



# **PIAF - Pedagogical Scenario**

(PIAF = Développement de la pensée informatique et algorithmique dans l'enseignement fundamental – Development of computational and algorithmic thinking in basic education)

# Title

Be Quick!

# **Practical Information**

(Ideal) Number of students: 16 Age of the students: 9 – 12 years Duration of the scenario: 4 sessions of around 40 minutes each

# Main discipline of the Scenario

- C 1.4 Describe the outcome of a sequence of actions
- C 3.1 Repeat an action sequence a certain number of times
- C 4.2 Compare two objects according to a given criterion

# **Description**

Learners are presented to different algorithms used by computers to sort numbers. At first, learners are presented with the challenges of sorting arrays of numbers and strings (e.g. names). Then they learn the algorithms designed for computers for sorting arrays of numbers. The taught sorting algorithms are Radix, Bubble and Selection. Students learn these algorithms first by a topic introduction by the teacher and then by hands-on activities either on paper or through physical exercises.

# PIAF-specific competencies/goals

Spe	Specific PIAF Competencies:		
C1	Competency 1: Abstracting away / generalizing > 1.4. Describe the outcome of a sequence of actions > Students describe and execute the steps needed, and their correct order, for each sorting algorithm. Students are orally asked to describe the order of steps of each sorting algorithm.		
C2	Competency 2: Compose/decompose a sequence of actions > 2.2. Complete a sequence of actions to reach a simple goal > Students define and execute their personal strategies for searching an element from a sorted or unsorted array of elements. Students follow the specific sets of steps used on different sorting algorithms to be able to sort an array of numbers.		







C3	Competency 3: Control a sequence of actions > 3.1. Repeat an action sequence a certain number of times > Students repeat the specific action sequences of the steps from each sorting algorithm such as comparing pairs of numbers and determining which one is bigger.
C4	Competency 4: Evaluate objects or sequences of actions > 4.1. Compare two objects according to a given criterion > Students are tasked to compare two numbers and decide whether to rearrange them or not based on which number has a bigger value

# Pre-requisite for the activities

Numbers: comparing numbers (i.e. lesser than, greater than)

# **Digital Resources**

Technical	Didactic
Tool for measuring time (stopwatch, cellphone)	Course notes and attachments







# Organization of the classroom









# Scenario (Sequence of the activities)

Activi	Activity 1: Importance of Sorting		
1.	Introduction (2')	<u>Group Format</u> : Whole class <u>Instruction</u> : <i>"Today you will be organizers. You need to help in finding certain items as quickly as possible. Let's start with the following activity."</i> <u>Students task:</u> If any, students may inquire about the activity <u>Instructors' role</u> : Introduce the task and answer students questions (if any)	
2.	Find the names (13')	Group Format: Whole class/ Individual Document: Attachment A for teachers; Attachments 1 and 2 for students Instruction: "I will distribute two different sheets (Attachments 1 and 2) with many names. We need to find some names. I will give you the first sheet, we do the exercise and then I will give you the second sheet. Please only start looking for the names after my signal. Once you <b>circle</b> all three names, raise your hand silently. <i>Ready? The names you need to find are 'Anna, Luke, and</i> <i>Jenna'. Go!." "Now, using the second sheet, we'll repeat what</i> <i>we just did. Are you ready?"</i> <u>Students task</u> : Look for the names on each sheet <u>Instructors' role</u> :. Record the time needed for the first and last student of each sheet to find the names. Explain how sorting the names according to alphabetical order simplifies the search. Students interact by responding to the questions. <u>Expected response:</u> All students should be able to find the 3 names. Some students may require more time, others may be tempted to tell other fellow students where the names are	4.1
3.	Who ate the pie? - unsorted (10')	<u>Group Format:</u> Whole class/ Individual <u>Document:</u> Attachment B for teachers <u>Instruction:</u> "Now that you have seen how organizing items helps in identifying items easily, your help is required in a new case. We will start by unorganized guesses and then see the difference if guesses are organized. Now we want to help Ms. Agnes. She is angry because a dog came into the house and ate her pie. Even though she closed the door, she forgot to close the small kitchen window. The dog that came	2.2 3.2











	in is big enough to reach the window but not so big because otherwise it wouldn't fit through the window. Because of this, Ms. Agnes is sure the guilty dog is 20 cm tall. Inside these boxes, we have 6 suspects from the neighborhood, each wearing a tag showing their height. Let us look for the dog that ate the pie. I will pick students to point to the box to open and find the dog!" <u>Students task</u> : Students interact by responding to questions <u>Instructors' role</u> : Guide the class with questions to reach the goal. Count the amount of attempts the students needed for finding the correct dog. <u>Expected response:</u> Maximum number of attempts is 5.	
4. Who ate the pie? – sorted (15')	Group Format: Whole class <u>Document:</u> Attachments B and C for teachers <u>Instruction:</u> "This time the detective helped us organize the dogs based on their heights. What do you think will happen? Will it take us more time to find the dog? Let us give it a try I will reorganize the dogs and boxes on the board so we can give it another try. The police just added more suspects. This time I will add other dogs of different heights." <u>Students task</u> : Students interact by responding to questions <u>Instructors' role</u> : Leads students to the conclusion that organizing helps save time. Ask students retrospective questions. <u>Expected response:</u> All answers are accepted at this point.	2.2 3.2 4.1
5. End of session: finalize activity and summarize (5') Activity 2: Radix So	<u>Group Format</u> : Whole class <u>Instruction</u> : <i>"What did we learn today?"</i> <u>Students task</u> : Verbal description of what has been learned during this session <u>Instructors role</u> : Guide the students with questions for obtaining the expected answers Covered topics: -Organizing items helps us become more efficient	
1. Reminder (5')	<u>Group Format</u> : Whole class <u>Instruction</u> : "Can someone remind me of what we did last time?" <u>Students task</u> : Verbal description of the	









	activities done in the previous session <u>Instructors' role</u> : Guide the students with questions for obtaining the expected answers Covered topics: -Finding names on random and organized lists -Ms. Agnes found the dog faster after the detective organized the dogs by height	
2. Radix Sorting - Intro (15')	Group Format: Whole class <u>Document:</u> Attachment D for teachers <u>Instruction:</u> "Today, we will talk about sorting data in computers. We will learn some ways computers organize and sort numbers. I will now ask you to focus with me on the numbers on the board. I can tell that many of you have already sorted them mentally. However, when the computer has the numbers, it cannot think like us, and can only work using a strategy and taking it step by step. Let's see how we can arrange numbers using the Radix Sorting method." <u>Students task</u> : Students interact by responding to questions <u>Instructors' role</u> : Explain Radix sorting	3.1 4.1
3. Radix Sorting - Try it yourself (15')	Group Format: Individual <u>Document:</u> Attachment D for teachers; Attachment 3 for students <u>Instruction:</u> "Let us see how well you understood this method. Solve the following sheet and once done we will discuss the answers." <u>Students task</u> : Solves the sheet <u>Instructors' role</u> : Attentive to support <u>Expected response</u> : Some might find it challenging, the instructor can facilitate by reminding the steps and to not skip or do the steps in different order.	1.4 3.1 4.1
4. End of session and summary of activity (5')	<u>Group Format</u> : Whole class <u>Instruction</u> : "Today we learned about the Radix sort method. Can someone explain to me the steps done in the Radix sort method?" <u>Students task</u> : Verbal description of what has been learned during this session <u>Instructors' role</u> : Guide the students with questions for obtaining the expected answers Covered topics:	1.4







	-Radix sorting	
Activity 3: Bubble	Sorting	
1. Reminder (5')	Group Format: Whole class Instruction: "Can someone remind me how the Radix sort method works?" Students task: Verbal description of the activities done in the previous session Instructors' role: Guide the students with questions for obtaining the expected answers Covered topics: -We used Radix sorting to organize the numbers from least to greatest. The individual steps of the Radix sort algorithm	1.4
2. Bubble Sorting - Intro (12')	<u>Group Format:</u> Whole class <u>Document:</u> Attachment E for teachers <u>Instruction:</u> "Today we will learn another type of organization method used by computers. If I pour gaseous water in the glass, you noticebubbles. You see, the large bubbles will rise first, then the smaller ones follow. The same applies to Bubble sorting, the new method we'll learn today. I need 6 volunteers to stand in front of the room. We are going to sort the height of the volunteers. Let's sort an example together. " <u>Students task</u> : Voluntary students take the roles as instructed. Other students interact by responding to questions. <u>Instructors' role</u> : Explain the bubble sort algorithm using the example of sorting height of the volunteers.	3.1 3.2 4.1
3. Bubble Sorting - Act it out! (15')	<u>Group Format:</u> Whole class <u>Document:</u> Attachment F: Teacher's sheet <u>Instruction:</u> "I will take 6 volunteers to hold the numbers. The rest will help us apply the Bubble sorting strategy. I will call on you to come up and instruct the students to open the card and take the action needed to achieve our goal." <u>Students task</u> : Students take the roles as instructed <u>Instructors' role</u> : Facilitate the activity	1.4 3.1 4.1
4. End of session and	<u>Group Format</u> : Whole class <u>Instruction</u> : "Today we learned about the Bubble sort method. Can someone explain to me the steps done in the Bubble	1.4











summary of activity (8')	sort method. Can any of you compare the differences between Radix and Bubble sort method?" Students task: Verbal description of what has been learned during this session Instructors' role: Guide the students with questions for obtaining the expected answers. If possible, ask them to compare between Radix sorting and Bubble sorting. Covered topics: -The 2 sorting algorithms: Radix and Bubble -Bubble sorting as another organization strategy	
Activity 4: Selection	n Sorting	
1. Reminder (5')	<u>Group Format</u> : Whole class <u>Instruction</u> : "Can someone remind me of what we did last time? Can someone remind me how the Bubble Sort method works?" <u>Students task</u> : Verbal description of the activities done in the previous session <u>Instructors role</u> : Guide the students with questions for obtaining the expected answers Covered topics: -We learned about Bubble sort algorithm to organize the numbers from least to greatest	1.4
2. Selection Sorting - Intro(12')	Group Format: Whole class <u>Document:</u> Attachment G for teachers <u>Instruction:</u> "So, let's sort the following numbers using Bubble sort. Then we will sort the same numbers using Selection sort, the new method you will learn today." <u>Students task</u> : Students interact by responding to questions <u>Instructors role</u> : Show the different number of steps in each sorting method <u>Expected response:</u> Some students might find one of the strategies easier than another	3.1 4.1
3. Selection Sorting - Act it out! (15')	<u>Group Format:</u> Individually <u>Document:</u> Attachment H for teachers <u>Instruction:</u> "I need 7 volunteers to hold the numbers. The rest will help us do the organization using the Selection sorting method. I will call on you to come up and instruct the	1.4 3.1 4.1











	students to open the card, select the card if needed and swap it until we achieve our goal." <u>Students task</u> : Students take the roles as instructed <u>Instructors' role</u> : Facilitate the activity	
<ol> <li>End of session and summary of activity (15')</li> </ol>	<u>Group Format</u> : Whole class <u>Instruction</u> : <i>"What did we learn today? Which are the (3)</i> <i>sorting methods we learned? How do each of them work?</i> <i>Which one is your favorite? Why?"</i> <u>Students task</u> : Verbal description of what has been learned during this session <u>Instructors' role</u> : Guide the students with questions for obtaining the expected answers. If possible, ask them to compare between each sorting method Covered topics: -The 3 sorting algorithms: Radix, Selection, and Bubble -Selection sorting as another sorting algorithm	1.4







#### Assessment

Following a specific sorting method, ask the students to sort a set of numbers.

Competencies/ PIAF- Goals	Activities for the assessment	Assessment criteria
1.4. Describe the outcome of a sequence of actions	Students describe and execute the different steps taken to reach the ordered numbers	Being able to recognize the different steps taken in each sorting method
2.2. Complete a sequence of actions to reach a simple goal	Students define and execute their personal strategies for searching an element from a sorted or unsorted array of elements.	Selecting the correct actions to arrange numbers
3.1. Repeat an action sequence a certain number of times	Students repeat the specific action sequences of the steps from each sorting algorithm.	Using place values to compare numbers and switching numbers following correct steps.
4.1.Compare two objects according to a given criterion	Students compare pairs of numbers and determine which one is bigger.	The successful execution of the sorting algorithms and that the numbers are correctly sorted on each step.

### Received Feedback on the created Scenario

If you have had the opportunity to experiment with the scenario presented here, suggest some feedback on it: what worked well, the obstacles encountered, the learner's feedback, your feelings, possible ways to improve it.







# Bibliography

Studyflix. (2019). Bubble Sort. https://studyflix.de/informatik/bubblesort-1325

Tyagi, Arjun. (2016, September 24). *Radix Sort-GeeksforGeeks* [Video]. Youtube: <u>https://www.youtube.com/watch?v=nu4gDuFabIM</u>

Tyagi, Arjun. (2016, September 24). *Selection Sort-GeeksforGeeks* [Video]. Youtube: <u>https://www.youtube.com/watch?v=xWBP4lzkoyM</u>

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# Attachments

# **Attachments Overview**

Activity	Teacher Attachment	Student Attachment
1.2	А	1, 2
1.3	В	
1.4	B, C	
2.2	D	
2.3	D	3
3.2	Е	
3.3	F	
4.2	G	
4.3	Н	







# **Teacher's Attachments**

#### Teacher's Attachment: A

Used in activity:	1.2: Find the names
Along with Student's Attachment(s):	1 and 2

#### Sub-activity with Attachment 1: Unorganized names

Give one copy of Attachment 1 to each student. The attachment contains a dashed line that you can use to fold the page before giving it to the student to ensure they don't immediately start the exercise. Once everyone has a sheet, ask the students to search for the three names. Ask them to raise their hand silently once they have found the names. Record the time for the first show of hand and the last show of hand. (make sure that all of the students are focused on the activity)

#### Sub-activity with Attachment 2: Organized names

Now that the names are organized. Repeat the same process. Ask the students to raise their hand silently and record the time taken for the first and last show of hand.

#### Discussion and questions after completion of the 2 sub-activities

Share with the students the fastest and slowest times from each sub-activity and indicate on which sub-activity the response times were better. **Ideally, the time taken in the second sub-activity should be shorter.** 

Ask the students why they think this happened? The final answers should highlight that on the second list the names were sorted alphabetically, which made it easier to find the required names.

Once the students are aware of how advantageous it was for them to have a list of names sorted alphabetically, the following conclusion can be mentioned: "Therefore, organizing and arranging the items we are working with helps us identify what we need in a better way."

Relate this conclusion to items students may have at home: "How much easier is it to find a spoon in the kitchen than in a bedroom? It has its own place - usually in one of the drawers along with all the other spoons. Imagine you need to find a spoon in the bedroom or your clothes from a basket every morning. Being organized is more efficient"







#### Teacher's Attachment: B

Used in activity:	<ul><li>1.3: Who ate the pie? - unsorted</li><li>1.4: Who ate the pie? - sorted</li></ul>
Along with Student's Attachment(s):	none

Here you will find images of dogs, badges and boxes to print. For activities 1.3 and 1.4, you will be rearranging the badges and dogs behind the boxes.

Ensure all dogs fit behind the box images and that all the boxes are the same size. The dog with the <u>20 cm</u> tall badge is the one that ate, therefore any dog can be picked as the guilty one.

Hide each of the dogs behind a box and attach them to the board. Start by narrating the story of Ms. Agnes, an old woman who left the pie on the table and went to the market. The window was half open. When she came back, she saw that the pie was eaten! The police have suspects of the dogs that were in the area and the woman will try to find the dog. We know that the guilty dog is <u>20 cm</u> tall.

Let us help by selecting a box and looking at the dog.

The teacher will ask different students to find the dog. Each student will have up to 5 attempts to find the guilty dog. If the guilty dog is found, record the number of trials (on a whiteboard, notepad or similar) needed by each student. After each student, rearrange the boxes. At the end, compare the number of trials from all the students who participated.

Explain that some got lucky and some did not. Ask the students to observe the highest number attempts possible to find the dog. ( = 5 times)















































Print 1 box for each dog. Ensure that all printed boxes are the same size and that they are bigger than the printed dogs









#### Teacher's Attachment: C

Used in activity:	1.4: Who ate the pie? - sorted
Along with Student's Attachment(s):	none

This time, using the same printables from Attachment B, arrange the hidden dogs from short to tall. Tell the students that this time they'll have **up to 3 attempts** to find the correct guilty dog of 20 cms.

**Note**: Highlight that the suspected dogs might be different this time and that the height badges have also changed. This is to guarantee they do not choose based on their memory of the dogs (and their location) presented earlier.

Allow random students to try and find the dog. Record the different attempts taken every round.

#### Closing the activity and retrospective

Discuss the maximum number taken and the strategy used. Some strategies that could have been used are:

- Randomly select the boxes
- Start from one side (beginning or end)
- Start from exactly the middle.

Ask the students:

- 1) How did you try to find/guess where the guilty dog was? Did you have any method or strategy for trying to find the dog before running out of attempts (5 for the first activity, 3 for the second)? If yes, could you briefly share it to the rest of the class?
- 2) Was it easier to try to find the guilty dog at the beginning when the dogs were not organized by height or on the second time?

In conclusion, the students should notice that if we order our dogs from the smallest to biggest on a left to right order, as soon as one box is chosen, we can remove from the suspect list other dogs as well. For example, if we're looking for a 20cm tall dog and the dog in the opened box is 15cm tall, then we can discard that dog as well as all the other dogs (in unopened boxes) on the left side if that opened box from the list of suspects. It is thus more efficient to pick the box in the middle as we eliminate from our suspect list half of the remaining dogs each time. That is why organizing from least to greatest would save time.

Finish the exercise by saying: "The same applies to finding numbers. If I say, I am thinking of a number between 0 and 50 and ask you to guess what the number is. Instead of counting from 0 and on, you can ask, is it below 25 or above. Then the guess is reduced by half already...and you continue with the same strategy until the number is guessed. "







#### Teacher's Attachment: D

Used in activity:	2.2: Radix Sorting - Intro
	2.3: Radix Sorting - Try it yourself
Along with Student's Attachment(s):	3

**Before the lesson:** The following videos in English can help you understand how the Radix sorting works.

Video 1: https://www.youtube.com/watch?v=nu4gDuFabIM

Video 2 (only the first 2 minutes): <u>https://www.youtube.com/watch?v=XiuSW\_mEn7g</u> Explain the students by doing a Radix sorting in front of them using the numbers of your choice. You can use the same numbers from the videos.

Main points about Radix sorting:

- The final sorting should have the lowest number on the left and the highest on the right
- Always start the sorting steps and substeps from left to right
- Step 1: Start sorting the numbers only based on the value each number has in its **ones** position.
  - Substep 1: Start with 0, that is, starting from the left, look for any number that has a 0 in its ones position. Whenever a number meets this criterion, place it at the start (i.e. left side) of the new list of numbers.
  - Substep 2: Now repeat the previous substep but this time looking for any number that has a 1 in its ones position.
  - Substeps 3 to 11: These substeps are the same as substeps 1 and 2, and cover the other numbers that can be in the units position, that is, 2 to 9
- Step 2: From the new list of numbers generated after step 1, sort the numbers only based on the value each number has in its **tens** position. Another 11 substeps are required here to individually check numbers 0 to 9. For numbers with only 1 digit, the number in its tens position will be counted as a zero.
- Step 3: From the new list of numbers generated after step 2, sort the numbers only based on the value each number has in its **hundreds** position. Another 11 substeps are required here to individually check numbers 0 to 9. For numbers with 2 digits, the number in its hundreds position will be counted as a zero.







#### Solution for Attachment 3, : Radix sorting Student's Try it yourself sheet

Exercise 1:

Numbers to rearrange:

040, 039, 128, 075, 080, 003

First step: Rearrange based on ones

040 080 003 075 128 039

Second step: Rearrange based on tens

003 128 039 040 075 080

Third step: Rearrange based on hundreds

003 039 040 075 080 128

Exercise 2:

Numbers to rearrange:

067 275 683 096 352 061

First step: Rearrange based on ones

061 682 352 275 096 067







Second step: Rearrange based on tens

352 061 067 275 682 096

Third step: Rearrange based on hundreds

061 067 096 275 352 682







#### Teacher's Attachment: E

Used in activity:	3.2: Bubble Sorting - Intro
Along with Student's Attachment(s):	none

**Before the session:** The following videos in English can help you understand how bubble sorting works.

Video 1: <u>https://www.youtube.com/watch?v=nmhjrl-aW5o</u> Video 2: <u>https://www.youtube.com/watch?v=ylQuKSwPlro</u>

The following video can be shown to the students; it demonstrates how bubble sorting works along with a dance choreography: <u>https://www.youtube.com/watch?v=lyZQPjUT5B4</u>

**For the activity:** For explaining the Bubble sorting, ask for 6 voluntary students to stand in front of the class with different height. For the first round, ask the students to watch as you compare height of the first two volunteers and then swap if needed. It is vital to verbalize the steps and the reasons for doing (or not). For example, "Now, I'm going to sort the height from the shortest to the tallest by using bubble sort method. We start by comparing first two students here. Who is taller here? If he/she is taller, we will sort them to the right place." Keep doing this until the first round is done. Thus, the tallest student will stand at the last position of the line. Once the students acquire an idea of how the Bubble sorting works, ask them to tell you what to do.

Idea for placing voluntary students for the activity

- 1.) Try not to initially place the tallest student at the last position
- 2.) Try to mix the height of students. So, it will be easier to show how bubble sort works







#### Teacher's Attachment: F

Used in activity:	3.3: Bubble Sorting - Act it out!
Along with Student's Attachment(s):	none

Note: Use the printables with number at the end of this attachment.

**Before the session:** Have the numbers written or printed on big cards so they can be hold by the students and easily seen by the other students.

**For the activity:** You will need at least 6 volunteers for holding the number cards. You can request an additional volunteer for holding an object for indicating the 2 numbers that are being compared.

Students will stand and act out the sorting exercise. Ask the students to demonstrate the Bubble sorting. Pick 6 students to stand each holding a number and then ask students to arrange the numbers. The teacher can sit among the classmates and watch the students perform the task.

Two sets of numbers are provided below as well as the sorting progression for the teacher to verify that the numbers are being sorted correctly and following the Bubble sorting logic.

**Set 1**: 40 39 128 75 80 3

Set 2: 67 275 683 96 352 71

These same two sets of numbers are used in activity 4.3 and Attachment H. The numbers for these two sets can be found ready-to-be-printed at the end of Attachment H.

#### Exercise with set 1:

	Left rectangle (unorganized numbers)					ized	Right rectangle (organized numbers)
Initial order	40	39	128	75	80	3	







First round	39 40 75 80 3	128
Second round	39 40 75 3	80 128
Third round	39 40 3	75 80 128
Fourth round	39 3	40 75 80 128
Fifth round	3	39 40 75 80 128
Final order		3 39 40 75 80 128

#### Exercise with set 2:

	Left rectangle (unorganized numbers)	Right rectangle (organized numbers)
Initial order	67 275 683 96 352 71	
First round	67 275 96 352 71	683
Second round	67 96 275 71	352 683
Third round	67 96 71	275 352 683
Fourth round	67 71	96 275 352 683
Fifth round	67	71 96 275 352 683
Final order		67 71 96 275 352 683

#### Advice:

- Continuously ask students to say what needs to be done and what happens next. Examples: "swap the positions of these 2 numbers", "move the number where the organized numbers are", "start comparing again", etc.
- It's important that the students follow the steps used on the Bubble sorting method and to discourage them from skipping steps or using another method for sorting the numbers.
- As a variation of the activity, you can assign specific roles to certain students (who are not holding a number card), e.g.: One student decides which pair of numbers to compare, another one decides if the 2 numbers that are being compared need to swap positions.
- At the end of each exercise, ask the students to briefly describe the Bubble sorting process and the final outcome, i.e. an organized list of numbers







• The teacher has the chance to assess the performance of each student individually through this activity.







#### Teacher's Attachment: G

Used in activity:	4.2: Selection Sorting - Intro
Along with Student's Attachment(s):	none

**Before the lesson**: watch this video about the Selection sorting method: <u>https://www.youtube.com/watch?v=xWBP4lzkoyM</u>

For the activity: Start the activity by asking the students to sort the following using **Bubble** sorting.

Write the following numbers on cards and arrange them in the following order:

84 27 985 48 28 843

This is how the number cards should be arranged after each pass of the **Bubble sorting** method:

	Unorganized numbers	Organized numbers
Initial order	84 27 985 48 28 843	
First round	27 84 48 28 843	985
Second round	27 48 28 84	843 985
Third round	27 28 48	84 843 985
Fourth round	27 28	48 84 843 985
Fifth round	27	28 48 84 843 985
Final order		27 28 48 84 843 985

Now that students remember how Bubble sorting works, show students the steps for the Selection sorting method. For explaining this method, you will need one card to write each number plus 1 card (called "Selection Card") where you will (re)write the number you are selecting to compare.

"We start by drawing 2 rectangles next to each other. We place our unorganized numbers in the rectangle on the right. The left rectangle is where we place the organized numbers. We select the first number, 84, copy it to our Selection Card, and compare it with the next number, in this case, 27. We want to always have the smallest number in our Selection Card and because 27 is smaller than 84, we erase the 84 from our Selection Card and copy 27. Now we compare the number in our Selection Card (27) with the next number, 985, which is bigger than the current







number (25) in our Selection Card so then we move on with the next number which is 48." (...) "Now that we have compared all numbers for the first time, we look at the number in our Selection Card which is 27. That means that number 84 and 27 need to switch places. Once we do that, we move the first number, 27 in the first cell, to the rectangle on the left. We start again with copying the first number, which is now 84, in our Selection Card and start again with comparing each individual number with the one in the Selection Card."

Remember to show the selection and swapping steps before moving the number. Here is the progression of how the sorting should go.

84 27 985 48 28 843
---------------------

27			84 985 48 28 843
27	28		985 48 84 843
27	28	48	985 84 843
27	28	48 84	985 843
27	28	48 84 843	985

Numbers sorted: 27 28 48 84 843 985







#### Teacher's Attachment: H

Used in activity:	4.3: Selection Sorting - Act it out!
Along with Student's Attachment(s):	none

Before the session: Have the numbers written or printed on big cards so they can be hold by the students and easily seen by the other students. Have an additional blank card which will be the Selection Card. The material of the Selection Card should allow the student to easily write, delete, and re-write numbers.

For the activity: You will need 7 volunteers: 6 for holding the number cards and another one for holding the Selection Card and (re-)writing the selected number for comparison. Two sets of numbers are provided below as well as the sorting progression for the teacher to verify that the numbers are being sorted correctly and following the Selection sorting logic..

Set 1: 40 39 128 75 80 3 Set 2: 67 275 683 96 352 71

These same two sets of numbers are used in activity 3.3 and Attachment F The numbers for these two sets can be found ready-to-be-printed at the end of this attachment.

Exercise with set 1:									
	Left rectangle (organized numbers)	Right rectangle (unorganized numbers)							
Initial order		40 39 128 75 80 3							
First round	3	39 128 75 80 40							
Second round	3 39	128 75 80 40							
Third round	3 39 40	75 80 128							
Fourth round	3 39 40 75	80 128							
Fifth round	3 39 40 75 80	128							
Final order	3 39 40 75 80 128								







	Left rectangle (organized numbers)	Right rectangle (unorganized numbers)							
Initial order		67 275 683 96 352 71							
First round	67	275 683 96 352 71							
Second round	67 71	683 96 352 275							
Third round	67 71 96	683 352 275							
Fourth round	67 71 96 275	352 683							
Fifth round	67 71 96 275 352	683							
Final order	67 71 96 275 352 683								

#### Exercise with set 2:

#### Advice:

- Continuously ask students to say what needs to be done and what happens next. Examples: "compare the number with the one in the Selection Card", "swap the positions of these 2 numbers", "move the number where the organized numbers are", "start comparing again", etc.
- It's important that the students follow the steps used on the Selection sorting method and to discourage them from skipping steps or using another method for sorting the numbers.
- Remind to the students that the Selection Card must contain the smallest number.
- The swapping will be always be between the left-most unorganized number and the smallest unorganized number. After the swap, the left-most unorganized number will pass to the left side along with the other organized numbers.
- At the end of each exercise, ask the students to briefly describe the Selection sorting process and the final outcome, i.e. an organized list of numbers







Set 1

# 





























Set 2

# **275**

















# 







**Student's Attachments** 







Attachment 1: Find the names

Below is the list of names. Find the following names and circle them. When you're done, raise your hand to inform the teacher and remain in silence.

Names to find: Anna, Luke, and Jenna

\_\_\_\_

Mila Ella Avery Sofia Camila Aria Scarlett Victoria Madison Luna Grace Chloe Penelope Layla Riley Zoey Nathan Thomas Leo Isaiah Charles Josiah Hudson Christian Hunter Connor Eli Ezra Aaron Landon Nora Lily Eleanor Hannah Lillian Addison Aubrey Ellie Stella Jenna Natalie Zoe Leah Hazel Violet Aurora Savannah Audrey Brooklyn Bella Claire Skylar Lucy Paisley Everly Anna Caroline Nova Genesis Emilia Kennedy Samantha Maya Willow Kinsley Naomi Henry Jackson Sebastian Aiden Matthew Samuel David Joseph Carter Owen Wyatt John Jack Luke Jayden Dylan Grayson Levi Isaac Gabriel Julian Mateo Anthony Jaxon Lincoln Joshua Christopher Andrew Theodore Caleb Ryan Asher Nathan Thomas Leo Isaiah Charles Josiah Hudson Christian Hunter Connor Eli Ezra Aaron Landon







#### Attachment 2: Find the names (again!)

Below is another list of names. Find the following names and circle them. When you're done, raise your hand to inform the teacher and remain in silence.

Names to find: Anna, Luke, and Jenna

AaronConnorJacksonMadisonStellaAddisonDanielJaxonMateoTheodoreAidenDavidJaydenMatthewThomasAndrewDylanJennaMayaVictoriaAnnaEleanorJohnMilaVioletAnthonyEliJosephNaomiWillowAriaEllaJoshuaNatalieWyattAsherEllieJosiahNathanZoeAubreyEmiliaJulianNoraZoeyAudreyEverlyKennedyNovaAuroraEzraKinsleyOwenAveryGabrielLandonPaisleyBellaGenesisLaylaPenelopeBrooklynGraceLeahRileyCalebGraysonLeoRyanCarterHenryLillianSamuelCarterHenryLilySavannahCharlesHudsonLincolnScarlettChoeHunterLucySebastianChristianIsaacLukeSkylarChristopherIsaiahLunaSofia					
AddisonDanielJaxonMateoTheodoreAidenDavidJaydenMatthewThomasAndrewDylanJennaMayaVictoriaAnnaEleanorJohnMilaVioletAnthonyEliJosephNaomiWillowAriaEllaJoshuaNatalieWyattAsherEllieJosiahNathanZoeAubreyEmiliaJulianNoraZoeyAudreyEverlyKennedyNovaAuroraEzraKinsleyOwenAveryGabrielLandonPaisleyBellaGenesisLaylaPenelopeBrooklynGraceLeahRileyCalebGraysonLeoRyanCamilaHannahLeviSamanthaCarterHenryLillianSavannahCharlesHudsonLincolnScarlettChoeHunterLucySebastianChristianIsaacLukeSkylarChristopherIsaiahLunaSofia	Aaron	Connor	Jackson	Madison	Stella
AidenDavidJaydenMatthewThomasAndrewDylanJennaMayaVictoriaAnnaEleanorJohnMilaVioletAnthonyEliJosephNaomiWillowAriaEllaJoshuaNatalieWyattAsherEllieJosiahNathanZoeAubreyEmiliaJulianNoraZoeyAudreyEverlyKennedyNovaAuroraEzraKinsleyOwenAveryGabrielLandonPaisleyBellaGenesisLaylaPenelopeBrooklynGraceLeahRileyCalebGraysonLeoRyanCarolineHazelLillianSamuelCarterHenryLilySavannahCharlesHudsonLincolnScarlettChloeHunterLucySebastianChristianIsaacLukeSkylarChristopherIsaiahLunaSofia	Addison	Daniel	Jaxon	Mateo	Theodore
AndrewDylanJennaMayaVictoriaAnnaEleanorJohnMilaVioletAnthonyEliJosephNaomiWillowAriaEllaJoshuaNatalieWyattAsherEllieJosiahNathanZoeAubreyEmiliaJulianNoraZoeyAudreyEverlyKennedyNovaAuroraEzraKinsleyOwenAveryGabrielLandonPaisleyBellaGenesisLaylaPenelopeBrooklynGraceLeahRileyCalebGraysonLeoRyanCarolineHazelLillianSamanthaCarterHenryLilySavannahCharlesHudsonLincolnScarlettChloeHunterLucySebastianChristianIsaacLukeSkylarChristopherIsaiahLunaSofia	Aiden	David	Jayden	Matthew	Thomas
AnnaEleanorJohnMilaVioletAnthonyEliJosephNaomiWillowAriaEllaJoshuaNatalieWyattAsherEllieJosiahNathanZoeAubreyEmiliaJulianNoraZoeyAudreyEverlyKennedyNovaAuroraEzraKinsleyOwenAveryGabrielLandonPaisleyBellaGenesisLaylaPenelopeBrooklynGraceLeahRileyCalebGraysonLeoRyanCamilaHannahLeviSamanthaCarolineHazelLillianSaruelCarterHenryLilySavannahCharlesHudsonLincolnScarlettChloeHunterLucySebastianChristianIsaacLukeSkylarChristopherIsaiahLunaSofia	Andrew	Dylan	Jenna	Мауа	Victoria
AnthonyEliJosephNaomiWillowAriaEllaJoshuaNatalieWyattAsherEllieJosiahNathanZoeAubreyEmiliaJulianNoraZoeyAudreyEverlyKennedyNovaAuroraEzraKinsleyOwenAveryGabrielLandonPaisleyBellaGenesisLaylaPenelopeBrooklynGraceLeahRileyCalebGraysonLeoRyanCarolineHazelLillianSamuelCarterHenryLilySavannahCharlesHudsonLincolnScarlettChoeHunterLucySebastianChristianIsaacLukeSkylarChristopherIsaiahLunaSofia	Anna	Eleanor	John	Mila	Violet
AriaEllaJoshuaNatalieWyattAsherEllieJosiahNathanZoeAubreyEmiliaJulianNoraZoeyAudreyEverlyKennedyNovaAuroraAuroraEzraKinsleyOwenAuroraAveryGabrielLandonPaisleyBellaGenesisLaylaPenelopeBrooklynGraceLeahRileyCalebGraysonLeoRyanCamilaHannahLeviSamanthaCarolineHazelLillianSamuelCarterHenryLilySavannahCharlesHudsonLincolnScarlettChistianIsaacLukeSkylarChristopherIsaiahLunaSofia	Anthony	Eli	Joseph	Naomi	Willow
AsherEllieJosiahNathanZoeAubreyEmiliaJulianNoraZoeyAudreyEverlyKennedyNovaAuroraEzraKinsleyOwenAveryGabrielLandonPaisleyBellaGenesisLaylaPenelopeBrooklynGraceLeahRileyCalebGraysonLeoRyanCamilaHannahLeviSamanthaCarolineHazelLillianSamuelCarterHenryLilySavannahCharlesHudsonLincolnScarlettChistianIsaacLukeSkylarChristopherIsaiahLunaSofia	Aria	Ella	Joshua	Natalie	Wyatt
AubreyEmiliaJulianNoraZoeyAudreyEverlyKennedyNovaAuroraEzraKinsleyOwenAveryGabrielLandonPaisleyBellaGenesisLaylaPenelopeBrooklynGraceLeahRileyCalebGraysonLeoRyanCamilaHannahLeviSamanthaCarolineHazelLillianSamuelCarterHenryLilySavannahCharlesHudsonLincolnScarlettChloeHunterLucySebastianChristianIsaacLukeSkylarChristopherIsaiahLunaSofia	Asher	Ellie	Josiah	Nathan	Zoe
AudreyEverlyKennedyNovaAuroraEzraKinsleyOwenAveryGabrielLandonPaisleyBellaGenesisLaylaPenelopeBrooklynGraceLeahRileyCalebGraysonLeoRyanCamilaHannahLeviSamanthaCarolineHazelLillianSamuelCarterHenryLilySavannahCharlesHudsonLincolnScarlettChloeHunterLucySebastianChristianIsaacLukeSkylarChristopherIsaiahLunaSofia	Aubrey	Emilia	Julian	Nora	Zoey
AuroraEzraKinsleyOwenAveryGabrielLandonPaisleyBellaGenesisLaylaPenelopeBrooklynGraceLeahRileyCalebGraysonLeoRyanCamilaHannahLeviSamanthaCarolineHazelLillianSamuelCarterHenryLilySavannahCharlesHudsonLincolnScarlettChloeHunterLucySebastianChristianIsaacLukeSkylarChristopherIsaiahLunaSofia	Audrey	Everly	Kennedy	Nova	
AveryGabrielLandonPaisleyBellaGenesisLaylaPenelopeBrooklynGraceLeahRileyCalebGraysonLeoRyanCamilaHannahLeviSamanthaCarolineHazelLillianSamuelCarterHenryLilySavannahCharlesHudsonLincolnScarlettChloeHunterLucySebastianChristianIsaacLukeSkylarChristopherIsaiahLunaSofia	Aurora	Ezra	Kinsley	Owen	
BellaGenesisLaylaPenelopeBrooklynGraceLeahRileyCalebGraysonLeoRyanCamilaHannahLeviSamanthaCarolineHazelLillianSamuelCarterHenryLilySavannahCharlesHudsonLincolnScarlettChloeHunterLucySebastianChristianIsaacLukeSkylarChristopherIsaiahLunaSofia	Avery	Gabriel	Landon	Paisley	
BrooklynGraceLeahRileyCalebGraysonLeoRyanCamilaHannahLeviSamanthaCarolineHazelLillianSamuelCarterHenryLilySavannahCharlesHudsonLincolnScarlettChloeHunterLucySebastianChristianIsaacLukeSkylarChristopherIsaiahLunaSofia	Bella	Genesis	Layla	Penelope	
CalebGraysonLeoRyanCamilaHannahLeviSamanthaCarolineHazelLillianSamuelCarterHenryLilySavannahCharlesHudsonLincolnScarlettChloeHunterLucySebastianChristianIsaacLukeSkylarChristopherIsaiahLunaSofia	Brooklyn	Grace	Leah	Riley	
CamilaHannahLeviSamanthaCarolineHazelLillianSamuelCarterHenryLilySavannahCharlesHudsonLincolnScarlettChloeHunterLucySebastianChristianIsaacLukeSkylarChristopherIsaiahLunaSofia	Caleb	Grayson	Leo	Ryan	
CarolineHazelLillianSamuelCarterHenryLilySavannahCharlesHudsonLincolnScarlettChloeHunterLucySebastianChristianIsaacLukeSkylarChristopherIsaiahLunaSofia	Camila	Hannah	Levi	Samantha	
CarterHenryLilySavannahCharlesHudsonLincolnScarlettChloeHunterLucySebastianChristianIsaacLukeSkylarChristopherIsaiahLunaSofia	Caroline	Hazel	Lillian	Samuel	
CharlesHudsonLincolnScarlettChloeHunterLucySebastianChristianIsaacLukeSkylarChristopherIsaiahLunaSofia	Carter	Henry	Lily	Savannah	
ChloeHunterLucySebastianChristianIsaacLukeSkylarChristopherIsaiahLunaSofia	Charles	Hudson	Lincoln	Scarlett	
ChristianIsaacLukeSkylarChristopherIsaiahLunaSofia	Chloe	Hunter	Lucy	Sebastian	
Christopher Isaiah Luna Sofia	Christian	Isaac	Luke	Skylar	
	Christopher	Isaiah	Luna	Sofia	
Claire Jack	Claire	Jack			







#### Attachment 3: Radix sorting - Try it yourself sheet

#### Exercise 1:

Numbers to rearrange:

040, 039, 128, 075, 080, 003

First step: Rearrange based on ones

Second step: Rearrange based on tens

Third step: Rearrange based on hundreds







Exercise 2:

# Numbers to rearrange:

067, 275, 683, 096, 352, 061

First step: Rearrange based on ones

Second step: Rearrange based on tens

Third step: Rearrange based on hundreds







#### **Evaluation**

#### Sorting numbers with Bubble sorting.

Below, you will find a table with a series of unsorted numbers. Using the Bubble sorting method, sort this series of numbers by moving one number at a time, from the column in the left to the column on the right. The first sorted number is already given as an example. You can use the provided number cards for doing the number swapping and then annotating the results on the table.

	U	nor	ganiz	zed r	umb	ers			Organized numbers	
Initial order	5	4	104	67	15	29	89	11	36	
First round			5 4	4 67	7 15	29	89	11	36	104







#### **Evaluation answer sheet and materials for students**

**Note:** To ensure that the student has acquired an adequate understanding of the sorting algorithm, as a whole as well as its individual steps, it's important to evaluate all rows and not only the final sorted order of the numbers. For each row, check that the numbers are correctly sorted (even if it's not the final sorting order) and allocated in the correct column.

	Unorganized numbers C									Org	aniz	ed n	umb	ers					
Initial order	5	4	10	4	67	15	29	89	11	36									
First round			5	4	67	15	29	89	11	36	104								
				5	4	67	15	29	11	36	89	104							
					Ę	54	15	29	11	36	67	89	104						
						Ę	54	15	29	11	36	67	89	104					
							Ę	54	15	11	29	36	67	89	104				
								Ę	54	11	15	29	36	67	89	104			
									į	54	11	15	29	36	67	89	104		
										4	5	11	15	29	36	67	89	104	4
Final order											4	5	11	15	29	36	67	89	104







#### Number cards

Print and cut this set of cards for each student which will help them for the evaluation activity:

5	4	104	67	15
29	89	11	36	

