see what options players have - which planets they can currently visit (they don't have to be in order as we have them listed in the manual).

## 8.1 Countries
- **Background information**: Earth is the starting point for the ship. The crew is familiar with the mission. Each group can create their own moral code and rehearse the decision-making system.
- **Problem to solve**: On Earth, the ship's crew has no problem to solve. They are merely reiterated the main objectives of the mission (to find a potential source of dark matter). In this location, the ship's crew has not yet solved any mathematical problems.

## 8.2 Planet Ronus
- **Background**: Ronus is a planet where the crew is aware of the separatist movement and is still relatively close to Earth.
- **Problem to solve**: The dark matter supply from the C system (Bellum system) stopped a few months ago. The crew is asked to explore this system to help the planet Ronus.
- Crew can (crew must choose only one option)
    - ask for more information (leads to more information about Bellum)
    - aggressively demand information about dark energy research (the crew does not get the information and is reprimanded by an Earth representative)

- o require supplies based on Proxima Centauri's loyalty to Earth (the crew gets more dark matter, but is reprimanded by Earth)
- **NPC**: Isaak, Earth's representative on the planet Ronus. In the later stages of the game, the character may discover that he is a traitor.
- **Moral dilemmas**: none, consultation round without further discussion

## 8.3 Pauper stellae system (system B)

- **Background**: the Pauper system is the first solar system to be heavily affected by a lack of dark matter and poor living conditions. The people of Pauper are starving due to climate change. They are desperate for some dark matter to leave Pauper and go to Earth. In return, the planet will provide information about the separatist station and dark matter research.
- **Problem to solve**: The crew must decide how to resolve the situation. The planet demands dark matter from the crew, but if donated, it may be missing for the successful completion of the mission.
- **Options:**
  - o The Starflyer complies with the request for help and provides dark matter (causing a very negative reaction from Earth, loss of the ship's dark matter, and information about the Separatist lab.
  - o Refuse the request for dark matter and fly away (causes a positive reaction from Earth and shows bad news about deaths on Pauper).
  - o Refuse the request and threaten Pauper to get information about the Separatists (causing bad news about Pauper's fate and misleading clues about the Separatist research station).
- **NPC**: A representative of the planet Pauper Stellae, or a representative of Earth
- **Moral dilemmas**: should we help or not, that is the question. Helping has negative consequences for the crew.

## 8.4 Research station

The crew encounters a research station (not located at any solar system). In this location, it is not necessary to count examples at the stations, only present the crew with a problem to decide as an authority (Earth representatives). Scientists have discovered an unknown egg and present different scenarios of development (keep the creature in a lab, release it into the wild, etc.). For dilemmas, probabilities of problems or potential benefits are presented. The crew must make a decision, first in individual groups and then as a whole. It then proceeds to the next solar system (no more dark matter units are taken).

8.5 Bellum nebula system (system C)

- **Background information**: the Bellum System is on the brink of war. Two continents have declared war. Each continent is gathering every piece of dark matter available to gain supremacy. The continent of Sinistram offers the crew vital information on a Separatist base in exchange for dark matter, the continent of Dexteram offers information on a Separatist traitor near Earth. Both continents claim their adversary is lying.

- **Problem to solve**: The crew does not know any relevant arguments about this conflict. Both sides are asking for dark matter. For the first time, the crew can foresee the consequences of discovering a new element. What would these systems do if dark matter became available to all? It could lead to disaster. Discussion should be encouraged.

- **Options**:The crew can choose from a variety of options:
  - Provide the dark matter of the Sinistram continent (the characters get information about another solar system where the Separatists should be located or known about).
  - Provide the dark matter of the continent of Dexteram (the crew learns information about the separatist, who is the character of the planet's spokesman, Ronus - this one the characters already know).
  - Threaten both continents, force them to start discussing and use the authority of planet Earth. [Leads to the acceptance of much dark matter from the planet and a peaceful resolution of the conflict. Crew receives information about the Separatist base (clue 2/3)].

- **NPC**: Sinistram representative and Dexteram representative

- **Moral dilemmas**: is it okay to use authority and power for a good reason?

The pupils decide where to fly next. They then carry out tasks within their profession.

Here the story temporarily branches - the crew can return to the planet Ronus, where they will follow the separatist Isaak to the Inexpectat system, or go straight there. This decision has implications for the story of the planet Ronus.

8.6 Stellae inexpectat system (system D) - two planets (Sanus and Vultus)

- **Background information**: the Inexpectat is a system of two planets (Sanus and Vultus) that are in big trouble. A meteor is orbiting them unpredictably and will soon hit one of these planets. There are two possible solutions. The easy solution is to divert the meteor from one planet and save it, but in the process destroy or damage the other planet. The other planet will be destroyed. Different arguments will be presented on each planet. In the case of waiting, the fate of the system will be decided by chance.

- **Options**: The crew is presented with different information about each of the planets. Each group of players (by profession) can choose which information they are interested in (e.g. population, crime, political system, etc.) The information is then made available to all groups. If a crew wants more than 5 pieces of information, each additional piece of information needs to be paid for with dark matter. The crew must then decide unanimously. One of the planets is damaged by a meteorite. In each scenario, the ship receives the coordinates of the Arcanus system, which could provide information about the secret lab, plus a 3/3 clue.
- **NPC**: Representative of the planet Sanus and representative of the planet Vultus

## 8.7 Arcanus system (system E)

- **Background information**: during a jump into this system, the crew receives a distress call from one of the planets in the system. A research station is calling for help, one of their experiments has gone wrong. The crew discovers a separatist lab (with the final results of research on how to extract dark energy). If the Starflyer crew does not help the scientists, the station will be destroyed and with it the research. If they help, the scientists will spread the research results throughout the galaxy.
- **Problem to solve**: How to handle the situation and what to do with the dark matter formula? Which is the right decision? The crew makes a decision based on the information they have gathered during the game.
- **Options**: the crew can discuss several decisions:
  - To help scientists and spread knowledge of the new element (source of dark matter) throughout the Galaxy
  - Let the scientists die and preserve the status quo throughout the galaxy
- **NPC**: Scientists at the research station
- **Moral dilemmas**: what to do with the dark matter formula? What is the right solution to the whole situation?