sky4.0

CRITICAL THINKING

Sky4.0 curriculum

Co-funded by the Erasmus+ Programme of the European Union

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Project №: 2018-1-PL01-KA202-051081

PARTNERS

	INOVA+ - Portugal	www.inova.business
	Aviation Vallley - Poland	www.dolinalotnicza.pl
	QSR - Talent Driven Culture - Portugal	www.qsr.consulting
	INNpuls Sp. z o.o. - Poland	www.innpuls.pl
	Aerospace Cluster Association - Turkey	www.hukd.org.tr
	The Machine Tool Institute - Spain	www.imh.eus
	The Technical University of Madrid - Spain	www.upm.es

1 INTRODUCTION

1.1 Breaking the Ice

Duration of the activity	10 minutes (the duration depends on the number of participants)
Objective of the activity	Make the participants know each other
Guidance for a correct development of the activity	
Materials required for the activity	Notebook and pen for every training participant Slide numbers: 2-3
Methodology to implement and develop the activity	Ask the participants to present themselves for 2 minutes. Ask them to introduce themselves with name, background information and future career plans.

1.2 Introduction to the Subject

Duration of the activity	30 minutes (the duration depends on the number of participants)
Objective of the activity	Introduce the concept and why they might need this soft skill in professional life.
Guidance for a correct development of the activity	
Materials required for the activity	Notebook and pen for every training participant Slide numbers: 2-3
Evaluation of the activity	People's past experiences or personal traits may result in different ways of thinking which has different outcomes in different cases.

1.3 Training Structure & Intended Outcome

Duration of the activity	10 minutes
Objective of the activity	The trainees will be acquainted with the structure of the training and its intended outcomes
Guidance for a correct development of the activity	
Materials required for the activity	slide numbers: 4-5
Methodology to implement and develop the activity	Inform the participants about the training content: The training will be divided to 3 parts. The first one will be centered to explain the concept of critical thinking. The second one will show the phases to think critically with related personal skills such as: judgement skills and

	decision making. The third one will concentrate on a problem-solving and an exercise to strengthen the understanding.
Evaluation of the activity	Ask the group: what outcomes they expect individually to see the difference depending on mindset and career plans of trainees.

2 DEFINITION OF THE CONCEPT

2.1 What Kind of Thinker you are?

Duration of the activity	45 minutes
Objective of the activity	The trainees will be pushed to think what kind of thinkers they are while watching the video. Also they will learn characteristics of critical thinkers.
Guidance for a correct development of the activity	
Materials required for the activity	Slides: 6-7 **"Identify Your Thinking Style Video**" – HBR - https://hbr.org/video/4672762766001/identify-your-thinking-style
Methodology to implement and develop the activity	Ask trainees two times what kind of thinkers they are, before and after watching the video. Explain benefits of enhancing the way of thinking and think critically.
Evaluation of the activity	Trainees will hear different styles of thinking during video and their peers' ideas.

Learning activity 2.1 – What kind of thinker are you?

Our actions and behaviours are shaped by our way of thinking. We can be unrealistic, pessimistic, optimistic etc. Some people can be naturally skeptical while others trusting. As a way of thinking, some people are curious, some people are leaders. Mark Bonchek and Elisa Steele developed an analysing method according to two dimensions as focus and orientation.

Trainees will watch "Identify Your Thinking Style Video" (HBR) [1]

These differences may be because of past experiences or personal traits. All these ways of thinking have different outcomes in different cases. But critical thinking is about certain sets of methods aimed to explore evidence. Therefore, just approaches and methods may differ for those different thinkers.

Everyday work and life are chain of decisions; where to eat, what to eat, which U turn to take, whether or not the news is true… If you can control and enhance the way of your thinking and think critically, it enables you to solve problems more effectively, make better decisions and recognize pathological and manipulative thinking. A disciplined mind can produce important significant thinking which one can use in problem solving and that is critical thinking.

According to Paul and Elder (2006); A well cultivated critical thinker:

- raises vital questions and problems, formulating them clearly and precisely;
- gathers and assesses relevant information, using abstract ideas to interpret it effectively;
- comes to well-reasoned conclusions and solutions, testing them against relevant criteria and standards;
- thinks open mindedly within alternative systems of thought, recognizing and assessing, as need be, their assumptions, implications, and practical consequences; and
- communicates effectively with others in figuring out solutions to complex problems.

2.2 Dictionary Definition of the Concept

Duration of the activity	10 minutes
Objective of the activity	The trainees will learn historical roots of the meaning of the concept
Guidance for a correct development of the activity	
Materials required for the activity	Slide: 8
Methodology to implement and develop the activity	Explaining open source dictionary definition of critical thinking. Well known critical thinkers from History: Sonrates and Einstein.
Evaluation of the activity	Facilitating the link between the old roots and the current concept.

Concept of Critical Thinking is originally derived from Ancient Greek. Critical derives from two roots: kriticos (discerning judgement) and criterion (standards), implying discerning judgement based on standards.

Nowadays dictionary explains the concept as: thinking that explicitly aims at well-founded judgement and hence utilizes appropriate evaluative standards in the attempt to determine the true worth, merit, or value of something.

2.3 What is Critical Thinking?-Video

Watching "What is Critical Thinking" video by MACAT to have a quick understanding on the concept.

Duration of the activity	15 minutes
Objective of the activity	The trainees will have a general understanding of the critical thinking concept with visual aid.
Guidance for a correct development of the activity	
Materials required for the activity	Slide:8 "What is Critical Thinking" video by MACAT - https://www.youtube.com/watch?v=HnJ1bqXUnIM
Methodology to implement and develop the activity	After watching the video ask trainees if they can relate their everyday life and actions with the definitions and suggestions in the video.
Evaluation of the activity	Trainees are expected to give examples that hold how they think from their daily life cases.

2.4 Concept of Critical Thinking

Duration of the activity	20 minutes
Objective of the activity	The trainees will be able to increase their understanding of the concept and learn phases of thinking critically.
Guidance for a correct development of the activity	
Materials required for the activity	Slides: 9-10
Methodology to implement and develop the activity	Showing Critical Thinking descriptions of wellknown experts' and then the description of SKY 4.0 Project's. Later describing phases of thinking critically by giving their relations to some vital soft skills.
Evaluation of the activity	Description of the process of critical thinking.

Learning activity 2.4 - Concept of Critical Thinking

"Critical thinking is the intellectually disciplined process of actively and skilfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action. In its exemplary form, it is based on universal intellectual values that transcend subject matter divisions: clarity, accuracy, precision, consistency, relevance, sound evidence, good reasons, depth, breadth, and fairness..." (Michael Scriven & Richard Paul, 1987)[3]

In our project Critical Thinking is described as; "The ability to interpret, analyze, evaluate, make inferences, explain and clarify meanings. It is based on logical reasoning, the ability to work with concepts, the awareness of perspectives and own and other points of view, and systemic thinking. A progressive development of knowledge about one's own thinking and effective thinking strategies is necessary. Participants think that it can contribute to improve understanding of situations and processes, avoid failure and it is important for finding out the weak points of the industrial process." Also, it has to be stated that thinking critically is not criticizing.

We can divide critical thinking to phases as Description, Analysis and Evaluation. Each phase includes complex processes of wide range of skills and attitudes. To have a better understanding of a critical thinking judgement skills and decision making, creativity and problem-solving skills will be defined and demonstrated, too.[4]

3 THINKING CRITICALLY

Theoretical context: In Socratic questioning system, which is known as the best critical thinking teaching strategy, "questions", not answers, are considered as the driving force in thinking. Therefore, asking right questions will control the amount of information you receive and thinking critically. Asking question that will be answered with "yes" or "no" probably will not provide you with sufficient information. Also asking questions that can be answered with less effort can be deceptive and may cause false sense of security.

3.1 Description Phase

This phase starts with questions "What, When, Who, Where" and aims to gather the most information and argument possible. Being open minded and taking all possible points of views prevents misdirection.

Having one's opinons is very easy, however not all opinions have their supporting reasons at the background. Also checking if one's claim is supported by other sources of information is very helpful. From this point of the process reasoning will start. Therefor to have a structured reasoning content of the information gathered and their supporting evidences are important.

Sample questions can follow the following logic; instead of asking “what are the main causes of ….?”, ask “please explain what the main causes of ….. are.”

Duration of the activity	20 minutes
Objective of the activity	The trainees will learn about the initial phase of critical thinking.
Materials required for the activity	Slide: 11-13
Methodology to implement and develop the activity	Introducing Soctaric questioning system to trainees, importance of asking questions will be explained. First phase of critical thinking and its metholody will be described.
Evaluation of the activity	Ask trainees to come up with possible questions suitable to start critical thinking over a case: Ask for a raise or not?

3.2 Analysis Phase

This phase starts with questions “Why, How” and aims to understanding the problem, examines evidences while distinguishing unnecessary, inert information, identifying assumptions and understanding “what is not the case”.

Sample questions can follow the following logic; “why is …….. important for our process?”, “why should we concerned about this?”, “how do you know it?”, “how might your perspective be different from others?, “how can we solve this problem?”.

Understanding if an argument is correct or not, first one should confirm if that is really an “argument”. An unstated assumption can lead incomplete evaluation of arguments. An argument needs to have both “owner’s reasons/ position” and “owner’s conclusion”6. As an easy example; one of your friends is asking you to go to Finals game together because he has tickets for two. However same night your cousin is getting married, so you answer; “sorry, I can’t come to the Finals with you because I will be at my cousin’s wedding.” In your answer your cousin’s wedding is your reason, your conclusion is that you won’t be able to come.

“All reasoning is thinking but not all thinking is reasoning.” (Richard Paul, Founder of Critical Thinking Community) Reasoning is defined by R. Paul as directed, focused thinking that needs purpose (to solve at least one problem). “The point of critical thinking is to effectively solve problems using reasoning.” (Richard Paul).5

There are two kinds of arguments to consider; deductive arguments and inductive arguments. If your premises follow facts that are true and can be proven and followed by a true conclusion than it is defined as deductive argument. If your premises can not be said to be true and the conclusion is supported (but not proven) by the premises than it is defined as inductive argument (Center for Innovation in Legal Education)6. For example; while you and your friends are trying to choose a restaurant for dinner; received argument from your group members: “It is too late, restaurant closes

at 8.00 pm" (deductive argument) or "we should go to the restaurant near school because they have the best salads in town" (inductive argument). The hour which restaurant closes can be proven easily however salad tastes different for each person. Evaluation of deductive and inductive arguments also differ.

After structuring well reasoned arguments with their evidences evaluation phase can start.

Duration of the activity	40 minutes
Objective of the activity	The trainees will learn about the second phase of critical thinking.
Guidance for a correct development of the activity	
Materials required for the activity	Slides: 14-18
Methodology to implement and develop the activity	Trainees should learn the necessary item for analysis; what is an argument, what is not an argument and kinds of arguments. Definitions will be given along with everyday basic examples for better understanding.
Evaluation of the activity	Ask trainees to come up with possible questions suitable for analysis. Ask them to generate one deductive and one inductive argument over an everyday case: Stay home or go out for Sunday?

3.3 Evaluation Phase

This phase starts with questions like "What If, So What, Why not" and aims to evaluate the best argument/ solution and judging the success or failure before making a decision, simply to understand how strong the reasoning is. This phase utilizes strong judgements skills. Utilizing the same example given above: while your friend evaluates your argument of not being able to go to finals with him, he may want to learn at what time the wedding will happen exactly, or if you are sure that both events were at the same day. Perhaps he would like to see the weddding invitation as an evidence of day and time. Maybe he will ask you "why not go to finals instead of boring wedding ceremony?".

To evaluate an argument one should break down an argument into premise (owner's reason/ position), conclusion, application of reason or logic and the relationship of the premise and conclusion.

Duration of the activity	40 minutes
Objective of the activity	The trainees will learn about the third phase of critical thinking.
Guidance for a correct development of the activity	
Materials required for the activity	Slides: 19-23
Methodology to implement	Trainees should learn the necessary item for evaluation; understanding if the reasoning is good or bad; if they rely on evidences, challenging examples, making counter examples and making a decision.

and develop the activity	
Evaluation of the activity	Ask trainees to come up with possible questions suitable for evaluation. Ask them to generate one good argument over a case: Should I go vegetarian or not?

3.3.1 Judgement Skills and Decision Making

Using critical thinking process to form an opinion and/ or reach a conclusion is evaluated as good judgement which are essential parts of decision making.

- There is a significant difference between a reason and an argument which results bigger difference in thinking and background depends on how good or bad the reasoning is. We can compare reasons with other ways of judging. People often make decisions based on emotion, intuition or faith. You don't have to put these away while thinking critically but requires putting these other ways of thinking and reacting under the microscope of reason. Conforming common sense does not make everything smooth or ideas useful. Most of the time opposing common sense enables being more open minded and helps rational thinking. "Rational mind doesn't worry, rational mind acts" (Dr. Richard Paul, 2015)[5].
- For evaluating deductive arguments one should learn "if the premises are true and if the form of argument valid". For evaluating inductive arguments one should try to learn "if the premises are true or acceptable, if the premises are related with the issue and if the premises are compelling enough to justify the conclusion" (Center for Innovation in Legal Education)[6].
- To judge and challenge an example one should create counter examples to show if arguments fail. If you can't create a counter example, then you need to inspect the truth of the argument and it's at that point that you start considering what the arguments are about, if they make sense and whether they are true. If arguments are satisfying enough and are true, perhaps because they are backed up by good sub-arguments, then you know that you have a good argument. This phase end by decision making and communicating your decision with related people.
    - "Taking time to critically think also will provide ownership over our beliefs. As we think critically about our own or others beliefs', we develop the skills that allow us to know why we believe what we believe"[6]

3.4 Case Study- Which Would you Rather Battle?

Duration of the activity	45 minutes
Objective of the activity	Have trainees to experience reasoning and evaluate each others' arguments to decide, free from logical flaws.
Guidance for a correct development of the activity	

Materials required for the activity	Slide: 24 For teacher: Two flipcharts, chart papers and chart pens and two asisstants. For trainees a pen and paper.
Methodology to implement and develop the activity	Ask trainees to answer: "Which would you rather battle? 1 horse sized duck or 100 duck sized horses?" Divide the class in to two groups, one that choose to battle with 1 horse sized duck and the other choose to battle with 100 duck sized horses. Ask trainees to pick a side initially and have them seated with a pen and paper remaining as two different groups. Depending on the size of the class if needed trainees can work in smaller groups. Ask two groups to write down their own arguments for choosing the side they are at. Then collaborate all answers on different flipcharts for both sides. Ask each group to write down three arguments from the list that they feel best to make their case and hand them to the assistants. The best and strongest arguments will then float to the top and the results will be shown. The goal is to focus on the strongest arguments put forward by each side. Allow trainees to argue at any time. Running through the ideas will allow people to comment and to support and challenge what is being said by their peers. While groups discuss arguments presented everyone is free to reconsider their position and change sides. Whilst a hypothetical discussion, it highlights the importance of good reasoning and forming a good argument free from logical flaws.
Evaluation of the activity	Trainees will be free to change sides during evaluation of arguments. Case study does not have a definite conclusion.

4 PROBLEM SOLVING

Theoretical context: "The point of critical thinking is to effectively solve problems using reasoning." (Richard Paul).[5] Problem can sometimes be complex and linked to some other problems. Then one should prioritize, align problems that needs solution to solve the main problem. To have a better understanding of critical thinking, a problem-solving study can be used since it is an exercise in problem solving itself. Critical thinking and problem-solving go together. They both refer to using knowledge, facts, and data to solve problems effectively. But with problem-solving, you are specifically identifying, selecting, and defending your solution.[8]

4.1 What is Problem Solving?

Duration of the activity	40 minutes
Objective of the activity	To teach to the trainees the idea of problem solving related to critical thinking.
Materials required for the activity	Slides: 25-31
Methodology to implement and develop the activity	Lecture on definition of problem solving and the importance of it for developing critical thinking skill.
Evaluation of the activity	Ask questions to students to learn if they understood exactly about the problem solving process and whay it is really important to think cirtically for soving problems.

The basic definition of problem solving is the process of identifying a problem, developing possible solution paths, and taking the appropriate course of action. So why is problem solving important?[9] Because, good problem-solving skills empower you both in your personal life and they are critical in your professional life. Employers often identify everyday problem solving as crucial to the success of their organizations. For employees, problem solving can be used to develop practical and creative solutions, and to show independence and initiative to employers.

Problem-solving can be an efficient and rewarding process, especially if you are organized and mindful of critical steps and strategies. Remember, too, to assume the attributes of a good critical thinker. If you are curious, reflective, knowledge-seeking, open to change, probing, organized, and ethical, your challenge or problem will be less of a hurdle, and you'll be in a good position to find intelligent solutions. In order to solve a problem in a better and efficient way it will be helpful to have a check list, at least at the very beginnig of the learining phase.

We are thinking critically and, in a problem-solving mindset when we[10]:

- Rely on reason rather than emotion
- Evaluate a broad range of viewpoints and perspectives
- Maintain an open mind to alternative interpretations
- Accept new evidence, explanations and findings
- Are willing to reassess information
- Can put aside personal prejudices and biases
- Consider all reasonable possibilities
- Avoid hasty judgments

You should remember that problem solving is an essential soft skill. It is the ability to recognize difficulties or complications, identify possible solutions, implement them, and finally follow up to make sure they were successful.[11] And, problem solving is a process. Most strategies provide steps that help you identify the problem and choose the best solution. two basic types of strategies: algorithmic and heuristic.

But what do you do when there is no single solution for your problem? Heuristic methods are general guides used to identify possible solutions. A popular one that is easy to remember is IDEAL (Bransford & Stein, 1993):

- **Identify the problem:** The first task is to determine if a problem exists. Sometimes when you think this point through, you may conclude that there really isn't a problem, just a misunderstanding. If that's the case, fine. If not, and you determine that there is indeed a problem, you need to identify exactly what it is. According to Barry Lubetkin, a New York clinical psychologist, how systematically someone weighs the pros and cons of a problem and how clearly the person can define and state it, is also an indication of highly developed intelligence.
    - Identify the problem
    - Provide as many supporting details as possible
    - Provide examples
    - Organize the information logically

- **Define the context of the problem:** Once you've determined the problem, analyze it by looking at it from a variety of perspectives. Is it solvable? Is it real or perceived? Can you solve it alone or do you need help? Sometimes by looking at it from many angles you can come up with a resolution right away. You may also reveal a bias or narrow point of view that needs to be broadened.
- **Explore possible solutions or strategies:** Problems can be solved in many ways. Brainstorm a list of several possible solutions. Put down anything that comes to mind and then go over the list and narrow it down to the best possibilities. Having several viable options leads to obtaining the best results.
    - Use logic to identify your most important goals
    - Identify implications and consequences
    - Identify facts
    - Compare and contrast possible solutions

- **Act on best solution:** Go over your list of possible solutions. Different situations call for different solutions. Quite often what works in one situation, may not work in a similar one. Take time to determine what will work best for the problem at hand. After all, implement your solution. Instead of approaching problems and challenges as insurmountable obstacles, we can view them as opportunities to focus on our critical thinking and problem-solving skills
    - Use gathered facts and relevant evidence
    - Support and defend solutions considered valid
    - Defend your solution

- **Look back and learn:** The look and learn phase engages learners in self-reflection, self-questioning about the process, and thinking about what has been learned and how they might learn from the experience.

4.2 Chimpanzee Problem Solving- Video

Duration of the activity	20 minutes

Objective of the activity	Objective ist to make student recognize that not only the humankind but also the animals try to solve problems in daily life.
Materials required for the activity	Slide: 32 https://www.youtube.com/watch?v=yrPb41hzYdw
Methodology to implement and develop the activity	What is the best way to get a peanut out of a tube that cannot be moved? Watch a chimpanzee solve this problem in the video [Geert Stienissen, 2010].
Evaluation of the activity	Ask questions about the video: What does Problem Solving Look Like? Describe the series of steps you think the chimpanzee used to solve this problem.

Watch the "Chimpanzee Problem Solving" video to recognize that not only the humankind but also the animals try to solve problems in daily life.

4.3 Problem Solving Case Study

Duration of the activity	60 minutes
Objective of the activity	To teach the trainees how they can solve the problems in a real life. The fact that the main objective of case studies, is to find a real-life application of a theoretical concept or solution.
Materials required for the activity	Slide: 33
Methodology to implement and develop the activity	Use the IDEAL Problem Navigation Guide (in Appendix) to help you work through a problem involving critical thinking in the real world. A car maker compared its luxury car to four other wellknown European luxury cars. Its car outperformed each of the four other cars, which were more expensive. It outperformed one of the other cars on a braking test, another on acceleration, another on cornering, and another on interior noise. What can you conclude about the performance of the car that outperformed each of the other cars tested?
Evaluation of the activity	Underline the need for the process or tool to use for solving the problem. And advice the trainees to develop their tool to solve problems. In this case they will be more efficient in solving problems.

A case study can provide the necessary platform for students to communicate and collaborate about a situation that concerns a certain group. They can be used to help a group of learners or others focus on a specific concept, or they can help those solve a problem. Additionally, they can be used

to analyze a current practice, like an ineffective policy. Although case studies are not a new teaching method, they are a method that can be useful, providing an opportunity for students to think outside the box. By a case study, students can actively engage in applying learned concepts, objectives, and knowledge to hypothetical situations by using critical and higher order thinking skills to answer tough questions.

5 APPENDIX

IDEAL PROBLEM NAVIGATION GUIDE[1]

1. Identify the problem and explain how it can be an opportunity.
2. Define at least two or three goals for your problem-solving process.
3. Explore possible strategies and new information that could help you accomplish each of the important goals listed above.
    a. Strategies and information to accomplish Goal 1
    b. Strategies and information to accomplish Goal 1
    c. …
4. Anticipate the outcomes of different strategies to help you decide which ones you will act on.

First Strategy	
Possible Positive Outcomes	Possible Negative Outcomes

Second Strategy	
Possible Positive Outcomes	Possible Negative Outcomes

…….. Strategy	
Possible Positive Outcomes	Possible Negative Outcomes

[1] https://www.tntech.edu/cat/pdf/useful_links/idealproblemsolver.pdf

5. Look back and Learn.

    a. After acting on your strategies, what did you notice about the problem you identified?

    b. After acting on your strategies, what did you notice about the goals you defined?

    c. After acting on your strategies, what did you notice about the strategies you explored?

d. After acting on your strategies, what did you notice about your ability to anticipate their effects?