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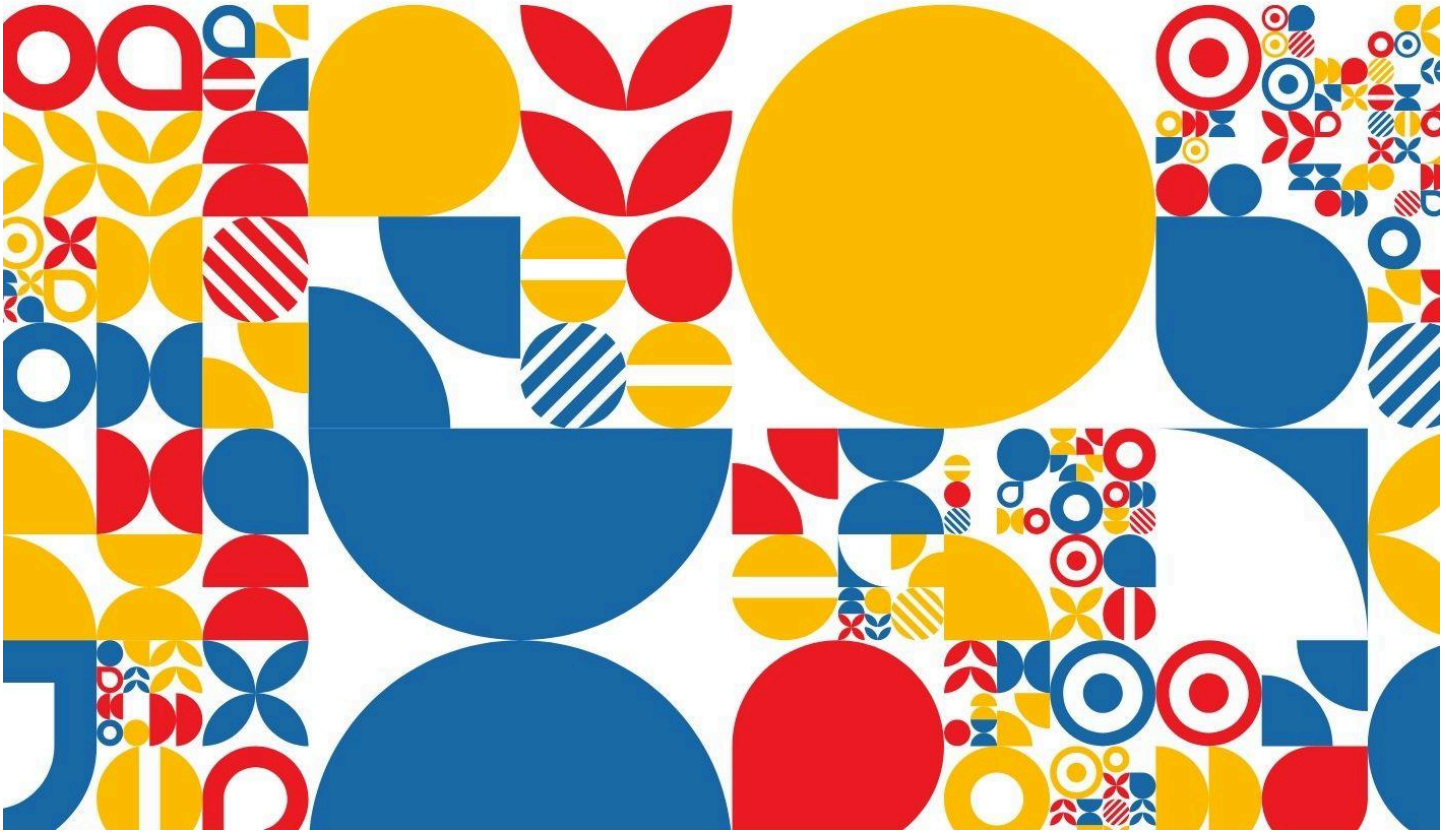
brainfinity
COLLABORATIVE PROBLEM SOLVING CHALLENGE

CONSOLIDATED REPORT & GAP ANALYSIS

Project Nr: 2022-1-PT01-KA220-SCH-000086691

This Report is a Result of the WP2 - BRAINFINITY Educational Content , which primary objective is to present a systematic analysis of the existing practices and literature in the EU, in the framework of teaching higher-order thinking skills,



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I. Introduction

"Brainfinity Detectives - Collaborative Problem Solving Challenge is a Strategic Partnership in School Education among organisations including schools, NGOs, companies, and training experts. It focuses on working with young students aged 11-14 in Portugal, Slovenia, Bulgaria, and Serbia. This project is funded by the EU Commission's Erasmus+ Program under Project Nr: 2022-1-PT01-KA220-SCH-000086691.

The primary objective of this collaboration is to cultivate students' creative thinking and independent problem-solving abilities, preparing them to thrive in an uncertain future. The foundation of this initiative lies in the development of high-order thinking skills. Our analysis has revealed the rapid pace at which technology is evolving, consequently reshaping the world of work. Numerous traditional jobs have vanished, while others have undergone significant transformations. With the unpredictable advancement of technology, it becomes challenging to predict what life will be like in ten or twenty years. Our society may undergo dramatic changes before our very eyes. However, research and speculation shed light on the abilities children will require in the future. Unfortunately, the current education system has yet to adapt to this new knowledge. Drills and practice exercises are no longer effective, as they fail to engage and motivate children.

As a result, the contemporary workforce lacks valuable skills such as problem-solving, innovation, and collaboration. Experts widely recognize these skills as crucial for success in today's society (Euro Lex: http://bit.ly/EurLexSkills, Economic forum: http://bit.ly/FutureJobSkills). Based on the evidence presented, it is evident that educational systems require projects that foster the development of higher-order thinking skills. Higher-order questions impose advanced cognitive demands on students, encouraging them to transcend literal inquiries. The current educational system emphasizes memorizing facts over finding possible solutions and validating them. Given the unpredictability of the future labor market, the cultivation of transferable skills becomes imperative for the next generation. Although some countries and schools implement methods to nurture creative thinking (CT) and problem-solving (PS), there is no universal methodology in place.

Therefore, our project centers around resolving this issue by equipping teachers with the necessary methodology, diverging from traditional pedagogy, to teach high-order thinking skills. Additionally, we introduce fun and engaging problem-solving challenges during lessons. Problem-solving and creativity are undoubtedly the skills of the future, and it is essential to instil them in primary school to ensure our children are prepared for whatever lies ahead. Brainfinity offers a viable path to make this a reality!

The BRAINFINITY project proposes an innovative approach to develop students' problem-solving skills through detective tasks that foster teamwork, fun, and challenges.

Our methodology offers a universal framework for creating and teaching problem-solving skills and high-order thinking, applicable in primary schools, high schools, and other adult organizations.

By implementing Challenge-Based Learning in the classroom, we leverage children's natural inclination for challenges and play, which has been proven as the optimal learning method (Education 4.0, School of the Future, WEF 2020). Furthermore, we exemplify interdisciplinary learning within schools by encouraging students to combine knowledge from different subjects to solve tasks, thereby moving beyond the confines of individual subjects they are currently studying. We foster engagement and learning by presenting real problems through captivating stories, riddles, and challenges. To cultivate critical thinking, we promote the regular practice, enabling students to solve problems more effectively. Moreover, we incorporate digital technologies and foster the development of data analysis skills to enhance problem-solving abilities.

In accordance with the project plan and activities, this Consolidated Report constitutes an integral part of **WP2 - BRAINFINITY Educational Content.** Its primary objective is to present a systematic approach to teaching higher-order thinking skills, which is poised to generate substantial awareness regarding the crucial skills and competencies essential for students' future employment. By offering comprehensive support to teachers in the identification and development of these essential skills, the report aims to make a significant impact.

Hence, the Consolidated Report serves the purpose of encompassing the collective efforts of all project partners. Drawing upon the Country Reports that document existing practices employed in teaching problem-solving and high-order thinking skills in schools, as well as relevant literature on the subject, the report distills valuable insights and facilitates comprehensive analysis. This rigorous analysis is instrumental in identifying gaps and shortcomings, ultimately paving the way for the creation of a Competency Matrix designed for both students and teachers. The Competency Matrix will lay the groundwork for the development of the Brainfinity Educational Content, marking an essential milestone in the project's progress.

II. Methodology for Literature Review & Existing Good Practices

The initial phase of this WP encompasses two distinct steps. The first step involves an extensive search for existing literature reviews that examine relevant publications. Through critical analysis, we extract key insights and present a comprehensive summary of our findings. Simultaneously, we delve into the realm of existing good practices—proven methods and approaches within the given topic.

To gather a robust collection of good practices in problem-solving skills and high-order thinking skills, we employed a methodology that combined national desk-based analysis and on-field analysis. This approach enabled us to explore the current state of affairs and available options within the educational landscape. We conducted exploratory, descriptive, and explanatory studies within the target groups, which encompassed teachers, students, schools, training centers, and other educational facilities. By scrutinizing successful, effective, and impactful practices, we gained valuable insights into the methodologies that have yielded positive results.

Conversely, our research into existing literature pertaining to the topic predominantly relied on desk-based analysis and online research. This approach allowed us to access a wide range of literature and study options, encompassing pertinent conclusions in the field. We defined a set of topics as a guide for our research focus, with each partner taking responsibility for conducting effective research, identification, analysis, and compilation of existing good practices and literature. The topics covered include critical thinking in youth/students (its importance, improvement strategies, and specific activities), problem-solving skills (its importance, improvement strategies, and specific activities), employability skills/future job skills and competencies, and detective tasks.

The data collected throughout this process was consolidated into a common file (Annex 1), serving as the foundation for the development of each partner's Country Reports (Annex 2). These reports offer in-depth analysis, highlight key findings, and identify existing gaps within the aforementioned topics. The insights garnered from this report will serve as a basis for recognizing weaknesses and areas for improvement in current practices and literature, setting the stage for the overall development of BRAINFINITY - Educational Content (WP2).

It is important to note that while this assessment provides indicative results, it is not an exhaustive needs analysis. The focus on a selection of practices may not fully represent the current overall level of practice across each country. Partner organizations contributed with their knowledge and experience to provide a comprehensive understanding of local, regional, and national practices, which may account for variations in consistency and the absence of a shared framework.

III. Literature Review Analysis

Analyzing the literature reviews on pedagogy approaches to teaching problem-solving and higher-order thinking skills in Portugal, Slovenia, Serbia, and Bulgaria reveals both commonalities and differences in their strategies, themes, and challenges. Each country emphasizes the importance of developing these skills in students, but they approach it from slightly different perspectives.

In Portugal, the literature review highlights the shift from traditional teaching methods to more active and investigative approaches. The focus is on engaging students through discussions, games, and problem-solving activities, as well as promoting pedagogical differentiation to address individual student characteristics. The teacher's role is seen as crucial in guiding the student's learning process and stimulating critical thinking. The challenges identified include the need to motivate teachers to embrace change and evolve scientifically and technologically.

Similarly, in Slovenia, the emphasis is on inquiry-based learning (IBL) and project-based learning (PBL) as effective methods for promoting critical thinking, problem-solving, and collaboration. Problem-based learning (PBL), cognitive strategy instruction (CSI), metacognitive training, computer-based instruction, and collaborative learning are also mentioned as effective approaches. The Slovenian literature review highlights the importance of aligning education with the Sustainable Development Goals and the need for intersectoral cooperation and enhanced support mechanisms for students.

In Serbia, the literature review emphasizes the commitment to achieving the UN's Sustainable Development Goals for Education and the importance of developing higher-order thinking skills. The focus is on teacher competencies, such as love for the subject and students, creativity, adaptability, communication, and collaboration skills. The review also mentions the significance of teamwork, presentation techniques, and subject-matter competence. The challenges identified include resource limitations, teacher training, and the prevention of student dropouts.

In Bulgaria, the literature review acknowledges the importance of individual student abilities, effective organization of activities, scientific and pedagogical knowledge, use of modern technologies, teamwork skills, and the ability to motivate students. The review also highlights the need for clear evaluation criteria, creativity, critical thinking, adaptability, collaboration, communication skills, and emotional intelligence. The focus is on creating a positive classroom environment and promoting ethical awareness.

Across all four countries, there is a shared understanding of the importance of developing problem-solving and higher-order thinking skills in students. The literature reviews

underscore the need for student-centered approaches, teacher guidance, and the integration of modern technologies. Collaboration, critical thinking, creativity, and adaptability are recurring themes in all countries, emphasizing their significance in the educational context. The role of teachers is crucial in implementing these approaches and supporting student development.

However, there are also differences in the specific strategies and initiatives mentioned. Slovenia emphasizes IBL, PBL, and STEM education initiatives. Serbia highlights the importance of intersectoral cooperation and student support mechanisms. Portugal emphasizes active and investigative teaching approaches, while Bulgaria emphasizes individual student abilities and emotional intelligence.

These differences may stem from varying national priorities, educational contexts, and cultural factors. While there are commonalities in the broad goals of promoting problem-solving and higher-order thinking skills, each country tailors its approaches to suit its specific needs and challenges.

Overall, these literature reviews provide valuable insights into the pedagogy approaches used in Portugal, Slovenia, Serbia, and Bulgaria for teaching problem-solving and higher-order thinking skills. By understanding their similarities and differences, educators and policymakers can gain a broader perspective and adapt effective strategies to enhance student learning and competencies in these areas.

IV. Good Practices Analysis

In analyzing the gathered good practices in pedagogy approaches to teaching problem-solving and high-order thinking skills in Portugal, Slovenia, Serbia, and Bulgaria, several common points and differences can be observed. Let's explore these aspects in detail:

1. Common Points:

Emphasis on Active Engagement: All four countries prioritize active student engagement in the learning process. They encourage students to actively participate, think critically, and collaborate with peers.

Problem-Based Learning: Problem-based learning is a common strategy used in all countries. It involves presenting students with real-world problems or challenges to solve, fostering their problem-solving skills and critical thinking abilities.

Hands-On and Experiential Learning: The countries emphasize hands-on and experiential learning approaches, providing students with practical experiences to deepen their understanding of problem-solving concepts.

Collaboration and Teamwork: Collaborative learning is prevalent across the countries. Students are encouraged to work in teams, promoting effective communication, cooperation, and collective problem-solving.

Integration of Technology: Technology integration is a shared trend among countries. Teachers utilize educational apps, digital platforms, and interactive tools to enhance learning experiences and make them more engaging.

Cross-Curricular Implementation: All countries recognize the importance of integrating problem-solving and high-order thinking skills across various subjects, allowing students to apply these skills in different contexts.

2. Differences:

Country-Specific Initiatives: Each country has its own specific initiatives to promote problem-solving and high-order thinking skills. For example, Portugal emphasizes entrepreneurship and interdisciplinary projects, Slovenia focuses on mini-entrepreneurial projects and scavenger hunts, Serbia highlights Brainfinity problem-solving competition, and

Bulgaria concentrates on STEM education.

Systemic Support: While Portugal and Bulgaria exhibit systemic support for their good practices through specific programs and initiatives, Slovenia and Serbia rely more on individual teacher initiatives, indicating differences in the level of systemic support for implementing these approaches.

Focus Areas: Slovenia and Bulgaria largely concentrate on science and STEM-related subjects, while Serbia mentions the adoption of outcome-based teaching across the curriculum. Portugal emphasizes entrepreneurship and interdisciplinary learning, highlighting a broader scope.

Teacher Training: The level of teacher training and readiness for implementing these approaches may vary across the countries. Some countries mention the need for adequate teacher training to effectively implement the strategies.

Assessment Practices: The countries may have different approaches to assessing problem-solving and high-order thinking skills. Portugal mentions criteria-based assessment, while Bulgaria highlights a shift from written assessments. Serbia mentions the challenge of assessing individual problem-solving skills within a group setting.

3. Potential Benefits and Limitations:

The potential benefits across the countries include enhanced problem-solving skills, improved teamwork and collaboration, increased student engagement and motivation, development of critical thinking abilities, cross-curricular learning opportunities, and the cultivation of transferable skills. However, limitations such as time constraints, classroom management challenges, varying student abilities, and resource limitations are also mentioned, which may impact the implementation of these practices.

Overall, while there are common points such as active engagement, problem-based learning, and collaboration, the countries exhibit variations in their specific initiatives, systemic support, focus areas, and assessment practices. These differences highlight the unique aspects and priorities within each country's pedagogical approaches to teaching problem-solving and high-order thinking skills.

V. National Surveys

To effectively gather teachers' feedback on high-order thinking skills and the implementation of activities to foster these skills, a comprehensive survey (see Annex 3) was developed and administered among teachers in all partner countries. The purpose of this survey was to gain insights into the specific high-order thinking skills (such as critical thinking, problem-solving, mathematical competencies, etc.) deemed essential for students to succeed in their future careers.

The conclusions derived from these surveys serve as the foundation for the development of the Competence and Skills Matrix. This matrix will play a pivotal role in creating the Brainfinity Educational Content and serve as a crucial instrument in breaking away from the confines of traditional education, which fails to consider the requirements of future job markets.

Across the European Union, a total of 130 responses were collected through the surveys conducted with teachers from various schools and educational institutions (as part of the project partner countries). Employing a qualitative methodology, the primary data collection tool employed was Google surveys (Survey Results provided in Annex 4).

The surveys were primarily designed to gather teachers' opinions and feedback on the identified high-order thinking skills. Furthermore, the aim was to understand their perspectives regarding the necessary skills teachers should possess in order to effectively cultivate these skills in their students. Additionally, teachers were encouraged to share concrete examples of activities they have implemented in their classrooms that promote the development of such skills.

Here are the main conclusions derived from the surveys:

1. To foster high-order thinking skills in students, teachers need to possess the following skills, competencies, and knowledge:

a) Passion and motivation for teaching.
b) Excellent communication and listening skills.
c) Ability to engage with students and create a student-centred learning environment.
d) Proficiency in various teaching strategies, such as project-based learning, inquiry-based learning, and collaborative learning.
e) Adaptability to cater to students' individual needs and learning styles.
f) Use of assessment as a tool for learning and providing constructive feedback.
g) Proficiency in relevant subject matter and technology.
h) Critical thinking, problem-solving, and decision-making skills.

i) Empathy, patience, and persistence in teaching.
j) Ability to teach lessons in different ways to accommodate all students.
k) Promotion of collaboration and cooperation among students.
l) Knowledge of Bloom's taxonomy and Gardner's theory of multiple intelligences.
m) Commitment to continuous improvement and lifelong learning.

By having these skills, teachers can effectively help students develop their analytical, evaluative, and synthesizing abilities, as well as improve their communication, collaboration, and creativity.

2. The teachers mentioned various activities and practices that they use to promote the development of high-order thinking skills in their students. These activities can be grouped into several categories:

a) Practical and hands-on activities: Many teachers mentioned using practical activities, experiments, and investigations that require students to analyze and interpret data. These activities often involve real-life examples and visual representations of concepts.
b) Problem-solving and critical thinking activities: Teachers mentioned using problem-solving tasks, coding challenges, case studies, and debates to help students develop critical thinking and problem-solving skills. These activities often involve students working in groups or teams, which also helps to promote collaboration and communication skills.
c) Language and literacy activities: Several teachers mentioned using activities that involve reading, writing, and oral communication to help students develop language and literacy skills while also learning about other subjects. Examples include literature circles, reading comprehension activities, and discussions about movies or other media.
d) Project-based learning and interdisciplinary activities: Teachers mentioned using project-based learning, city quests, visits to museums and exhibitions, and interdisciplinary activities to promote the development of high-order thinking skills. These projects often require students to use a variety of skills, such as research, analysis, and synthesis, as well as to collaborate with their peers.
e) Games and competitions: Many teachers mentioned using games, charades, challenges, and competitions to motivate students and promote the development of high-order thinking skills. These activities often involve problem-solving and critical thinking, as well as communication and collaboration.
f) Metacognitive strategies and self-reflection: Teachers mentioned using metacognitive strategies, such as self-reflection, goal-setting, and peer feedback, to

help students develop self-awareness and take ownership of their learning.

g) Inquiry-based learning and exploration: Several teachers mentioned using inquiry-based learning activities, such as scavenger hunts and exploration tasks, to encourage students to formulate hypotheses, design experiments, and analyze and interpret data.

Overall, these teachers are using a wide variety of practices and activities to promote the development of high-order thinking skills in their students. By incorporating these activities into their lessons, teachers are helping students to develop essential skills such as critical thinking, problem-solving, communication, collaboration, and creativity.

3. Based on the given responses, here's a summary of the frequency of each skill mentioned, ordered by the percentage of occurrences:

- Critical thinking and problem-solving: 24 occurrences (44.4%)
- Communication and collaboration: 14 occurrences (25.9%)
- Language and literacy skills: 9 occurrences (16.7%)
- Practical and hands-on activities: 9 occurrences (16.7%)
- Metacognitive strategies and self-reflection: 6 occurrences (11.1%)
- Inquiry-based learning and exploration: 6 occurrences (11.1%)
- Project-based learning and interdisciplinary activities: 5 occurrences (9.3%)
- Games and competitions: 5 occurrences (9.3%)

VI. Conclusion of the Report

Analyzing the gathered information in good practices and literature review in Portugal, Slovenia, Serbia, and Bulgaria, we can draw key findings and provide recommendations for improving problem-solving skills development in the EU. Furthermore, we should discuss the implications of the report for future research and practices. Let's proceed with a detailed analysis and conclusion:

1. Key Findings

Common Approaches: Across the four countries, there is a strong emphasis on active engagement, problem-based learning, hands-on and experiential learning, collaboration, and the integration of technology in teaching problem-solving skills.

Subject Focus: Slovenia and Bulgaria particularly highlight STEM education, while Portugal emphasizes entrepreneurship and interdisciplinary learning. Serbia mentions the adoption of outcome-based teaching across various subjects.

Teacher Initiatives vs. Systemic Support: Slovenia and Serbia rely on individual teacher initiatives, while Portugal and Bulgaria have specific programs and initiatives providing systemic support for implementing problem-solving approaches.

Benefits and Limitations: The identified benefits include enhanced problem-solving skills, improved teamwork and collaboration, increased student engagement and motivation, and the development of critical thinking abilities. Limitations include time constraints, classroom management challenges, and varying student abilities.

2. Recommendations for Improving Problem-Solving Skills Development in the EU

Strengthen Systemic Support: EU member states should strive to provide systemic support, such as teacher training programs, resources, and initiatives, to promote problem-solving skill development in schools. This can ensure consistent implementation and sustainability.

Foster Interdisciplinary Approaches: Encourage the integration of problem-solving skills across various subjects, promoting interdisciplinary learning experiences. This can help students understand how to apply problem-solving skills in diverse real-world contexts.

Promote Collaboration and Technology Integration: Encourage collaborative learning and the integration of technology tools and platforms to enhance problem-solving activities. This can facilitate communication, teamwork, and engagement among students.

Assessments and Feedback: Develop assessment practices that effectively measure problem-solving skills, both individually and in group settings. Provide constructive feedback to students, focusing on their problem-solving processes and critical thinking abilities.

Continuous Professional Development: Provide ongoing professional development opportunities for teachers to enhance their pedagogical approaches and deepen their understanding of problem-solving skill development.

3. Implications for Future Research and Practices

This report highlights the importance of further research on the effectiveness of different pedagogical approaches in promoting problem-solving skills in diverse educational contexts. Future studies could explore the long-term impact of problem-solving interventions, investigate the scalability and adaptability of successful practices, and identify strategies for overcoming limitations and challenges.

Moreover, the report underscores the need for cross-national collaborations and knowledge-sharing among EU member states to exchange best practices and learn from successful initiatives. This can contribute to the development of a comprehensive framework for problem-solving skills development in the EU.

In conclusion, the gathered information in good practices and literature review, and National Surveys from Portugal, Slovenia, Serbia, and Bulgaria reveals commonalities in approaches, such as active engagement, problem-based learning, and collaboration. However, differences exist in systemic support, focus areas, and assessment practices. By implementing recommendations for strengthening systemic support, fostering interdisciplinary approaches, promoting collaboration and technology integration, and providing continuous professional development, EU member states can enhance problem-solving skills development and prepare students for the challenges of the 21st century. Future research should continue to explore effective approaches and strategies to further advance problem-solving skill development in educational settings.

VII. Annexes

1. Common File with gathered good practices and Literature Review: WP2/A1 - Review of literature and existing good practices

2. Country Reports:
   - AEG1 - Portugal: AEG1_BRAINFINITY Country reports on findings.docx
   - JUMPINHUB - Portugal: JUMPINHUB_BRAINFINITY Country reports on findings.docx
   - SMART - Slovenia: BRAINFINITY Country reports on findings - Slovenia, SMART.docx
   - PSS - Slovenia: BRAINFINITY Country reports on findings - PSS.docx
   - IMO - Serbia: IMO BRAINFINITY Country reports on findings.docx
   - SAV - Serbia: SAV, Serbia_BRAINFINITY Country reports on findings .docx
   - RAGINA - Bulgaria: RAGINA, Bulgaria Country report on findings.docx
   - AMA - Bulgaria: AMA - BRAINFINITY Country reports on findings.docx

3. Implemented Surveys:
   - https://forms.gle/erBeyHMpRHYt2B5m6

4. Survey Results:
   - BRAINFINITY Detectives - Problem solving skills (Odzivi)

Partners

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