D4.1 Report on first intervention in schools

Project title: Promoting Youth Scientific Career Awareness and Its Attractiveness through Multi-stakeholder Cooperation

Project Acronym: MultiCO

Project ID: 665100

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1 Introduction

This deliverable reports on the development of methodology for the intervention studies and the implementation of the first interventions undertaken April – July 2016. MultiCO researchers are following an agreed methodological approach, with some variations determined by contexts in the partner countries. The report outlines how partners have planned and approached the first intervention – and what has been achieved in this early part of the project. There are variations in how partners have been able to initiate the work in schools, and the five interventions planned in each country will be accomplished along slightly different time lines according to local circumstances.

The methodological approach of the MultiCO intervention stems from the over-arching research questions outlined in the proposal. The research questions relevant to WP4 were discussed in the second partnership meeting as a starting point for outlining the methodology that would be implemented across the partnership. As the project progresses we can see how these questions are being addressed through different aspects of the project.

The project seeks responses to the following research questions (RQs):

1. What factors affect student motivation, interest, relevance and attitudes towards learning and what are the impacts of using a context approach in secondary school science? (WP5 questionnaires)
2. What contemporary, or future science-related careers, exist in identified fields and what skills are needed in these careers as identified from scientists' stories? (WP2 various tasks)
3. What perceptions of science-related careers do stakeholders hold and what perceptions of careers and working life skills needed in these careers, are held by students? (WP2 perceptions of stakeholders (2.11) and students (2.12))
4. What criteria identify best practice scenarios and the cultural differences important in establishing such scenarios? (WP3 various tasks)
5. What are students' and the public's perceptions of the scenarios as motivators for science learning awareness of future careers and stimuli for promoting science-related careers? (WP3)
6. What is the impact of science learning using career-based scenarios on students' creativity, reasoning and collaboration skills, plus other working life skills particularly for science-related careers? (WP4)

Other possible research questions were raised in the second partnership meeting – those that seem to have relevance are summarised here, with some ideas about how they are being addressed in the intervention work and wider project:

- How do teachers work with career-based scenarios in enriching science teaching and learning?

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- What choices do teachers make regarding scenarios, and what are their reasons for this choice? (could be teachers' ideas about careers/learning/interest/what fits the curriculum).
  (Data source: Notes from planning meetings, teacher interviews)
- Where does the scenario fit into the teaching module? Reasons for plans. (Notes from planning meetings)
- How is the scenario presented to students and what follows in the teaching approach? (observation)
- How do students respond to/interact with the scenario? (Observation and interviews with students)
- How do teachers reflect on the scenario as part of teaching and learning? (Teacher interview)

- What is the influence of career based scenarios on student engagement and situational interest in science learning? (Analysis of observations, post questionnaire)
- To what extent does awareness of life-skills enhance students' interest in science learning? (Analysis of various strands of project)
- Design-based research approaches to enhancing students' awareness of science careers: what are the main challenges? (Analysis of intervention)
- How do teachers perceive the issue of responsibility in science and its relevance for science teaching? (Teacher interview – when?)

The research questions should remain as an ongoing item for discussion as each partner carries out interventions and we obtain results from other work packages.

A preliminary reporting structure for partners to provide country reports was drawn up as follows:

Research Questions

List those being addressed in the intervention study – and how they link to data sources.

Participants

Table to show the participants, classes, scenarios and timescale of the intervention.

Research approach

How the research has tracked the process of intervention including how it has been set up and implemented, indicating data sources. For example:

Notes taken at planning meetings with teachers, including reasons for choice of scenario and teaching context, timing (e.g. once – or over several weeks);

Observations recorded, focusing on teacher – student dialogue, small group work (using equipment to video overall lesson and audio selected groups);

Follow up interviews with students and teachers to get perceptions of the scenarios used and reflections.

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Analysis

Outline how the data sources will be analysed and reported.

Findings

Provide an account of the results of analysis and conclusions, according to analytical procedures chosen.

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2 Collated report from partners

2.1 Research questions and approach

Partners have addressed some or all of the above research questions, with some variations.

The overall methodology follows the design based research (DBR) approach: based on a theoretical framework, educational interventions are developed with teachers that include career-based scenarios that are planned collaboratively with different MultiCO stakeholders (teachers, industry partners and students). To study the interventions' impact on learning, they are implemented in authentic learning contexts (in school or in out-of-school learning environments). Through an iterative prototyping approach with feedback cycles they are continually refined and improved (see UBO design Appendix 1). The goal is to contribute to theory on one hand and to educational practice on the other. The MultiCO projects aims to develop design propositions and theories that can inform the development of innovative interventions (career-based scenarios) by others. Assessment of knowledge and skills using the SOLO taxonomy is also part of the UT research approach (Appendix 2). Multiple methodologies and mixed methods are utilized.

2.2 Research participants

2.2.1 UBO participants

The participants were 4 teachers (two female, two male) and 152 students (7th grade, age 12/13 years) at three schools (see Table 1).

Case	School, Class	Number of students	Scenario, subject
1	Beethoven-Gymnasium (BG), 7c*	25	Crime scene, Physics
2	Beethoven-Gymnasium (BG), 7d	29	Crime scene, Physics
3	Liebfrauenschule (LFS), (girls' school), 7a*	20	Crime scene, Physics
4	Liebfrauenschule (LFS), (girls' school), 7c	21	Crime scene, Physics
5	Gymnasium zum Altenforst (GAT), 7c	28	Giant dinosaurs, Biology
6	Gymnasium zum Altenforst (GAT), 7d*	29	Giant dinosaurs, Biology

Table 1: UBO Participants and scenarios/subjects (*classes that had been involved in scenario development before)

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2.2.2 UCL participants

The participants were 8 teachers and 217 students (Year 9, age 13/14 years) at three schools.

Case	School, Class	Number of students	Scenario, subject
1	Queen Elizabeth Girls, class H	24*	Crime scene, Physics
2	Queen Elizabeth Girls , class P	27	Crime scene, Physics
3	Crownwoods, 9D2	31*	Apple diversity, Biology
4	Crownwoods , 9D1	32	Apple diversity, Biology
5	Canons, 9B1	25*	GEMS, Biology
6	Canons, 9B2	26*	Switch to solar power, Physics
7	Canons, 9A1	26	Recycling, chemistry
8	Canons, 9A2	26	Recycling, Chemistry

Table 2: UCL Participants and scenarios/subjects (*classes that had been involved in scenario development before)

2.2.3 UEF participants

The participants were 7 teachers and 144 students (age 13-14 years) at three comprehensive schools.

Case	School, Class	Number of students	Scenario, subject
1	Kontiolahti School, Eric	18	Water purification, Chemistry/Physics?
2	Kontiolahti School, Janet	16	Heat balance Energy, Physics
3	Kontiolahti School, Susan	16	Heat capacity, Physics
4	Lyseo Comprehensive School, Ian	16	Water purification, Chemistry
5	Lyseo Comprehensive School, Ian	16	Water purification, Chemistry

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6	Lyseo Comprehensive School, Patricia	16	Climate zones, Biology
7	Mertala School, Marcy	13	Thermal expansion, Physics
8	Mertala School, Mary	17	Thermal expansion, Physics
9	Mertala School, Mary	16	Thermal expansion, Physics

Table 3: UEF Participants and scenarios/subjects. The topics are based on the school curriculum following the National Core Curriculum. One lesson takes 45 minutes, and 90 minutes lesson is called a double lesson. Ian in the school 2 and Mary in the school 3 had two different groups which both participated in the intervention.

2.3 Working with the scenarios

Partners worked with teachers in schools, either in workshops, focus groups or with individual teachers to plan how the intervention would incorporate scenarios into teaching modules or units. Scenarios were selected based on their 'fit' with curriculum topics, their potential to stimulate students' interest, and also with regard to how they link to science-related careers. This report includes a brief account of intervention planning.

2.3.1 UBO cases

In the three schools, the scenarios were chosen to fit to the school curricula. These are developed individually in each school and sometimes vary strongly (e.g. subject course sequence). The school curricula are based on the National Education Standards that focus on the development of competencies. For the three science teaching subjects (biology, chemistry, physics), the German Science Educational Standards define four areas of competence: 1. Use of content knowledge; 2. Acquirement of knowledge; 3. Communication; and 4. Evaluation and judgement. For the teachers involved in this study, it was important to cover these four areas if possible. The interventions were therefore planned to follow a common structure: the scenarios were used as an introduction to the theme, followed by an inquiry phase (use of content knowledge & acquirement of knowledge) and a consolidation phase that referred back to the scenario (communication, and evaluation & judgement). The following extract from the UBO country report shows how one teacher used the scenario 'crime scene' which was also used in subsequent cases in Germany and also in the UK.

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Case 1: BG-7c, Crime scene

School, Class	Students' age	Number of students	Date, Time, Place	Duration	Scenario, subject	Stage/phase 1) scenario, 2) inquiry 3) consolidation
Beethoven-Gymnasium, 7c	12-13 years	25	16.06.2016, 7h55-8h40, school	45 min	Crime scene, Physics	Scenario
			27.06.2016, 9h50-10h35, school	45 min		Consolidation

The teacher used the scenario 'Crime scene' in her physics lessons (theme: electricity). She had been involved in the creation of this scenario and had done the whole planning for the inquiry part of the unit. For this part, she had chosen six themes that the students were supposed to work on in small groups (four students per group; one theme per group). Their task was to present their theme afterwards to the other students. The groups were free to choose the type of presentation (e.g. poster, power point presentation…). The six themes were "When and why is electricity dangerous?", "Fuse", "Automatic circuit breaker", "ELCB", "Earth conductor" and "First aid for electrical accidents".

Lesson 1 (16.06.2016, 7h55-8h40):

Scenario

The teacher asked the students to build small groups (four to five students per group). They could decide who they want to work with. As a result, six groups were composed of girls or boys only (no mixed groups). The "Crime scene"-photo was presented (IWB) to the students. The teacher did not mention the title of the scenario (= "The mysterious case of Juliana"). She gave oral instructions about the students' tasks. Then the students started their work. After all groups had solved the criminal case, the teacher distributed the themes for the inquiry part randomly to the groups of students. They started their inquiry and were asked to continue at home.

Lesson 2 (inquiry part of the unit; no observation)

Lesson 3 (27.06.2016, 9h50-10h35):

Inquiry & Consolidation

The students presented the results of their group work (one of the themes had already been presented in the previous lesson).

At the end of the lesson, the "Crime scene"-photo was presented to the students again (IWB). A discussion was conducted about how the accident might have happened, what to do to help a person in case of an electrical accident in general and what the students can do at their homes to prevent such accidents. The discussion lasted about 15 minutes.

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2.3.2 UCL cases

In the three schools scenarios were chosen on the basis of curriculum topic and interest value. The following extracts illustrate how different scenarios were chosen.

Case 1 Queen Elizabeth Girls: UBO Crime Scene

The teachers H and P were flexible with regard to the topic to focus on for MultiCO. They decided to explore the topic of electricity in physics, and to have some inquiry based practical work leading on from the Crime Scene scenario designed by UBO. This plan is typical of the ways in which the UCL teachers include scenarios within a teaching unit:

Lesson 1 (60 minutes)

- Scenario introduction: Presentation of the scenario and medical report. Students discussed as a class.
- Expert groups: Students were divided into 5 expert groups – each group read one job description and respective expert report. Students' versions of the reports were produced, to engage students in discussion and their own research into what might have caused the death. Students completed the assessment report for their expert group.
- Jigsaw groups: Students worked in new jigsaw groups, so that each group had a different expert from the original groups. Each student presented their findings. After group discussion, each group gave their conclusion, with justification.
- Conclusion: By the end of the lesson, the teacher presented the original 5 expert assessments and crime scene solutions and student and original solutions were compared.

Lesson 2 (60 minutes)

- Revisiting the scenario: Presentation of the picture with the electric circuit. Revisiting how did electricity cause the death.
- Lesson contents: type of circuit (parallel and series); compare circuits (bulbs, position of switches, current, etc. This involved students in practical investigation to find out about circuits and revisit previous learning.
- Summary: differences between circuits.

Lesson 3 (60 minutes)

- Revisiting the scenario: presentation of the report's photos (piece of evidence A2 – black mark on finger). Discuss how could this caused burning?
- Lesson contents: heating, resistance, safety. Use fuse demonstrator.

Lesson 4 (no observation)

- Revisiting the scenario
- Lesson contents: voltage, length. Students were involved in practical investigations to establish relationships between these variables and links with heating and resistance.

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Case 2 Crownwoods: UBO Apple Diversity

At Crownwoods biodiversity was relevant to the B3 module, so the teachers chose the scenario 'Apple Diversity' accordingly, to be implemented in two lessons of 100 minutes each (lesson 1 had 100 minutes, and lesson 2 had two blocks of 50 minutes each). The research team showed this scenario, developed by UBO, to the teachers. They thought this was engaging and could link to the school visit to take place to Kew Gardens. The planned learning content and methods are presented below.

Inquiry (Science learning) & Consolidation:
Biology:

- Learning content: diversity of organisms as a resource; organisms and habitats; agriculture: pests, fertilisers, herbicides & pesticides (future challenges: food, climate change, health, biodiversity)
- Methods:
    - Checking the crop diversity (e.g. apples, rice, potatoes) in a nearby supermarket and comparing the results to national or global databases of cultivated varieties available in a country or in the world;
    - Collecting information on pests and pest control, effects of monoculture, use of fertilisers and herbicides & pesticides, global threats to agriculture and discuss the value of crop diversity in relation to these challenges;
    - Testing the taste/smell/consistency of different varieties of a crop species (e.g. apples) and discussing the different aspects of biodiversity.

Case 3 Canons: UCL GEMS

At Canons the biologist chose the GEMS scenario (UCL) because it had relevance to the KS4 Biology curriculum. It could be extended well into interesting current developments in biotechnology and genetics. It was very applicable to future careers in biology.

The physics teacher was attracted to the Switch to Solar scenario (UCY) by the design of the cartoon style that she felt would appeal to her students as it was colourful and fun. She found it easy to see the curriculum links - the students had learned about renewable energies during the year and so she thought this would be good as a re-cap but also as a chance to focus on a specific topic of solar energy. She included practical investigations using the solar panels in the lab. During the intervention she mentioned that the curriculum links were the biggest factor in making her choice. Also, she felt that the relationship with each element of STEM was obvious within this scenario and this was a priority for her.

The chemistry teacher chose the Recycling scenario (UCY) for her chemistry class. She could see the links with the chemistry curriculum that she had taught and would be teaching them from the new curriculum and therefore it was easy to consider what activities to do in the intervention. In addition to that, from teaching the class previously in the year, she was aware of

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what type of activities she could organise for students to do that would engage and interest her students.

The intervention was planned to happen during 3 hours (first block 09:00 – 11:00; second block 11:20 – 12:20)

2.3.3 UCY cases

Working with schools and classrooms (students), the team have drafted 3 scenarios (1 from each school-participant) in the following topics: photovoltaics, IVF and environmental adaptation. In an effort to bring students into contact with the scientist from the very beginning, after having identified the scenario topic (hosted in the context of the last teaching unit to be taught in grade 7), and in collaboration with the teachers, the UCY team arranged students' meetings with scientists (Electrical engineer, geneticist and environmental manager) two face to face and one via skype. Prior to the meetings, the students developed interview protocols in groups and during the interview each group kept notes of all the information needed to develop the scenario. After the interview, the students elaborated on the information collected and created a comic presenting the scientist's story.
The scenario design process took 3 lessons (each school/class) in mid-May and the team has managed to track the whole process collecting qualitative data with regards to students' participation and engagement in the scenario design using observation sheets and audio recordings. After having designed the scenarios researchers have also conducted interviews with 28 students (chosen on the basis of their engagement in the scenario design process and pre-test data) and their teachers about their participation in scenario design.
UCY has not been able to classroom-test pre-designed scenarios. The reason for this was that they received permission from the Ministry of Education late, and after the scenario design process, and schools were too close to exams for them to be in a position to accommodate this part of the intervention. They plan to do the first intervention in September.

2.3.4 UEF cases

A number of interventions have been successfully completed (as shown above). The choice of scenarios and intervention development was as follows – details of one case are provided in the findings section.

Eric worked with a career-based scenario in enriching science teaching and learning, by mixing the career presentation and visit of his former student with a scenario which he had used earlier in his teaching. Janet used a career-based scenario created by her students in enriching science teaching and learning. She also created her own scenario and approached the heat topic in a multifaceted way. The intervention started by a presentation of a career and ended by a task related to that career. Susan decided to start the intervention by an episode of teaching after which the students created scenarios related to the topic. Ian planned the intervention together with the MultiCO-project's team members. He used an article as a part of the scenario and

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combined a visit to a Third Party company in his teaching. During the visit the careers were discussed. Patricia was the only biology teacher participating in the interventions. Her fictive scenario was created together with the MultiCO team and the related inquiry linked to a botanical garden was very open. Marcy and Mary are very experienced in using scenarios and they planned the intervention together. Their scenario was a video concerning work in a metal company and the students also visited this local company.

2.3.5 UT cases

Concept mapping with the Cmap Cloud tool was used to determine the initial knowledge structure students have about science-related careers and working life skills. The team have focused on science related careers and skills that are connected with the planned modules (Energetics, Food industry, Pharmacology, Cosmetics+ 1). This concept mapping technique will be implemented after every module to see changes in students' knowledge structure.

Workshops for teachers have been carried out for:
a) Introducing the Energetics scenario for teachers and explaining its purposes.
b) Introducing a scenario evaluation instrument (teachers also filled it in and had an opportunity to make comments if something was not understandable)
c) Introducing group work needed after the scenario evaluation (related to career awareness and working life skills)
d) Introducing and doing practical work related to building solar panel needed in Energetics scenario.

Practical work will be followed at the beginning of September 2016, with designing and constructing the solar panel for charging students' smart phones. This will be observed by two observers.

2.4 Data collection across the partnership

Data have been collected in the different case studies by audio-recording and/or video-recording the lessons, taking fieldnotes and/or photographs, audio-recording students' discussions during their work, observing teachers' and students' work, discussing with teachers, and using questionnaires. Some partners used specific instruments for observation, surveying students and evaluating with teachers.

2.5 Data analysis

The observation and interview data are now being analysed using normal procedures for qualitative data analysis, (content, thematic and narrative approaches). For observations, the analysis will identify critical aspects of the lessons in relation to the research questions, for example, the focus might be on

- How students work together

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- How students construct arguments
- How students interact with teacher/adult
- How teacher interacts with students
- Non-verbal behaviour

Questionnaires will be analysed using quantitative techniques.

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2.6 Findings

Most partners are still analysing data and so findings at this stage are preliminary. Three partners have completed data collection for their first interventions, two of these (UBO and UEF) have drawn out some findings, so examples from Country reports are included here. The UCL team are still analysing data but present the first findings of one of the interventions.

2.6.1 UBO Cases

Preliminary analysis was done using content analysis. The analysis will be completed during the next weeks, and the results will be used to inform the following research steps (scenario development and further intervention studies, Tasks 4.3-4.5, see fig. 1).

Choice of scenarios and structure of the interventions

In the three schools, the scenarios were chosen to fit to the school curricula. These are developed individually in each school and sometimes vary strongly (e.g. subject course sequence). The school curricula are based on the National Education Standards that focus on the development of competencies. For the three science teaching subjects (biology, chemistry, physics), the German Science Educational Standards define four areas of competence: 1. Use of content knowledge; 2. Acquirement of knowledge; 3. Communication; and 4. Evaluation and judgement. For the teachers involved in this study, it was important to cover these four areas if possible. The interventions were therefore planned to follow a common structure: The scenarios were used as an introduction to the theme, followed by an inquiry phase (use of content knowledge & acquirement of knowledge) and a consolidation phase that referred back to the scenario (communication, and evaluation & judgement).

Scenario 1: Crime scene ("The mysterious case of Juliana")

During the first two interventions (cases 1 & 2), students did not read the career descriptions that had been given to them as part of the scenario material. Therefore, their choice of an expert was not well informed. It was decided to supplement the scenario material by "application forms" for the expert reports, in order to promote text reading and helping the students to justify their choice of a specific expert. This material was used in case 3 and 4 (at LFS). In all four cases, students showed positive emotional reactions (laughing, calling the other students' attention) to the experts' names that had been chosen explicitly to make them more attractive and recognisable (e.g. "Peter Power"- electrician; "Helena Healthy" – pharmacists; "Flora Florida" – horticulturalist"). Students mentioned during the group discussions that they appreciate this kind of problem-based approach (e.g. "You really have to think yourself and not just answer a question or carry out instructions.").

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In the questionnaire, a lot of students said that they liked the scenario because of the different careers ("I liked it because the jobs were great, and because such a job would be interesting."; "I liked it because you learned about different careers and because it was exciting.").
They also appreciate the unexpected turn ("I liked that you were mislead several times, e.g. chewing gum instead of pills."; "I would have liked to get more of such misleading information and more experts."). Some students mentioned that the scenario was a bit too short and easy for them and that they would have liked to work on a more difficult case ("It was exciting but a bit too easy").

Scenario 2: Giant dinosaurs

During their museum visit and especially during the scientist's lecture, many students seemed to be disinterested (signs of annoyance or boredom such as eye-rolling and moaning). This is in accordance with statements in the student questionnaire (e.g. "I had to listen to needless things."; "I did not like the long lecture.") and teachers' answers in the interview: both teachers stated that the subject (dinosaurs and their anatomy and physiology) fitted well to the curriculum but that the form of presentation (lecture) had not been adequate for the majority of their students. During the interviews with small student groups, they said that they had expected to see the paleontologist doing his work (e.g. using typical methods) instead of listening to a lecture.
However, some students seemed to be very interested: during the museum visit, they stayed close to the scientist and asked questions concerning the exhibits or artifacts presented. After the lecture, they approached the scientist again to talk to him. Their main focus of interest was on "cloning dinosaurs" and "making them alive again", as it has been shown in films such as "Jurassic Parc".
Many students mentioned that they liked to be outside the classroom and to visit the museum ("I liked the field-trip to the university, because the museum was really interesting."; "I liked the museum because you could see real research there."; "I liked that we went to the museum and did not have lessons."; "…to touch the big [dinosaur] bone.").
In relation to the scenario itself (a film about fossil findings on the island Mallorca, a very popular travel destination for Germans), the students' opinions vary: During the interviews with small student groups, they stated that the scenario film was boring as there were no young people involved (e.g. "Who cares about an old couple on their holidays?"). Watching a film in their biology lessons, they were used to "more action". This has also been mentioned in the questionnaire ("The film could have been more exciting."). However, other students mentioned in the questionnaires that they liked to watch the movie (e.g. "I think it's good that we also saw a film about it.").

Some first analysis from the students' questionnaire (closed-end questions) confirms the results from observations and interviews: The data show that in total the crime scene scenario was evaluated more positively than the giant dinosaurs. The readiness to acquire new information – which might be interpreted as a sign for interest (Krapp 2007) – is higher after the crime scene scenario (Fig. 1).

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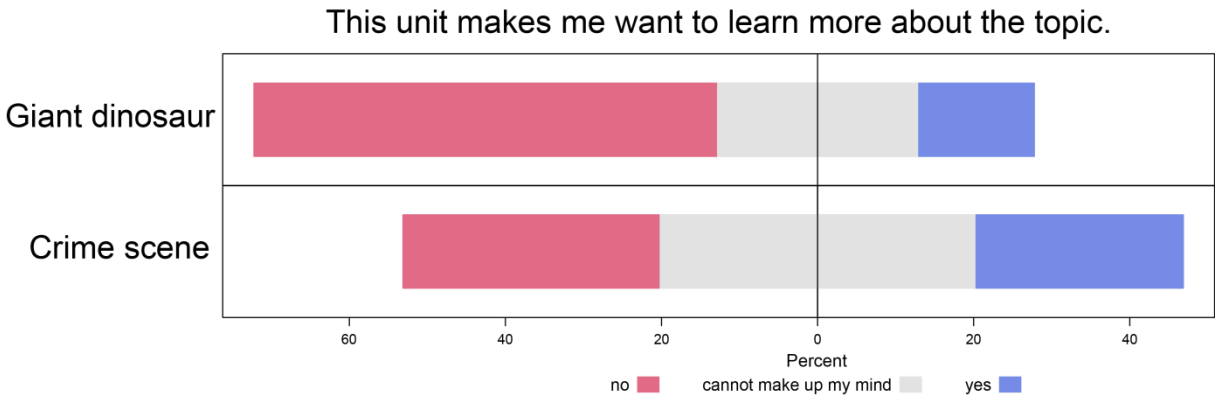

Figure 1: Scenarios' influence on the students' readiness to acquire new information (data from student questionnaire; n=122; n=54 giant dinosaurs, n=68 crime scene).

Even if students state that they have acquired new knowledge in both scenarios, and that both scenarios were easy to understand, the "crime scene" scenario's topic seems to be much more important for them personally (Fig. 2). More students have the feeling that the knowledge from the "crime scene" scenario might be useful in the future. About half of the students liked the format of the "giant dinosaurs" unit (this might be mainly referring back to the museum visit, see above). However, the "crime scene" scenario was enjoyable to far more students.

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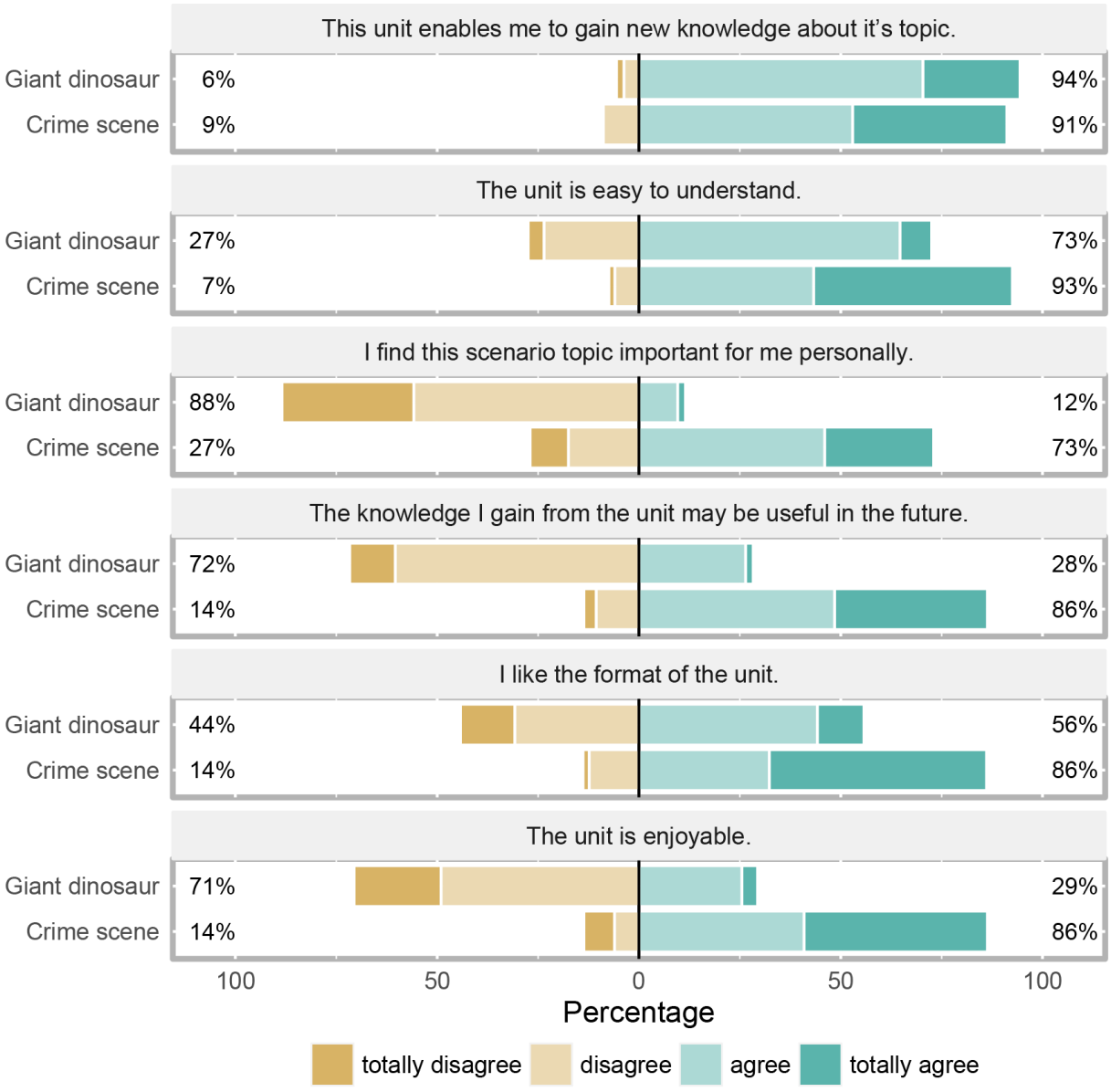

Figure 2: Answers from students' questionnaire (n=122), comparison between the two scenarios (n=54 giant dinosaurs, n=68 crime scene)

2.6.2 UCL Case 2

Scenario: Apple Diversity (UBO)

During the first lesson, students (in the scenario group) engaged with the planned activities with interest, but according to the teacher, this class is generally motivated and participative. They answered the teacher's questions and interacted with each other to discuss the activities on biodiversity issues. At the beginning of the video presentations, the majority of students looked focused and interested. However, over time, they became less engaged. The competition

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activity ("name the biggest number of apple varieties") was completed with enthusiasm, the same happening with the final activity – composing one article, leaflet, letter addressed to the government, or poster – reporting on the work of Charlotte Lusty and the Crop Trust.

In the second lesson, students were, again, participative, but less enthusiastic. The bulk of this lesson consisted in a "creative time" where students were instructed to write a job advert that called for a scientific role designed to work to preserve biodiversity (half page), focusing on: a) the skills needed, b) qualifications, and c) professional attitudes.
The first analysis of the questionnaires showed that, overall, students find the topic relevant, but some students mentioned that the videos were "a bit boring".

2.6.3 UEF cases

UEF cases were undertaken earlier than other partners due to the nature of the school year cycle. Some indicative findings are included here to show how the findings relate to research questions.

1. How do teachers work with career-based scenarios in enriching science teaching and learning?

What choices do teachers make regarding scenarios, and what are their reasons for this choice?
In Lyseo Comprehensive School 2, Ian had two groups which worked in a similar way. Also in Mertala School 3, two teachers, Marcy and Mary worked in a similar way; they were used to working as a team and the whole school had the same approach to enrich the teaching by using scenarios to start the instruction. Taking into account these two cases, there were six different approaches for using scenarios.

- Eric chose a familiar person and also a familiar scenario, which he had created and used earlier and made a new combination of these approaches. Presentation of the career, scenario and inquiries were intertwined to form an interesting entity. Eric's choices were based on his experiences and connections and he worked on his own in planning the intervention. Both the scenario and the fact that chemist was their teacher's former student interested the students.
- Janet used the scenario created by her students which aroused students' interest towards studies as she had predicted. She supplemented the presentation of a sport doctor by the story of two medical students who told in a video about the skills needed in their career. Janet created this video on her own. She considered the heat topic using an innovative approach taking into account health and climate change issues.
- Susan asked the students to create scenarios related to the topic studied. The students chose one career or socio-scientific issue for the scenario and created scenarios. Contrary to the original idea of scenario as a starting point of teaching, she used scenario

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after the instruction of the topic for presentation of careers. This is probably because the idea of scenario was new for her and she was not present at the teachers' workshop.

- Ian used a newspaper article as a scenario and connected it to the visit to the wastewater treatment plant where careers were presented. His choice was strongly based on the discussions with the MultiCO team and his previous good experiences on the visits outside the school.
- Patricia used fictive story as a scenario created together with the MultiCO team member. She intertwined the short story introducing the task and the role play in which the students familiarized with careers. She based her intervention on the co-operation and experience in using open inquiries.
- Marcy and Mary were very experienced in using scenarios. They decided to enlarge their scenario with the visit to a company, after the discussion with MultiCO team concerning the role of industry in the project. Marcy and Mary perceived that the visit is something new for their scenarios even though they had visited different places with their students also earlier. In the company as well at school, the students familiarized with different careers.

The scenarios which the teachers created are quite different. Those teachers who had used scenarios earlier (Mary, Marcy, Janet and Eric) used more profound scenarios and used lot of time to create something new. Susan, Patricia and Ian used scenarios first time in their teaching. Patricia and Ian (Lyseo Comprehensive School), in particular highlighted that the teacher should be free to organize scenario in his/her own way. The teachers perceived the co-operation with MultiCO researchers useful and comfortable. All of the teachers also were very "good teachers" and it was quite easy to select the content of scenario and inquiry which are in line with the national core curriculum and which the students are able to carry out. Ian and Patricia stated that open-ended approach in intervention would free the students to develop a wide variety of questions concerning the scientific careers and working life skills. Ian's scenario highlighted that citizens need to have an awareness of local environmental issues.

Where does the scenario fit into the teaching module?

The created scenarios are presented in Table 4. Also the stage where careers are discussed is shown as well as the nature of the inquiry in the intervention.

Table 4. Scenarios used by teachers

Teacher	Scenario	Career presentation	Inquiry and connection to scenario
Eric	Chemist-slides and fictive article	Chemist at the beginning and during the intervention	Separation methods as laboratory work, guided inquiry Inquiry is aimed to find solution to the scenario problem aa well as to learn who works with this kind of problems

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Janet	Video 'Sport doctor' created by students, video of medical students created by the teacher	Doctor in scenario at the beginning of intervention and in video	Search information for diagnosis and to present the influences of climate change for health, open inquiry Heat balance of human being in different cases from the viewpoint of a doctor
Susan	Students created scenarios after instruction	Meteorologist, fisherman, ringed seal keeper after teacher's teaching	Search for information about the topic, open inquiry After teaching period, familiarizing careers in the field
Ian	Newspaper article and preparation of questions for the visit and following visit	Careers in wastewater treatment plant during the visit	Purification of dirty water in the laboratory, closed inquiry Article presents the problem, the students familiarize the possibility for the existence of the same problem in their town during the visit and finally purify water in laboratory
Patricia	Short story about mysterious animal	Careers presented in the scenario and the persons interviewed in botanical garden	Search for information to present instructions how to take care of the animal, open inquiry Inquiry is aimed to find solution to the scenario problem and to learn who works with this kind of problems
Marcy and Mary	Video about the company, questions for the visit and following visit	Careers presented in video and in the company	Guided laboratory experiments Inquiry is aimed to find help for industry workers

How is the scenario presented to students and what follows in the teaching approach?

The teachers presented the scenarios for the students in different ways. Janet was the only teacher who used a video presenting a career as a starting point for her instruction. She used a scenario created by students which raised students' interest. After watching also the interview of medical students, the students were asked to draw in small groups a mind map of the skills that are important in the career of a doctor. Then Janet presented the different types of energy and some stages later four different cases concerning patient's problem related to heat balance, and the students were asked to think at home what kind of advice a doctor could give. Scenario

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and inquiries were linked to each other and the issues discussed were multifaceted. The aim to get students interested through scenario was very well reached.

Eric started intervention by presenting shortly Niko, chemist, and asked the students create questions for him concerning his career. Then Eric presented a newspaper article and dirty water coming from tap and asked the students to plan separation methods to purify water. When the students worked with separation methods the chemist was in class and scaffolded the students in their work as well as told about his life and career. In this way, career presentation was intertwined with other tasks mainly because of practical reasons, the chemist was not able to visit the school during the first lesson as originally planned.

Susan used scenario in a very different way compared to others. She started the intervention traditionally presenting the topic herself. After studying the topic, the students created scenarios concerning careers or issues related to the topic studied. Susan did not use the scenario as a motivator but instead as introducing careers to students.

Ian used an article as a scenario supplemented with the creation of questions for the visit out of the school. This approach is similar to the approach of Eric. Careers were presented during the visit to treatment plant and this approach was also similar to traditional study visit. However, careers were well introduced. Patricia used career presentation in a similar way: the students prepared questions and interviewed persons in scientific careers. In her approach careers were at first introduced in a fictive story.

Marcy and Mary used career-based video scenario to start the intervention. Discussion about careers continued during the visit in the company. The students were given a task to inquiry metals in a way which connected the company to the inquiry. Intervention continued very fluently from scenario to inquiry.

How do students respond to/interact with the scenario?

In Eric's class, students' started to plan a solution for the problem presented. They also started to create questions for chemist to be answered during his visit at school. In Janet's class students worked with a mind map presenting skills needed in a career presented. Susan's students created scenarios but they did not have the same opportunity to start with the scenario.

In the class of Ian, students discussed about the problem presented in the scenario and prepared questions for the visit. Ian's students also asked about the water supply situation in Joensuu area as well as about the water crisis which happened in Nokia area in Finland when visiting wastewater treatment plant. Also Ian himself asked about possibilities of fresh water and sewage water being contaminated in the town and this discussion continued in the school during the next lesson. The engineer highlighted that this catastrophic real life situation is not possible in this town. He also told to pupils that this community disposed their waste and garbage directly into Lake Pyhäselkä until 1970. This was quite surprising to students.

Patricia challenged her students: they continued to create questions for the visit but got also an open inquiry related to scenario which presented careers. The students in the classes of Marcy and Mary continued working with career-based scenario and familiarizing with careers during the company visit. Apart from the class of Susan, in other classes the students continued

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from the scenario to work further with issues presented in the scenario and later with inquiries which were somehow connected to scenario.

Variation exists in Mertala School students' responses with the scenario. Visit to Savonlinna Works Oy seemed to be more interesting than the scenario introduction in the school. Before and after the visit to the company, students' excitement could be heard from the students' comments about the possibility to visit the machinery:

> Finally something different from school work (male student)
> I'm eager to see the huge parts and machines inside (male student)
> I wonder if I can take photos inside (female student)

Unfortunately taking photographs inside the workshop was forbidden but lots of selfies were taken outside the workshop, with the company's helmets on. After a week continuing with the scenario in school was challenging and the students seemed to have forgotten almost everything from the visit; visits need to be connected to the next lesson immediately.

How do teachers reflect on the scenario as part of teaching and learning?

The participating teachers mainly used scenario as part of teaching and learning about careers not so much about the science topic. However, some teachers, Eric and Ian had scenario which was not only career-based but also presented a problem through an article. In all cases, working life skills were discussed with the students.

Marcy's and Mary's opinions about using scenario-based learning are mainly positive and the approach has been used in school 3 for several years and in several projects. Marcy and Mary also perceived the difference in teaching methods refreshing. In the discussions after the lessons, these teachers mentioned how hard it is to include the careers in the teaching. Both agreed on that more development and planning is needed in future scenarios to better enrich science teaching and learning through career-based scenarios and make good links between scenario, careers and inquiries.

The scenario idea was new to Ian and Patricia in school 2. Ian and Patricia discussed the role of scenario with MultiCO team many times. They told that it was not easy to create a good scenario which is suitable to outdoor learning and which includes elements of scientific careers. Patricia highlighted also the creativity element of scenario and Ian real world/everyday context as well as openness of the scenario.

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2.7 Final comments

The early stages of drawing out the cases from intervention data means that the report presented here provides only an initial overview of findings thus reported so far. More detailed analysis will follow to provide a synthesis of findings and their implications. One outcome of reviewing country reports is to inform the next intervention. In particular the career focus of the scenario and intervention needs to be more strongly emphasised; many teachers are mostly focussed on the activities for the inquiry stage and careers are a minor aspect of their concern. In planning the second intervention the career aspects need to be more prominent in many cases.

Clearly the scenarios are a central feature of all the interventions, so how these are planned and incorporated into teaching units is critical to their implementation – we need to ensure that data on the planning process is collected for reporting. Teachers have noted some of the impact of working with scenarios. Student organisation and management will impact on their experience of working with the scenarios, and from teachers comments it is clear that some groups are more collaborative than others and so they are not sure about the influence of the scenario on this aspect. The scenarios do help students to be more creative exploring different professions in science; they link with what is happening in the "real world", and show that science-related careers do not have to be "too intellectual" and hard or difficult to apply. Teachers have found that one disadvantage is not having time to explore in depth those professions beforehand. In addition, the main barrier to implementing this approach is the lack of time to think and link the contents with the syllabus. Teachers' careers knowledge is minimal and there is a lack of information and guidance on how to explore different careers.

Some students are not interested in science and/or not interested in that specific career, and that can lead to disengagement; if the scenario is "too" professional the focus diverges to other aspects that need to be covered in the curriculum

2.8 References

Krapp, A. (2007). An educational-psychological conceptualisation of interest. *International Journal of Educational and Vocational Guidance. Vol. 7,* No. 1, 5-21

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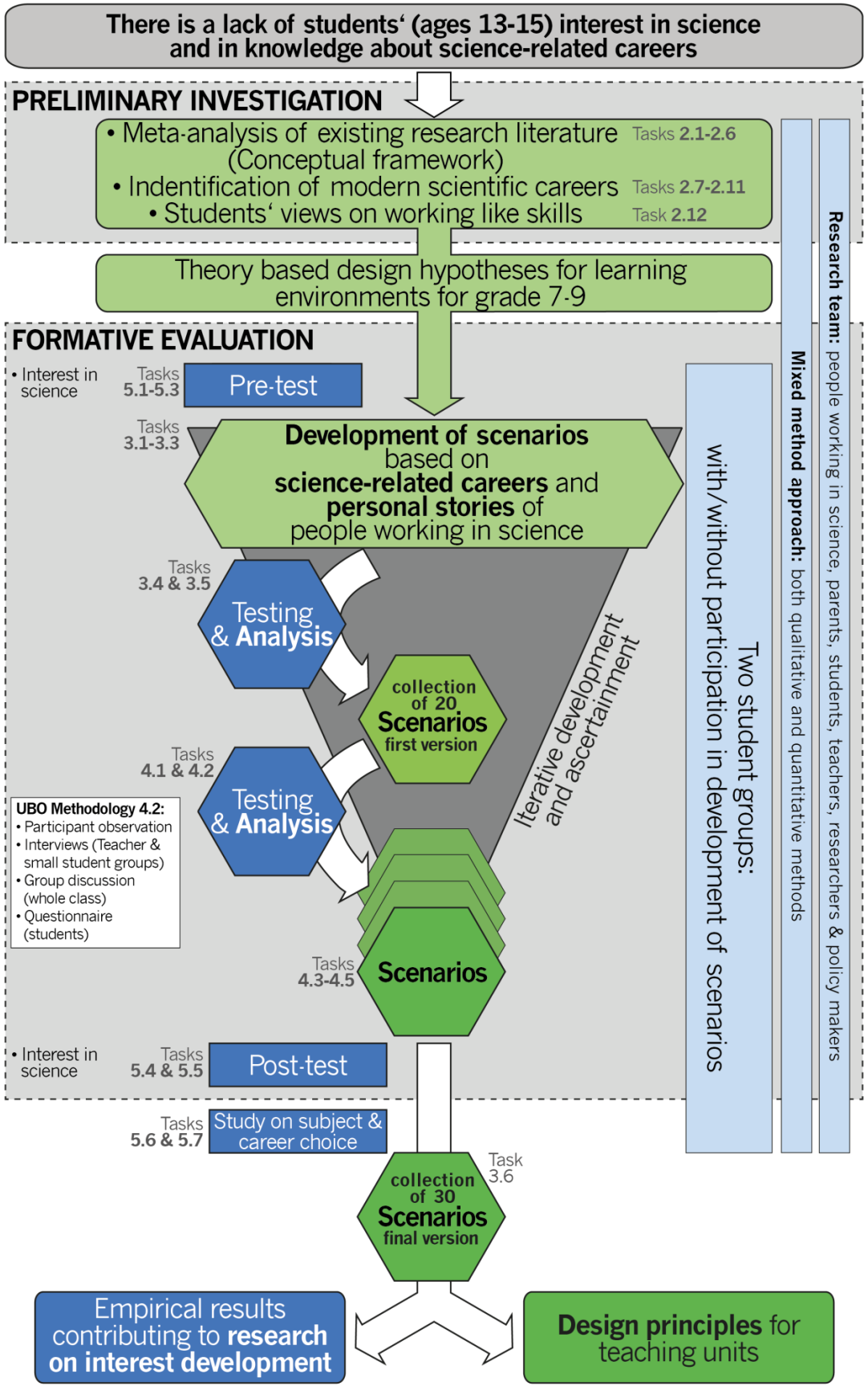
Appendix1



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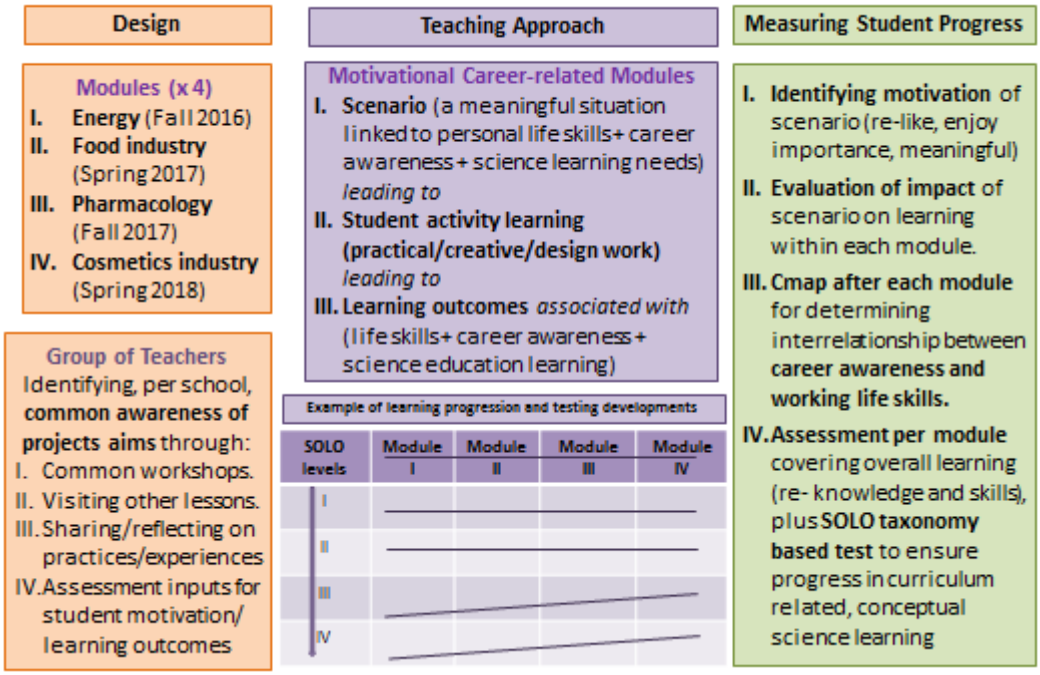
Appendix 2



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