



Ark of Inquiry: Inquiry Activities for Youth over Europe

Deliverable D2.5

Complete Population of the Ark of Inquiry Platform

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Summary

The Ark of Inquiry project aims to build a scientifically literate and responsible society through inquiry-based science education. The project seeks to expand young people's awareness of Responsible Research and Innovation (RRI) by disseminating across Europe engaging inquiry activities in Science, Technology, Engineering and Mathematics (STEM) domains.

The current deliverable describes the methodology and process behind the selection of inquiry activities in the context of the Ark of Inquiry project, presents an overview of the currently available inquiry activities from the perspective of the selection criteria and coverage of core elements of the Ark of Inquiry project, and describes how those inquiry activities are represented within the Ark of Inquiry platform.

The overview, which is the main focus of the deliverable, revealed that the inquiry activities as a whole represent an excellent coverage of the central components of the project. In other words, the Ark of Inquiry platform offers a broad array of engaging inquiry activities to pupils and teachers across Europe. Here are the main highlights:

1. Since the initial review (Deliverable 2.3) and piloting phase (end of 2015), the number of inquiry activities has grown from 68 to 524.
2. Inquiry activities are available in 13 different European languages.
3. The inquiry activities cover well all major STEM domains, except for engineering.
4. The coverage of the whole targeted age range (7 to 18) is comprehensive; there are at least 100 inquiry activities available on each targeted age group.
5. The inquiry activities are available at three different proficiency levels, ensuring that pupils with different sets of skills and knowledge (even within certain age level or range) can find inquiry activities that match their inquiry proficiency.
6. The inquiry activities can provide a comprehensive inquiry experience for pupils, as more than 60 % of the inquiry activities include all five inquiry phases and over 80% include at least four phases.
7. Through relevant study topics (e.g., related to the grand challenges) and comprehensive inclusion of Orientation and Discussion phases (Orientation and Discussion are the two key inquiry phases from the RRI perspective; either the Orientation or Discussion phase is included in more than 90% of the inquiry activities, and both phases are included in 68% of the inquiry activities), the inquiry activities provide extensive opportunities for addressing RRI.

8. Duration of the inquiry activities varies from 30 minutes to a whole semester. The average duration of two study hours ensures that the threshold to use inquiry activities is low, whereas the inquiry activities with longer duration can provide more extensive and challenging inquiry experiences.

Although this deliverable will mark the official end of WP2 and work on collecting new inquiry activities, it is expected that the amount of inquiry activities (and the community around the inquiry activities) will continue growing during and beyond the project due to contributions by various Ark of Inquiry communities.

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1. Introduction

The Ark of Inquiry project aims to build a scientifically literate and responsible society through inquiry-based science education. The project seeks to expand young people's awareness of Responsible Research and Innovation (RRI) by selecting engaging inquiry activities in Science, Technology, Engineering and Mathematics (STEM) domains and to make these learning resources available to European learners, teachers and schools through the Ark of Inquiry platform.

The focus of this deliverable is to provide an overview of the inquiry activities that have passed the Ark of Inquiry selection criteria (Deliverable 2.1) and are currently shared with teachers and pupils across Europe via the Ark of Inquiry platform. The deliverable can inform about the quality of the published inquiry activities, that is, to what extent the inquiry activities cover areas that are deemed important for the project. It can also be considered as an overview that helps teachers to get a general picture as to what kinds of inquiry activities are available in the Ark of Inquiry platform.

This deliverable consists of three main sections. The first section describes the methodology and process behind the selection of activities. The second section presents an overview of the inquiry activities from the perspective of the selection criteria (Deliverable 2.1) and coverage of core elements of the project (e.g., Dow and Deliverable 1.1). The third section describes how inquiry activities are represented within the Ark of Inquiry platform.

2. Methodology and process for selecting inquiry activities

The methodology for selecting the inquiry activities finds its origins in the Description of Work (DoW) and Deliverable 1.1 (Description of inquiry approach that fosters societal responsibility) and their translation into the set of selection criteria that was specified in Deliverable 2.1 (Criteria for selection of inquiry activities including societal and gender dimensions). The selection criteria are based both on a theoretical rationale and on contemporary research evidence and consist of seven mandatory elements (Existing activity, Targeted age range 7–18, Focus on STEM domain, Support for inquiry type of learning, Coverage of at least one inquiry phase, Targeted for a specific inquiry proficiency level, Evidence on the success of the activity) and two recommended elements (Support for societal responsibility and Integration between learning content and inquiry skills).

Based on these criteria, a template with guidelines for selecting and instructions for describing potential inquiry activities was developed and distributed among the partners of

the project in November 2014. In January 2015 a preliminary set of inquiry activities that were provided by each of the partners was reviewed against the criteria and the general aims of the Ark of Inquiry project. This initial review process and the following discussions led to some modifications to the original template. The most notable changes were that activities should include a part that is directly targeted at learners, and the change of the descriptors for the proficiency levels from Basic-Advanced-Expert to Novice-Basic-Advanced. The set of preliminary inquiry activities from the partners also identified some valuable sources of inquiry activities that have a high level of correspondence with the several central ideas behind the Ark of Inquiry. Inquiry activities from the Go-Lab project (<http://www.go-lab-project.eu>), for instance, to a large extent use the same inquiry cycle model (Pedaste et al., 2015) for their inquiry learning spaces, activities from the Compass (<http://compass-project.eu>) and MiGa (<http://migaproject.eu/>) projects greatly emphasise Responsible Research and Innovation related topics, while activities from the University Colleges Leuven-Limburg (UCLL) aim to build a perception of relevance of physics for both boys and girls by showcasing connections between the concept of quantum mechanics and everyday life phenomena. A more elaborate review of all inquiry activities proposed by partners during the month of February and the beginning of March 2015 was translated into a more detailed feedback to the individual partners related to their preliminary proposed inquiry activity descriptions. This included, for instance, advice on certain aspects of the descriptions in order to make them clearly aligned with the general framework of the Ark of Inquiry, requests to separate the teacher and learner parts in activities that were described in an intermixed format, and on some occasions to describe additional activities from resources that seemed well-aligned with the Ark of Inquiry project goals. The finalised revised versions of the descriptions were then collected by the University of Turku during the latter half of April 2015 and the beginning of May, and this resulted in a collection of 68 inquiry activities for piloting the Ark of Inquiry.

The initial set of 68 inquiry activities was analysed in Deliverable 2.3 (Population of the Ark of Inquiry platform for piloting). Though the overall picture was clearly positive, the analysis revealed some areas that required specific attention when collecting further activities: lack of activities for the youngest learner group, on the advanced proficiency level, and in some partner language areas. During autumn 2015 and spring 2016 the activities were piloted in partner countries. Major feedback from the piloting was that teachers and pupils generally liked the activities, but, in accordance with Deliverable 2.3, they requested more activities in local languages (during piloting the majority of the activities were in English). Based on the piloting feedback and results of D2.3, it was decided that particular attention was needed for collecting activities in each partner language. Collecting of inquiry activities by project partners and their networks has ever since continued until the end of January 2017 and has included several submission and feedback cycles.

3. Overview of inquiry activities

By 10 February 2017, a total of 524 inquiry activities have been published in the Ark of Inquiry platform (<http://arkportal.eu>). This can be considered as a remarkable increase from the initial 68 inquiry activities that were available at the end of 2015 when the project piloting started.

The following subsections will give an overview of the 524 inquiry activities by reviewing them as a whole¹ against the initial results (Deliverable 2.3) and coverage of the main selection criteria (Deliverable 2.1) and in relation to the general goals of the Ark of Inquiry (DoW).

3.1. Language

As it was mentioned above, the initial set of inquiry activities was dominated by English language activities (63 out of 68), and lack of activities in local languages was identified as one of the main shortcomings in the pilots and in the initial review conducted in Deliverable 2.3.

Figure 1 shows that inquiry activities are now available in 13 different languages (initially, they were available in 9 languages). Although the availability of activities has improved notably in all languages, the availability seems to vary considerably between different languages. As was the case at the time of the initial review, the availability of inquiry activities is the highest in English. This is good, because English is one of the global languages, meaning that in principle English language activities can be used in most countries. In addition to English, the availability of inquiry activities seems particularly good in Dutch, Finnish, and Greek, and good also in Estonian, French, and German (from these Dutch, French, Greek and German can be used in multiple countries). Among partner countries, the availability of inquiry activities is still relatively low in Hungarian, Italian, and Turkish, though clear progress has been made also in these language areas compared to the initial situation. As the focus of the project has been on existing inquiry activities, these differences could indicate that there are considerable differences between countries in teaching traditions and adaptation (and history) of inquiry learning in education. Regardless of the origins of these differences, it is clear that more effort is needed particularly in the last mentioned language areas to produce more inquiry activities.

¹ It is important to recognise that the range within each element of the selection criteria is so wide as a whole that a single activity that passes the criteria can (and shall) cover only part of the range (e.g., basic proficiency level physics activity for 13–15-year-olds). In order to accommodate various learners and teachers, coverage should therefore come from the collection of all activities.

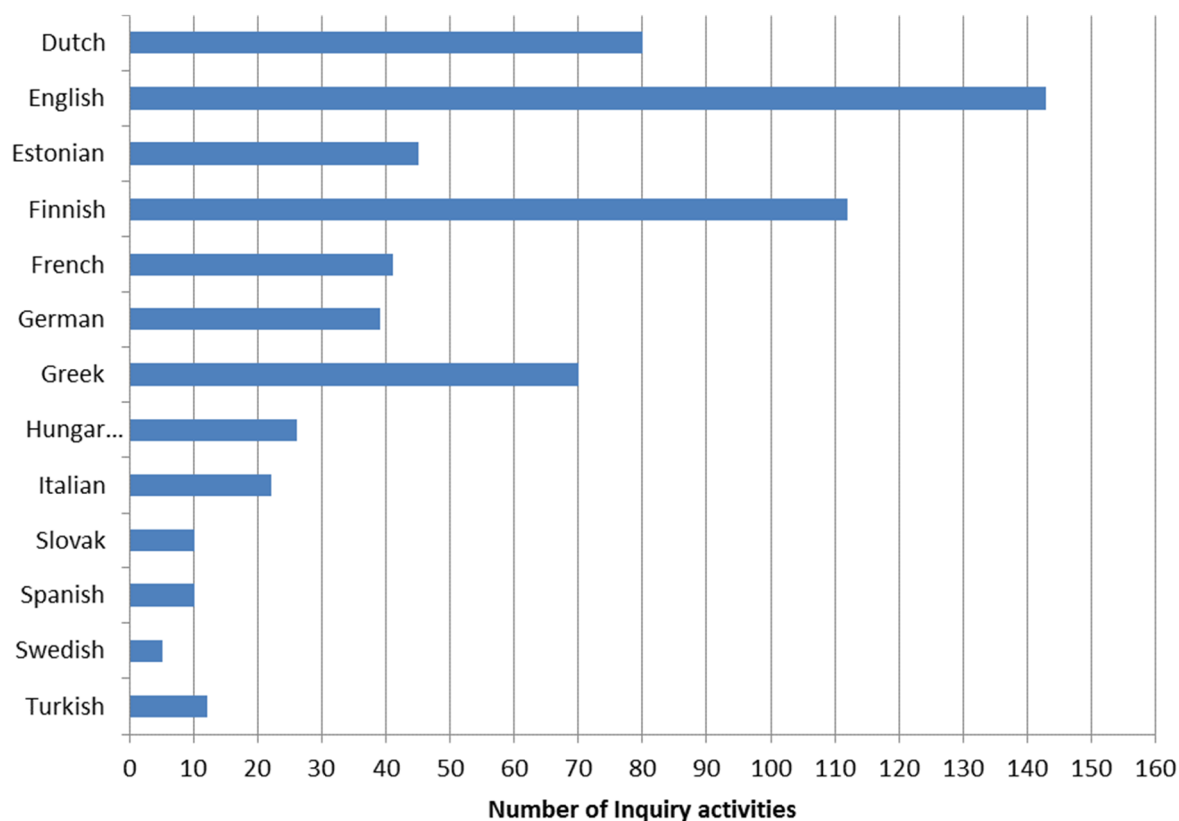


Figure 1. Availability of inquiry activities in different European languages (note: the sum of inquiry activities in different languages (615) is higher than 524 because some of the activities are available in multiple languages).

It is, however, important to notice that an inquiry activity being in a foreign language does not render it useless. First of all, there is a large variation in language dependency between inquiry activities, that is, some activities can be used with little effort in a foreign language, whereas others require some or a high level of adaptation. Secondly, language dependency is in many cases subjective and teachers and schools might actually seize different language activities as an opportunity to integrate content and second language learning (see Deliverable 2.4 for more details on the language issue in general and some potential solutions). Piloting and training has shown that while teachers and pupils tend to prefer inquiry activities that are in the local language, they can and are willing to use foreign language inquiry activities as well. As it was shown above, the availability of inquiry activities is good in languages such as English and German (and depending on the country, many others as well), which can be used in principle in most European countries; in other words, German and English inquiry activities, and particularly those in English, can supplement the collection of local inquiry activities in all countries.

Because language seems to be a factor in the use of inquiry activities in different countries (more so in some countries than in others), in the following section other aspects of the inquiry activities are investigated. The results will be represented first as a whole and then by language.

3.2. Domain

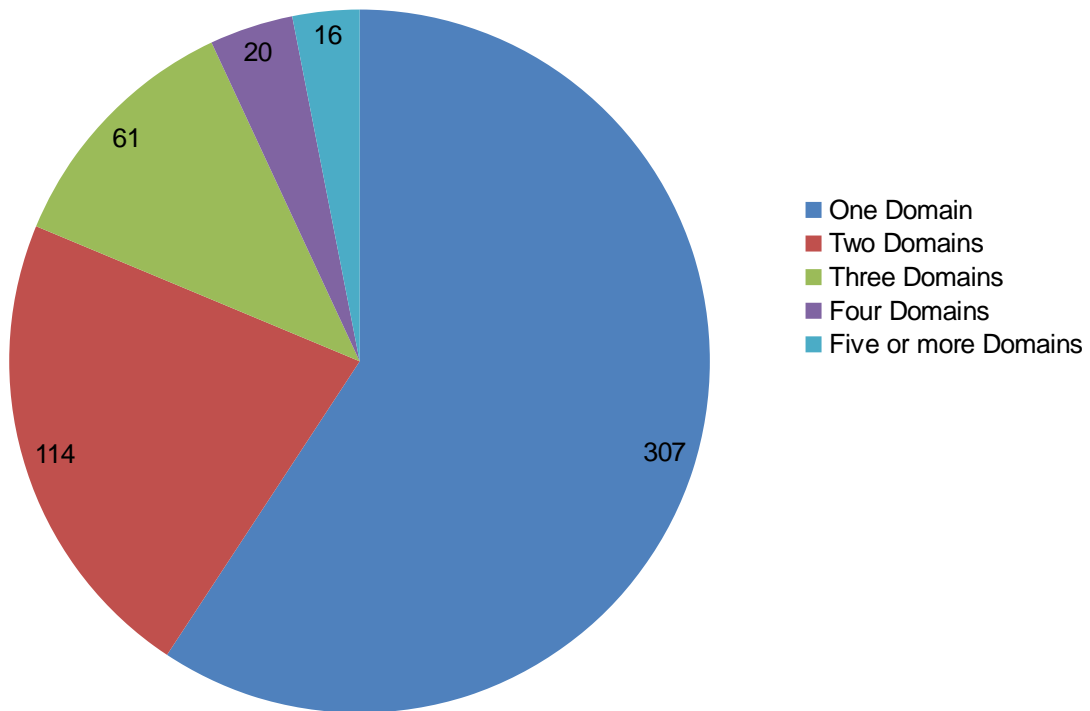


Figure 2. Number of domains covered within individual inquiry activities

Since the Ark of Inquiry targets inquiry activities in STEM domains, it is interesting to see the coverage of domains among the whole set of materials. The inquiry activities cover a total of 19 domains. The majority (80%) of the activities focus on one or two domains (Figure 2), while activities covering as many as 8 domains are also available. Most of the activities focus on the domain of Physics (Figure 3). Chemistry, Biology, Technology and Mathematics are the four other major domains covered by the activities. Thus, from the core STEM domains, all but Engineering seem to be well represented by the currently available inquiry activities. The 'Other domains' category consists of 8 domains (Astronomy, Evolution, Statistics, Geophysics, Social Sciences, Anatomy, Logic, Arts), each of which was covered in less than 10 inquiry activities. In all, a rather diverse range of domains is covered, with both single disciplinary and cross disciplinary activities.

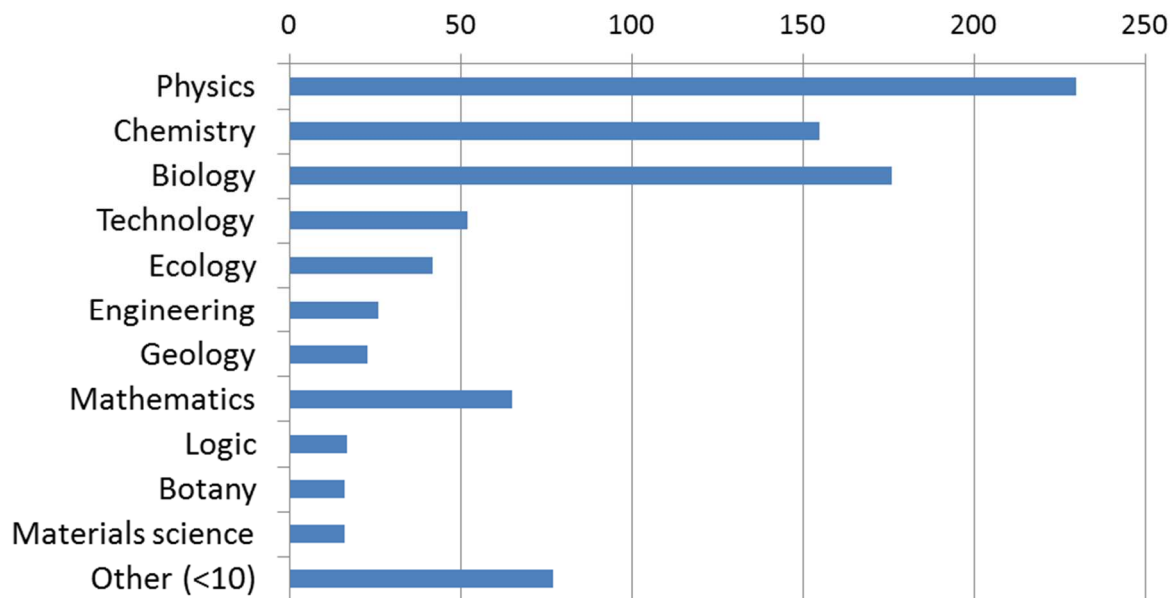


Figure 3. Frequency of individual domains' coverage by the inquiry activities

Table 1 presents distribution of domains across different languages. Overall, coverage of science domains seems to be the best independent of language. However, it is clear that in those language areas where more inquiry activities are available, the coverage across different domains is also broader.

Table 1. Frequency of individual domains' coverage by the inquiry activities across different languages

	English	Turkish	German	Greek	French	Dutch	Hungarian	Italian	Estonian	Finnish	Swedish	Spanish	Slovak
Physics	82	3	13	34	5	51	8	6	15	56	1	8	8
Chemistry	34	2	13	16	2	22	3	7	26	40	0	2	2
Biology	43	4	14	20	27	17	11	10	19	30	3	3	3
Technology	25	1	2	9	0	5	2	1	0	13	4	0	0
Ecology	10	0	4	3	1	3	2	4	3	19	1	1	1
Engineering	7	0	2	7	0	7	2	0	2	5	0	2	2
Geology	5	0	0	5	1	0	0	0	5	8	0	0	0
Mathematics	22	0	8	18	1	12	2	5	2	25	3	8	8
Logic	8	0	0	0	0	0	1	0	0	11	2	0	0
Botany	7	0	1	2	0	1	3	1	0	1	0	0	0
Materials science	4	0	0	0	0	2	0	0	0	10	0	0	0
Other (<10)	22	0	5	11	4	5	4	2	3	27	1	2	2

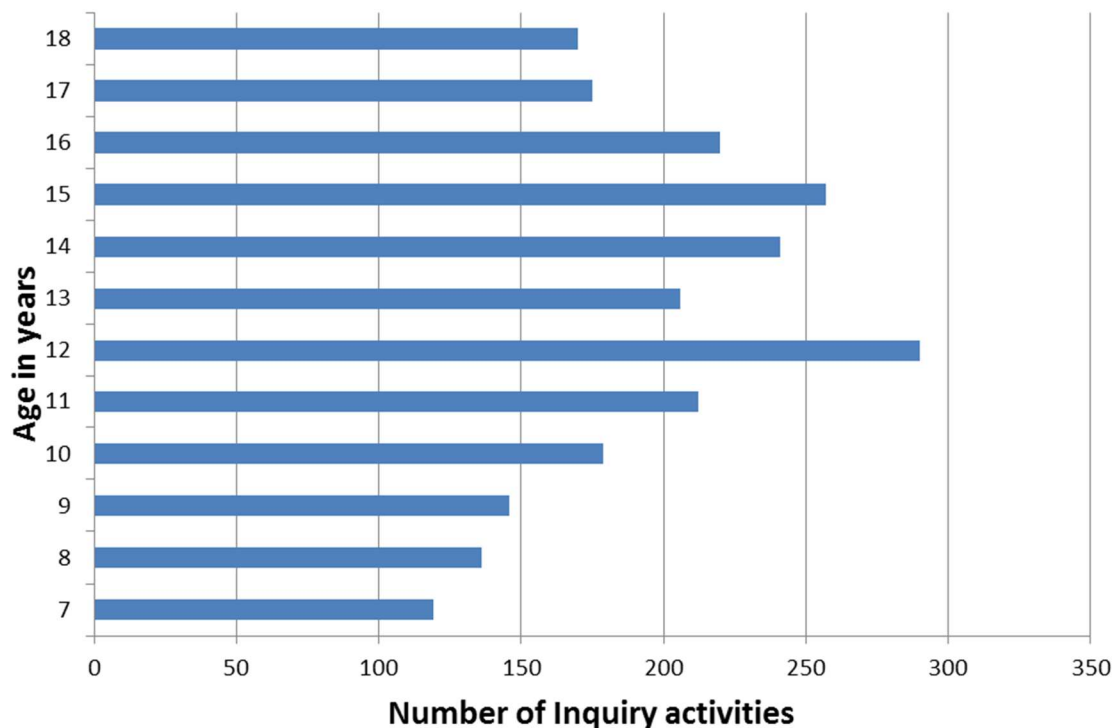


Figure 4. Number of inquiry activities available in each age within the targeted age range of the Ark of Inquiry

Figure 4 shows that the distribution of inquiry activities across the entire targeted age range (7–18) is very good. Both the initial review and feedback from the piloting suggested that there was a particular lack of inquiry activities for the youngest pupils (from 7- to 11-year-olds), but the situation has improved considerably during the past year. Even for 1st graders (7-year-olds) there are more than 100 inquiry activities available. However, despite the good overall age coverage, Table 2 shows that in certain languages there is a lack of inquiry activities for both the youngest and oldest age groups.

Table 2. Number of inquiry activities available in each age across different languages

	English	Turkish	German	Greek	French	Dutch	Hungarian	Italian	Estonian	Finnish	Swedish	Spanish	Slovak
7	29	0	5	7	21	20	11	6	4	39	4	0	0
8	33	0	5	12	23	21	11	8	6	40	5	0	0
9	34	0	8	14	24	21	5	8	6	51	3	0	0
10	43	0	11	23	25	21	10	14	6	51	3	0	0
11	48	11	13	28	22	24	10	16	8	68	2	3	3
12	63	11	12	52	21	44	11	20	29	69	2	4	4
13	51	12	13	39	9	27	6	12	29	37	0	5	5
14	63	12	25	48	13	31	7	13	31	35	0	8	8
15	66	12	18	37	15	50	8	12	35	33	0	6	6
16	60	0	17	37	15	43	5	11	40	14	0	5	5
17	43	0	11	28	14	37	5	3	30	14	0	1	1
18	40	0	11	27	14	37	4	3	30	14	0	1	1

3.3. Proficiency levels

In order to make inquiry learning engaging and productive, it is important to match the learner’s level of inquiry proficiency with suitably challenging inquiry activities. In the context of Ark of Inquiry this is supported by distinguishing the levels of inquiry proficiency. Inquiry proficiency, one of the central concepts in the Ark of Inquiry project’s inquiry framework, refers to pupils’ experience, skills and capacity regarding inquiry learning, and in the context of Ark of Inquiry, inquiry activities are divided into the following three proficiency levels: A – Novice; B – Basic; and C – Advanced.

The main distinctive features between the inquiry proficiency levels are problem-solving type (well- vs. ill-defined problem space), learner autonomy (from teacher-led to pupil-led), and RRI awareness (gradually expanding the amount and scope of interaction/discussion). At the lowest, Novice level (A), activities aim mainly at engaging learners in and introducing them to structured inquiry activities. At the Basic level (B) the inquiry activities become semi-structured and guide learners towards independency related to knowing how to inquire and reflect on and discuss issues related to the activity. At the Advanced level (C) learners can already shape their own inquiry activities and reflect and discuss outcomes in collaboration with various stakeholders.

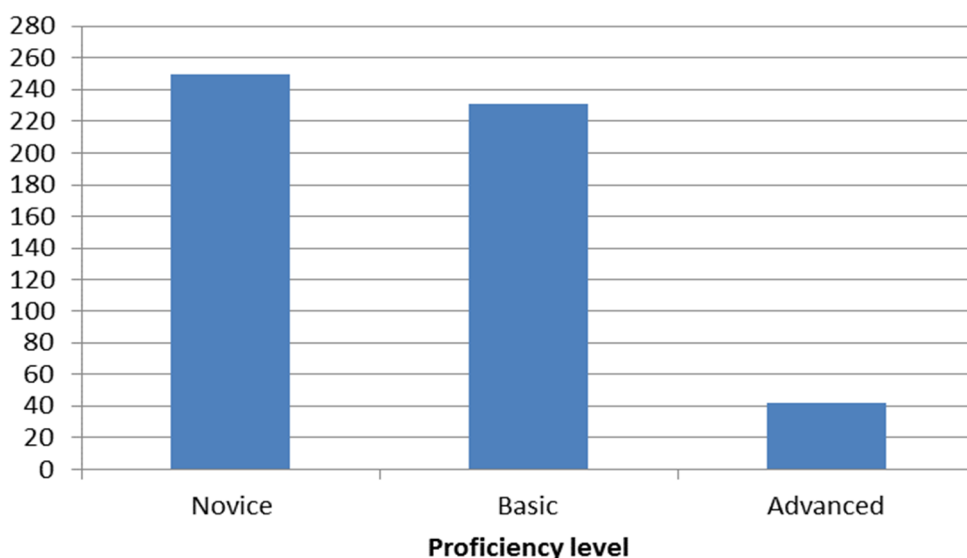


Figure 5. Number of inquiry activities on each proficiency level across the whole age range

As shown in Figure 5, the majority of the inquiry activities are on A- (48%) and B-level (44%), whereas there is only a limited amount of activities on the C-level (8%), suggesting that teachers might prefer to use basic or novice level inquiry activities, since they are easier to implement in every-day teaching (this interpretation is supported by the “estimated learning time” statistics on page 21). Lack of inquiry activities on the advanced level was identified as one of the issues in the initial review in Deliverable 2.3, and it seems that although the

amount of advanced level inquiry activities has quadrupled (from 11 to 42) since the initial review, the situation as a whole has not improved optimally. On the other hand, the situation may not be as critical as indicated by the numbers, because in many situations advanced level activities may be created from scratch, that is, the tasks may result from practical, real life problems discovered by pupils²³. Furthermore, by using the pedagogical scenario “Adjusting the inquiry proficiency level” (see Deliverable 2.4), teachers can transform any A- or B-level activity into a C-level activity.

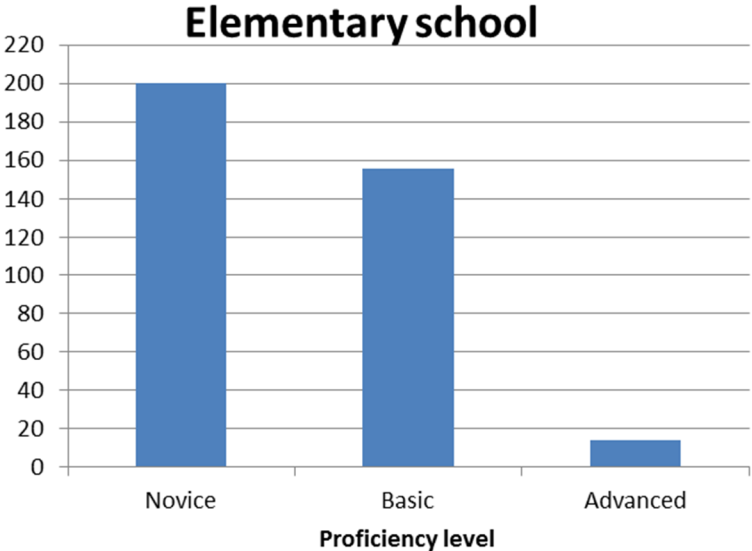


Figure 6. Number of inquiry activities on each proficiency level for elementary school

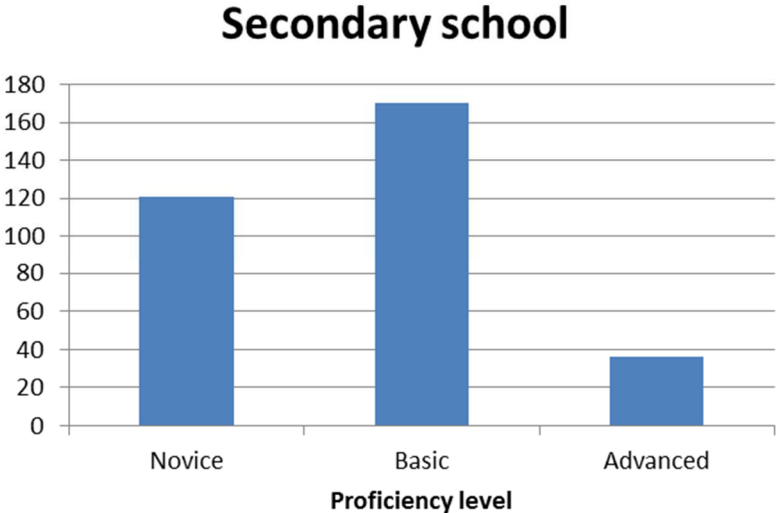


Figure 7. Number of inquiry activities on each proficiency level for secondary school

2 https://en.wikipedia.org/wiki/Boyan_Slat
 3 <http://www.forbes.com/sites/paulrogers/2014/03/28/sixth-grader-tells-government-how-to-save-400m-on-ink/#4ea6d7ff5463>

As can be seen from Figure 6 and 7, on elementary school level (ages 7 to 12) A-level activities are dominating, but there is also a good number of B-level activities. There is only a handful of C-level activities (14 C-level activities fit into elementary level), which is understandable, because younger pupils are not expected to be that experienced or advanced investigators. On secondary school level (ages 13 to 18), the emphasis shifts more towards B-level inquiry activities. This is good, because it can be expected that older pupils are capable of conducting and already seeking more challenging and open-ended inquiry tasks. Though nearly all C-level activities that are overall available (36 / 42) fit into secondary school level, there is clearly a need to identify and develop C-level activities in future projects.

Table 3. Number of inquiry activities on each proficiency level across different languages

	Novice	Basic	Advanced	TOTAL
Dutch	50	23	7	80
English	59	68	16	143
Estonian	31	13	2	46
Finnish	59	47	6	112
French	20	8	12	40
German	22	12	5	39
Greek	25	35	9	69
Hungarian	10	13	3	26
Italian	4	13	5	22
Slovak	9	1	0	10
Spanish	9	1	0	10
Swedish	2	3	0	5
Turkish	2	10	0	12
TOTAL	302	247	65	614

Table 3 shows the distribution of proficiency levels across different languages. As could be expected from earlier, there are differences between different languages. A-level activities are dominating in Dutch, German, and Estonian languages, whereas in Turkish and Italian B-level activities are the majority. In English, Finnish and Greek, there is a good balance between A- and B-level activities. French is the only language where there are more C-level activities than B-level activities. Overall, the best availability of C-level activities can be found in English, and the best balance of activities across the three proficiency levels is in French and Greek. Considering that overall, there are not so many inquiry activities available in Italian and Hungarian, the coverage of proficiency levels is surprisingly good in these languages.

3.4. Inquiry phases

Inquiry learning is a process that is often complicated for learners (e.g., Veermans, van Joolingen & de Jong, 2006), and dividing the process into phases can make it easier to be explained and understood, especially when learners are not yet very proficient. In the Ark of Inquiry the inquiry process is divided into five distinct phases (Orientation, Conceptualisation, Investigation, Conclusion, and Discussion) according to Pedaste et al. (2015) inquiry cycle model (see Deliverables 1.1. and 2.4. for more details on the inquiry phases; please note that “Pedaste et al. inquiry learning model” or “Pedaste et al. model” has been used in some previous deliverables to denote the “Pedaste et al. inquiry cycle model” used in this deliverable). According to the selection criteria (Deliverable 2.1), an activity needs to cover at least one of the five inquiry phases. This relatively loose criterion stems from the fact that existing inquiry activities that were not designed with these particular phases in mind will not necessarily comply with all phases of the Pedaste et al. inquiry cycle model. Another reason is that an activity that covers only one (or two) inquiry phases may cover/address that phase particularly well and setting a stricter criterion would mean exclusion of these activities from the Ark of Inquiry. In general, though, activities covering multiple phases are highly recommended and desired, because multiple phases can ensure that learners get a good and comprehensive learning experience in a process that a) resembles scientific inquiry, b) helps to improve their inquiry skills and proficiency (i.e. the ability to generate and evaluate and discuss scientific evidence and explanations), and c) promotes their understanding of the process of conducting science in a better and more responsible manner. Regarding the last point, the Orientation phase and the Discussion phase are considered particularly important in the context of Ark of Inquiry, because it is in those phases that RRI aspects can be thoroughly addressed most naturally.

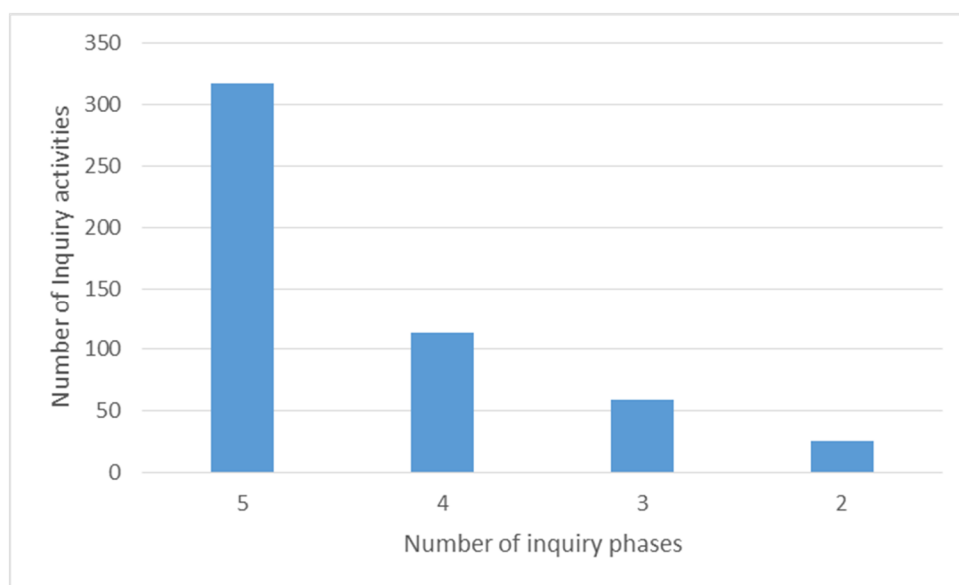


Figure 8. An overview of the amount of inquiry phases covered in individual activities

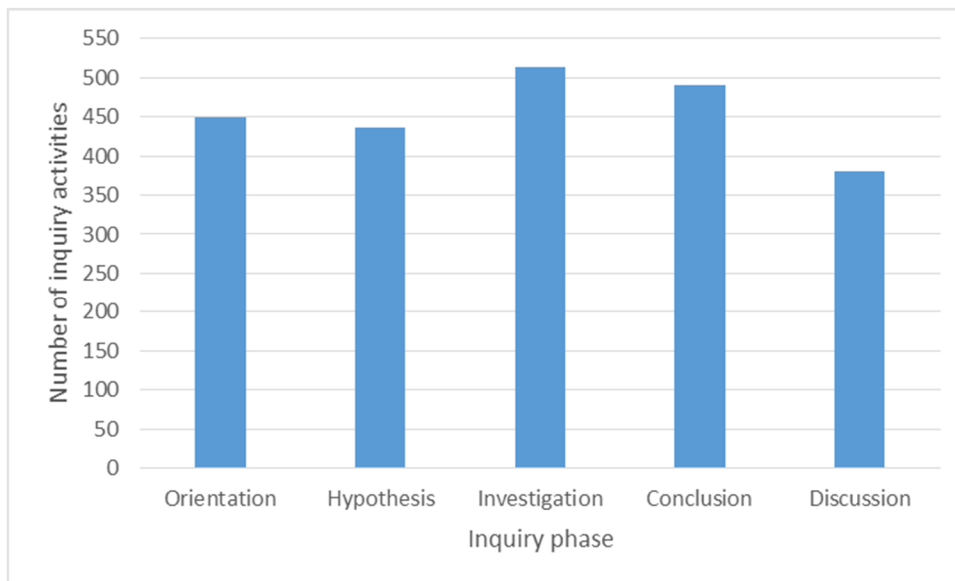


Figure 9. Number of times that an inquiry phase is included in an activity

As shown in Figure 8, the majority (61%) of the inquiry activities consist of all five inquiry phases and single phase activities are completely absent, which can be considered as an excellent outcome. As shown in Figure 9, Orientation, Conceptualisation, Investigation and Conclusion phases are present in more than 80% of activities (Investigation and Conclusion in almost all activities), and only inclusion of the Discussion phase is slightly less frequent – it is included in 73% of inquiry activities. However, in many cases it is natural that teachers create space for discussion at the end of a learning task, even though this phase is not included in the inquiry activity itself. Overall, the excellent coverage of inquiry phases suggests that inquiry activities distributed through the Ark of Inquiry can offer a comprehensive inquiry experience for pupils. Because the overall coverage of inquiry phases is good, inspection across different languages has been left out from this section.

3.5. Responsible Research and Innovation (RRI)

Responsible Research and Innovation (RRI) is a central theme in the European Union vision. RRI initiatives in science education aim to boost interest of children and youth in STEM and to prepare them to take responsibility in the research and innovation processes as researchers or citizens in the future. While formal science education aims at effectivity and efficiency of science education in school in the short run, RRI aims to foster science use outside of formal education in the long run and connect science education to globally recognised issues (e.g., the following seven Grand Challenges identified by the EU: sustainable agriculture, climate action and resource efficiency, global poverty, inclusive and secure societies, health and well-being, sustainable transport, and clean energy). In this light, it is positive to see that many topics of the inquiry activities cover the areas of the grand

challenges (e.g., pollution, CO₂ emission, Sea pH level, ecology, greenhouse effect, environmentally conscious transportation, solar energy, alternative energy).

RRI also requires a greater consideration of the interactions among science, technology and society in the school science curriculum in order to raise awareness of RRI and to meet the needs, interests and aspirations of young citizens at the same time. For this purpose, the Ark of Inquiry project advocates emphasis on three aspects that can help to foster pupils' awareness of RRI and in the longer run prepare them to take part in RRI: reflection, communication and discussion (Deliverable 1.6). In the section on inquiry phases it was already argued that, besides the general nature of the inquiry, the Orientation and Discussion phases were identified as phases that would be the most appropriate for implementing dimensions of RRI in the inquiry activities. The Orientation phase is included in 86% of the inquiry activities, Discussion is included in 73%, and both Orientation and Discussion are available simultaneously in 68% of the inquiry activities – this suggests that the majority of the inquiry activities are likely to be able to contribute to the RRI goals of the project. Because many of the existing inquiry activities have not been designed explicitly from an RRI perspective, Deliverable 2.4 (Pedagogical inquiry scenarios for re-use of inquiry activities) provides guidelines and suggestions for teachers as to how they can increase RRI elements in each inquiry activity.

3.6. Gender

Over the past years, research has documented a consistent decline in pupils' interest in science and science careers. This holds particularly in the case of girls. One of the goals of the Ark of Inquiry (and European Commission) is to make science more attractive for women in order to attract more women to science and science careers. Though the particular focus is on empowering girls in science, the global aim of the project is to promote gender inclusive science education (that is, empower girls in science without negatively affecting boys).

It has been found that Inquiry learning that emphasises learner-centred learning has produced positive results related to female pupils' interest across a broad array of topics in STEM. In Finnish pilots, for instance, inquiry topics ranged, e.g., from electricity to states of matter to recycling. Independent of gender, a majority of learners reported high levels of interest throughout all the inquiry activities. It is also assumed that inquiry activities that have a strong RRI component might be particularly engaging for girls (Knezek, Christensen, Tyler-Wood, & Periathiruvadi, 2013). Inquiry activities' potential to engage pupils is currently investigated more thoroughly in the context of WP5 (Evaluation; Deliverable 5.4), where data on students' engagement and interest while they are working on various inquiry activities is being collected in each partner country. These results will tell, on a broad scale, to what extent the inquiry activities are generally able to engage pupils, what kind of inquiry

activities are particularly engaging, and whether there are any gender related differences (e.g., whether there are certain types of inquiry activities that are particularly engaging for girls). One of the six pedagogical scenarios in Deliverable 2.4 is also devoted to providing guidelines and practical examples for teachers on how to empower girls in science and how to avoid gender stereotypes in teaching. This work has been extended within the project in UNESCO's 'Gender-inclusive guidelines'⁴. These materials are available to teachers in the Ark of Inquiry platform, in the Teachers' Toolbox section.

3.7. Learning Time

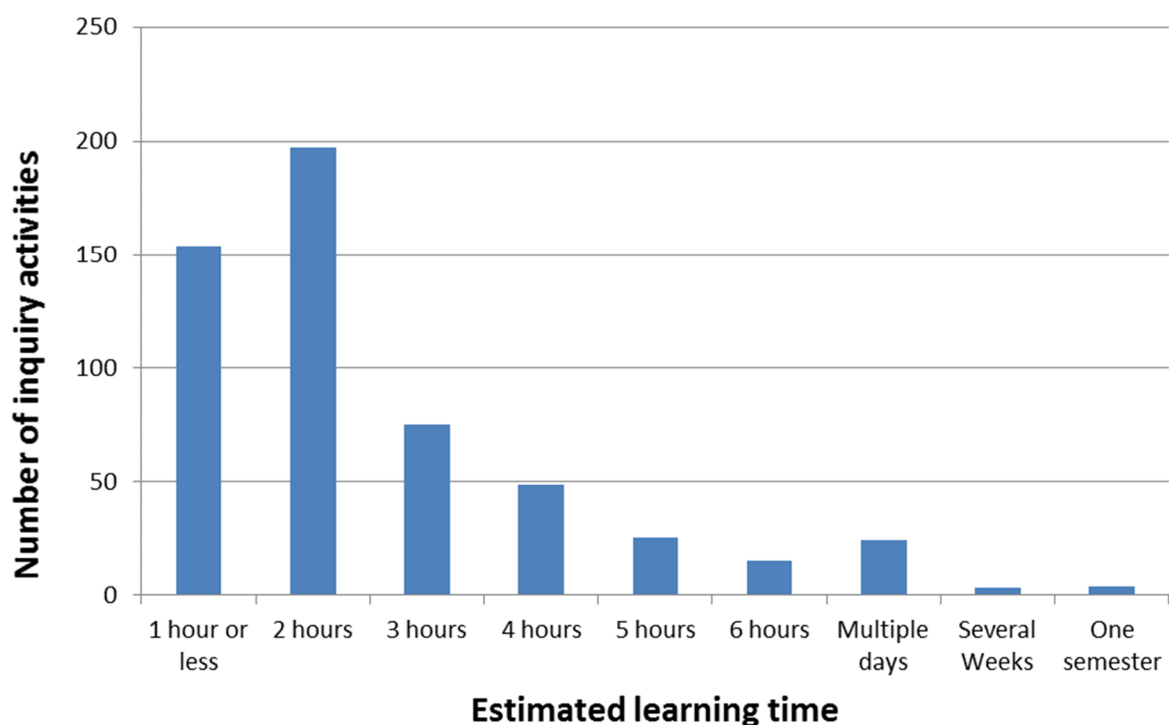



Figure 10. Distribution of inquiry activities by learning time

The median duration of inquiry activities is two didactic hours (90 minutes⁵). However, there is a large variation in the learning time between the activities, the shortest lasting less than one didactic hour (45 minutes) and the longest the whole semester (see Figure 10 for more details). The estimated learning time of an activity will likely be a factor for teachers and learners in deciding whether to engage with a certain activity. Inquiry activities with shorter duration might be preferred by less experienced teachers and pupils because they may offer

⁴ https://sisu.ut.ee/sites/default/files/ark/files/infographic_gender_guidelines_final_version_a4.pdf

⁵ Assuming that teachers use pedagogical scenarios and put extra emphasis on Orientation and Discussion phases, the durations in Figure 10 are likely to be underestimations.



a lower threshold to get familiar with inquiry learning and can be fitted more easily into the curriculum. Activities with a longer learning time might enable the pupils to learn more about the inquiry process than the shorter ones. The longer ones might also address the RRI aspect better (though that obviously depends on the content), but in any case the variance in range provides an option for teachers and learners to engage in projects with different durations based on the available resources, time, and goals.

4. Representation of inquiry activities within the Ark of Inquiry platform

Within the Ark of Inquiry platform (arkportal.eu) the inquiry activities are presented as a library of activities, allowing potential users to either scroll through the list of activities, search for activities using a search function or to select an activity based on keywords attributed to the activity from a word cloud. Additional support is provided in the form of the Teacher's Toolbox page and other features embedded into the platform.

The characteristics of the inquiry activities that were specified in “D2.1 Criteria for selection of inquiry activities including societal and gender dimensions” and discussed in the previous part of this deliverable (3. Overview of inquiry activities) are used within the platform to describe the activities in detail in order to allow users of the Ark of Inquiry platform to make informed choices when selecting activities. The information on each activity that is available for platform users includes: title of the activity, overall proficiency level, description of the activity, domain or domains, location (web-based or physical location), topic or topics, language or languages, proficiency level of the activity evaluated by inquiry phases covered (available through the search function), inquiry phases covered, age range, learning time, materials needed for the activity, evidence on the success of the activity, evidence description, copyright information and other restrictions, original website of the activity, RRI focus and RRI description (in the case of activities with a strong RRI component) and keywords (available through the search function).

4.1. Activity list

In the activity list (Figure 13), the user is presented with inquiry activities listed starting from the activity added to the platform most recently. This order aims to guide users to discover new activities. When looking through a list of activities, the users can see the names, the first paragraphs of the description and the locations of the activities. Full information about the activity is revealed upon selecting the activity (Figure 14) and clicking the “Show more” button. This allows the activity pages to be at the same time brief enough for pupils and yet detailed enough for teachers.

Inquiry activities

List of activities (484) Search Tag cloud

Η λειτουργία της θρέψης-Ισορροπημένη διατροφή 🔍

Ποιο είναι το ταξίδι της τροφής; Το μάθημα αυτό αποτελεί μια εισαγωγή για τη λειτουργία της θρέψης και της ισορροπημένης διατροφής. Οι κυριότεροι στόχοι του μαθήματος είναι οι μαθητές να είναι σε θέση να κατανοούν την λειτουργία της θρέψης του οργανισμού διαμέσου του πεπτικού συστήματος, να αναγνωρίζουν τα όργανα του πεπτικού συστήματος, καθώς, και να ξέρουν τα βασικά συστατικά μιας ισορροπημένης διατροφής. ...

The sound of Music: An interactive lesson on Standing Waves 🔍

Have you ever wondered about the Science of Music? How do musical instruments produce the different sounds we hear that when put in the right order a beautiful melody can be created? How many different sounds can we create? Or, is our imagination the only limit? When Science and Arts (music in our case) come together, the results are simply wonderful. ...

Ώσμωση-Ωσμωτικά φαινόμενα στα ζωντανά κύτταρα 🔍

Γνωρίζετε πώς μπορούν να διατηρηθούν τα τρόφιμα για μεγάλο χρονικό διάστημα χωρίς να αναπτυχθούν μικροοργανισμοί στη σάρκα τους; ...

Μεταγραφή και μετάφραση του DNA 🔍

"Έχει τα μάτια του πατέρα του!" ή "Ώςως φαίνε τα γονίδια μου!" είναι φράσεις που σίγουρα όλοι έχουμε ακούσει. Έχετε όμως αναρωτηθεί ποτέ πώς τα γονίδια καθορίζουν τα χαρακτηριστικά ενός ατόμου; Πώς γίνεται κάτι που δεν είναι ορατό ούτε με το γυμνό μας μάτι να είναι υπεύθυνο για το σχήμα των ματιών ή το χρώμα των μαλλιών μας; Το μάθημα αυτό αφορά στη μεταγραφή και μετάφραση του DNA.

Ογκομέτρηση 🔍

Η ογκομετρική ανάλυση είναι μία μέθοδος ποσοτικής ανάλυσης με την οποία προσδιορίζεται η συγκέντρωση ενός διαλύματος. Πατή ογκομετρική ανάλυση χρησιμοποιείται σε μεγάλη κλίμακα; Πατί είναι μία μέθοδος εύκολη και γρήγορη! Έτσι, σε αυτό το μάθημα θα χρησιμοποιήσουμε μία γρήγορη, πλήρη και αναγνωρίσιμη αντίδραση. Ποια άλλη; Την αντίδραση της εξουδετέρωσης! ...

Figure 13. Section of the activity list from the Ark of Inquiry platform

The sound of Music: An interactive lesson on Standing Waves

Overall proficiency level: **Basic**

Activity Description

Have you ever wondered about the Science of Music? How do musical instruments produce the different sounds we hear that when put in the right order a beautiful melody can be created? How many different sounds can we create? Or, is our imagination the only limit? When Science and Arts (music in our case) come together, the results are simply wonderful.

In this lesson pupils will have the opportunity to learn how standing waves are created using several virtual labs and applications. The pupils are first introduced to the lesson by watching a duet playing music on a glass harp. Then they are required to draw some hypothesis that will reflect on after they go through the experimentation phase.

The proficiency level of the activities can be considered as basic because in spite of the limited degrees of freedom that the inquiry activity allows there is still enough space for exploration and individual actions such as experiment design.

Details

Added by
Maria Irakleous

Date added
03.01.2017

Domains Physics

Orientation level Basic

Conceptualisation level Basic

Investigation level Basic

Conclusion level Basic

Discussion level Basic

Languages English

Typical Age Range (incl.) From 16 to 18

[Show more](#)

Figure 14. An activity form from the Ark of Inquiry platform

4.2. Search function

Within the search function (Figure 15), setting limiting parameters to several of the characteristics allows to filter the complete list of activities to find the ones most suitable for the current needs of the user. In addition to searching for specific text or keywords, the user can set parameters for following characteristics: location (either web-based or a location in the country of the user), domains, languages, proficiency level (either the overall proficiency level or the proficiency level of different inquiry phases), age range and learning time. The user can also search for activities containing a strong RRI component.

Search phrase

Typical Age Range (incl.) 6 20

Location Web-based
 Physical location

Languages

Overall proficiency level

Proficiency level for inquiry phases

Phase	Level A (Novice)	Level B (Basic)	Level C (Advanced)
<input type="checkbox"/> Orientation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="checkbox"/> Conceptualisation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="checkbox"/> Investigation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="checkbox"/> Conclusion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="checkbox"/> Discussion	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Domains

[+ Add more](#)

Other filters Learning time (Academic hours)
 Has strong RRI component?

Figure 15. The search form from the Ark of Inquiry platform

4.3. Tag cloud

A tag cloud (formerly known as word cloud, Figure 16) consisting of the most commonly used keywords or -phrases associated with inquiry activities provides another way to filter inquiry activities by displaying all activities related to specific keywords or -phrases. Keywords used most often are displayed as being bigger than the ones mentioned less frequently. For example, clicking on the phrase “DNA” within the tag cloud guides the user to a list of activities dealing with topics related to the solar system regardless of the actual domain or other characteristics of the inquiry activity. The advantage of this alternative is that it does not require ‘pre-knowledge’ on adequate filtering terms or keywords, since they are displayed on the screen in different colours. This allows the user to be more exploratory than with the search function.

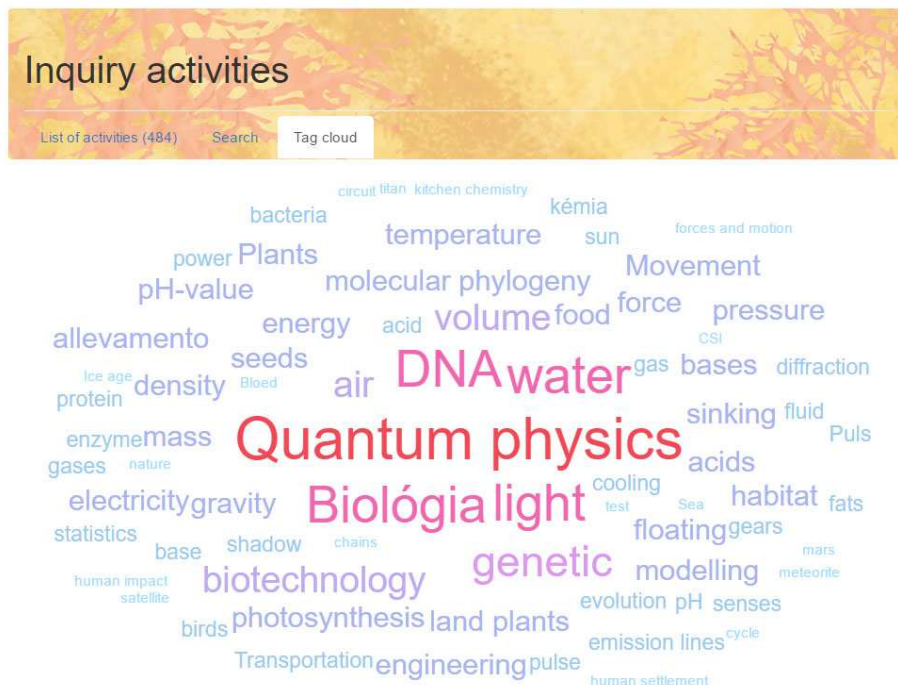


Figure 16. Example of the tag cloud form from the Ark of Inquiry platform

In addition to finding activities using aforementioned options, the Ark of Inquiry platform allows teachers and other users with similar roles to recommend certain activities to pupils within their pupil groups (Figure 17).

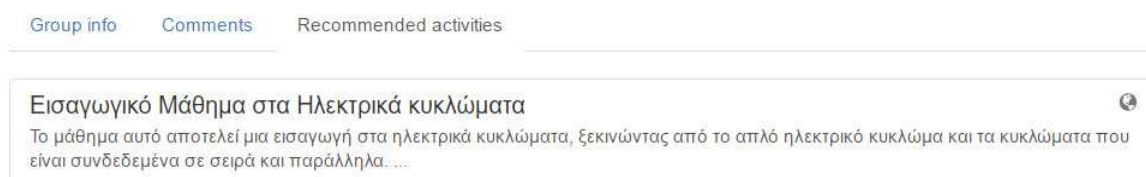


Figure 17. Example of a group page with one recommended activity

Activities that have proven themselves to be engaging and interesting to pupils are also promoted on the Ark of Inquiry Facebook community page (<https://www.facebook.com/ArkofInquiry>) as an activity focus feature (Figure 18). So far, there have been 18 activity focus features published consisting of a thematic illustration, description of the activity and the link to the activity.

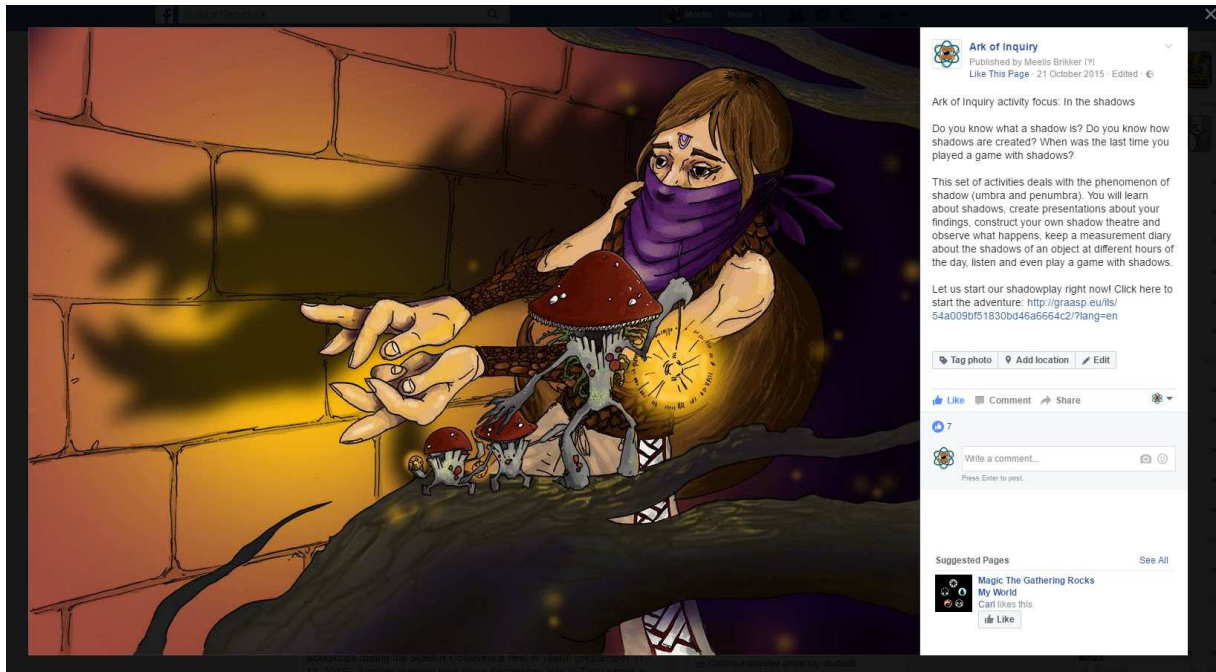


Figure 18. Example of an activity focus feature for the activity “In the shadows” from the Ark of Inquiry Facebook community page

4.4 Support for platform users

Additional pedagogical support for platform users is provided in the form of the Teacher’s Toolbox page, which includes pedagogical scenarios, evaluation instruments and an option for teachers to add their own evaluation instruments to the toolbox.

It is common that learning materials need modifications and additions before they can be used in the classroom. Six pedagogical scenarios have been developed that guide teachers to evaluate, redesign, improve and adapt inquiry activities in their classrooms. These scenarios alongside a thorough introduction and reasoning behind modifying inquiry activities are available for download at the bottom of the Teacher’s Toolbox page. Full overview of the pedagogical scenarios is available in Deliverable 2.4.

Pedagogical scenarios for redesigning inquiry activities

It is common that learning materials need modifications and additions before they can be used in the classroom. Six pedagogical scenarios have been developed that guide teachers to evaluate, redesign, improve and adapt inquiry activities in their classrooms.

[Introduction \(PDF | 2,88 MB\)](#)

[Pedagogical scenarios \(PDF | 5,1 MB\)](#)

Figure 19. Pedagogical scenarios on the Teacher's Toolbox page

The evaluation system used throughout the Ark of Inquiry project assesses pupils' progress in inquiry proficiency by measuring their inquiry skills on three levels of proficiency running from novice to basic to advanced inquiry skills. All the tools and materials needed to implement this system in the classroom are contained within the Teacher's Toolbox. These instruments are structured according to 8 categories and include instructions about using different aspects of the evaluation system. Full overview of the evaluation instruments is available in Deliverable 1.6.

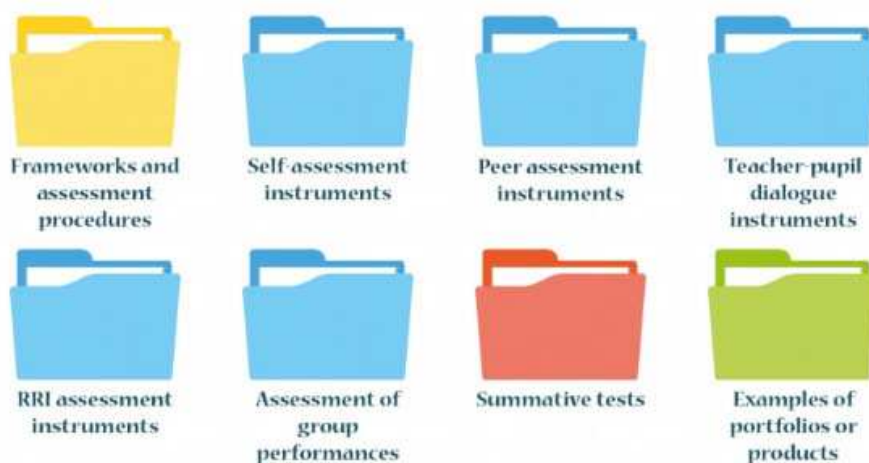
Teacher's toolbox

Evaluation instruments

The Ark of Inquiry project aims to build a scientifically literate and responsible society through inquiry-based science education and by providing learners with meaningful feedback to improve their inquiry proficiency. The evaluation system assesses pupils' progress in inquiry proficiency by measuring their inquiry skills on three levels of proficiency running from novice to basic to advanced inquiry skills.

This toolbox contains tools and procedures to evaluate pupils' inquiry proficiency and challenge their RRI competences. The toolbox puts an emphasis on *formative assessment*: *reflect on what has been done in order to decide what needs to be done next*. The toolbox provides instruments that can be used at three levels of proficiency: A (novice), B (basic), and C level (advanced). At each of the three proficiency levels pupils can take a summative test to confirm and prove their proficiency.

The toolbox is structured according to categories of instruments and now contains:



Instruments also available in Greek, Italian and Estonian.

Figure 20. Evaluation instruments on the Teacher's Toolbox page

Teachers who feel that they are able to support the community and add their own instruments to the current version of the toolbox are invited to do so, provided their additions get approved by the national coordinator.

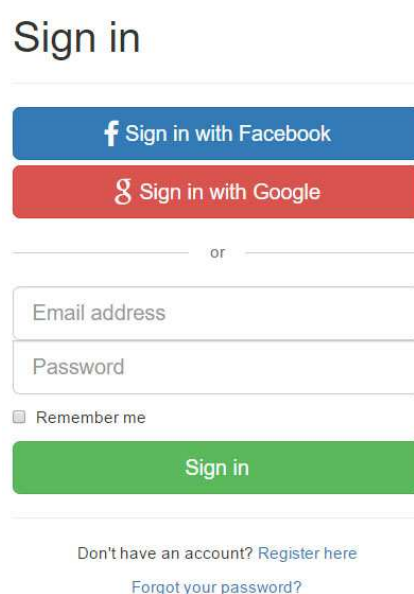
Add new tools!

The toolbox in its current form contains a first set of instruments and procedures. We invite teachers to add their own instruments or adapt existing ones and add new versions of them in the toolbox. A tool description template for submitting adapted or new tools is presented [here](#). You can send your instrument and tool description to the national coordinator in your country.

Figure 21. Option to add additional instruments to the Teacher’s Toolbox page

4.5. Ease of access

In the first version of the platform, many test users found it difficult to sign in and take their first steps within the platform. A valid problem was raised in the form of pupils younger than 13 not being able to have social media accounts or e-mails. In the current and final iteration, the users are offered additional options for signing up as a user or for logging in with their account. These options include signing in using either a pre-existing Google or Facebook account, but a hidden option exists as well – for users too young to have either social media accounts or e-mails, it’s possible to sign up using a username instead of an e-mail address. The use of this option is not encouraged (thus the input field stating “Email address”) as it makes administrative users (including national coordinators) unable to contact these users, but it ensures that all the interested parties have access to the platform, provided they have been informed of this.



The screenshot shows a 'Sign in' page with the following elements:

- A blue button with the Facebook logo and the text 'Sign in with Facebook'.
- A red button with the Google logo and the text 'Sign in with Google'.
- The word 'or' centered between two horizontal lines.
- An input field labeled 'Email address'.
- An input field labeled 'Password'.
- A checkbox labeled 'Remember me'.
- A green button labeled 'Sign in'.
- At the bottom, two links: 'Don't have an account? Register here' and 'Forgot your password?'.

Figure 22. Signing in to the platform

The tutorial of the platform was initially located on the Teacher’s Toolbox page, but this proved to be difficult to find. To make it easily accessible, it is now available on each of the platform pages, at the top of the page alongside a comprehensive list of national coordinators – project members entrusted with the task of guiding the user experience of

their local community members. National coordinators also act as a filter, making sure only trusted teachers who have either participated in the teacher training programme or other project events have access to advanced features such as adding their own inquiry activities or managing pupil groups.



ATTENTION TEACHERS: To upgrade your pupil account to a teacher account, please contact your **local coordinator**! View the [platform tutorial](#).

Figure 23. Information provided on each page: platform tutorial and the list of national coordinators

As a next step, a video version of the platform tutorial is planned to be produced and made available on the platform page as well on project related webpages and in social media. Additionally, a section of FAQ (frequently asked questions) is planned to be added to the Teacher's Toolbox page based on some of the user experiences documented during implementation events.

5. Discussion

The current deliverable has described the methodology and process behind the selection of inquiry activities in the context of the Ark of Inquiry project, presented an overview of the currently available inquiry activities from the perspective of the selection criteria and coverage of core elements of the Ark of Inquiry project and described how those inquiry activities are represented within the Ark of Inquiry platform.

The overview, which was the main focus of the deliverable, revealed that the inquiry activities as a whole represent an excellent coverage of the central components and aims of the project. Here are the main highlights:

1. Since the initial review (Deliverable 2.3) and piloting phase (end of 2015), the number of inquiry activities has grown from 68 to 524.
2. Inquiry activities are available in 13 different European languages.
3. The inquiry activities cover well all major STEM domains (except for engineering).
4. The coverage of the whole targeted age range (7 to 18) is comprehensive; there are at least 100 inquiry activities available in each targeted age group.
5. The inquiry activities are available in three different proficiency levels, ensuring that pupils with different sets of skills and knowledge (even within certain age level or range) can find inquiry activities that match their inquiry proficiency.
6. The inquiry activities can provide a comprehensive inquiry experience for pupils, as more than 60 % of the inquiry activities include all five inquiry phases and over 80% include at least four phases.
7. Through relevant study topics (e.g., related to the Grand Challenges) and comprehensive inclusion of Orientation and Discussion phases (Orientation and Discussion are the two key inquiry phases from the RRI perspective; either the Orientation or Discussion phase is included in more than 90% of the inquiry activities, and both phases are included in 68% of the inquiry activities), the inquiry activities provide extensive opportunities for addressing RRI.
8. Duration of the inquiry activities varies from 30 minutes to a whole semester. The average duration of two study hours ensures that the threshold to use inquiry activities is low and the activity can be fitted more easily into a curriculum, whereas the inquiry activities with longer duration can provide more extensive and challenging inquiry experiences.

Given that the focus of the project has been on existing inquiry activities, it can be considered surprising that the analysis of the inquiry activities identified only two shortcomings in relation to the coverage of the main goals and pedagogical principles of the project. The first shortcoming was that the availability of inquiry activities seems to vary notably between different languages, suggesting that there could be considerable differences between countries (and language areas) in teaching traditions and implementation (and history) of inquiry learning in education. The second shortcoming was that though the amount of C-level inquiry activities has quadrupled since the piloting phase, the availability of these advanced level activities is still low compared to A- (Novice) and B- (Basic) level activities. These kinds of shortcomings were anticipated in the project work plan, where it was foreseen that the existing inquiry activities might not optimally fit into the unique pedagogical framework of Ark of Inquiry. In order to bridge this gap, the project has developed pedagogical scenarios (deliverable 2.4) that are designed to help teachers (and other educational authorities and designers) to adapt and improve the existing inquiry activities in order for them to use these in various classroom situations and while implementing to better cover the principles that are considered important in the context of Ark of Inquiry. The pedagogical scenarios explicitly address the above shortcomings. The "Adjusting the inquiry proficiency level" scenario, for instance, provides instructions for teachers on how to change the proficiency level of individual activities; so, in principle, by using these guidelines any activity can be altered in a way that it becomes a C-level activity. The "Overcoming language and sociocultural barriers" scenario focuses on helping teachers to use and adapt foreign language inquiry activities, and it explains how foreign language inquiry activities can be seen and used as an engaging additional learning resource.

Overall, the 524 inquiry activities that are currently available offer a broad array of engaging inquiry activities to pupils across Europe. The inquiry activities are easily accessed through the Ark of Inquiry platform, which offers various different ways to log in and search for inquiry activities. The inquiry activity descriptions are something that the project is particularly proud of, because the descriptions provide a comprehensive yet compact overview of each inquiry activity, which means that teachers and pupils can save a lot of time while searching for inquiry activities: they can make a preliminary decision regarding the use based on the description without actually opening the inquiry activity. The Teacher's Toolbox, also conveniently located in the portal, includes the pedagogical scenarios designed to help teachers adapt the inquiry activities into their classrooms (Deliverable 2.4) and evaluation instruments to assess students' performance while conducting the inquiry activities (Deliverable 1.6). As an introduction to the platform, a tutorial alongside a list of national coordinators is available at the top of each page.

Although this deliverable will mark the official end of WP2 and work on collecting new inquiry activities, it is expected that the amount of inquiry activities (and the community around the inquiry activities) will continue growing during and beyond the project due to contributions by various communities. To name the most relevant communities, further

contributions are expected from the Ark of Inquiry partners and their networks, including related EU projects; museums and science centres have already contributed inquiry activities, and this is expected to continue; unofficial reports from teacher trainings (WP4) and project implementation (WP6) show that in many countries teachers have designed and used their own inquiry activities. During the implementation phase and beyond, it is important to encourage and support teachers to share and publish their inquiry activities in the Ark of Inquiry platform. The final deliverables of the work packages 3, 5, and 6 will eventually inform more about the use of inquiry activities across Europe (WP6), appeal of inquiry activities particularly from the pupils' perspective (Study card 6 in WP5), and characteristics of the communities around the platform and inquiry activities (WP3).

6. References

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