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Ark of Inquiry: Responsible Research and Innovation through Computer-Based Inquiry Learning

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Abstract: Ark of Inquiry is a learning platform that uses a computer-based inquiry learning approach to raise youth awareness to Responsible Research and Innovation (RRI). It is developed in the context of a large-scale European project (http://www.arkofinquiry.eu) and provides young European citizens (7–18-year-olds) with a pool of engaging inquiry activities. Computer-based inquiry learning has been found effective in many studies and is recommended for science education by several countries all over the world. Several EU policy documents, however, have emphasized the need to increase society's active involvement in knowledge creation and scientific discussions. Therefore, combining computer-based inquiry learning with the ideas of RRI is required. RRI is a key term in the current policy of the European Commission in the field of science education and in linking science with other domains. RRI is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view on the acceptability, sustainability and societal desirability of the innovation process. In the Ark of Inquiry project, we have developed a pedagogy that helps to link RRI to computer-based inquiry learning. In the current theoretical paper, we introduce this approach and explain how this has been implemented in the Ark of Inquiry project.

Keywords: inquiry learning, Responsible Research and Innovation, computers, science education

1. Introduction

According to various reports and case studies, young people have lost interest in science-related subjects and less frequently regard science as their future career field (e.g., Rocard et al., 2007). In order to ensure Europe's long-term capacity to innovate and to conduct high-quality research, science teaching needs to become more engaging.

One of the possibilities of making science lessons more engaging is applying personalized learning techniques and using computer-supported learning environments to enhance the effect of personalization. Learners can differ in many ways, such as gender and social backgrounds, general learning capacities and levels of mastery, interests in and preferences for certain topics, and preferences for ways and moments of learning. Personalized learning seeks ways to adapt to those differences present in a classroom.

Another possibility is to apply inquiry learning. Inquiry learning has been around for a long time, and it has been widely shown that inquiry-based science education can increase learners' interest in science and helps teachers feel more confident in their teaching. Learners describe inquiry learning as a fun way of learning exciting things without even noticing. There are numerous useful inquiry learning methods and activities available, but these are not being widely implemented yet. Use of computers makes it possible to apply learning analytics – collect and analyze data to adapt the learning process to the particular needs of learners. Learning analytics helps teachers learn more about

individual learners and tailor lessons and assignments to their capabilities and interests. It is especially important in the case of inquiry learning, where learners are often on very different levels even within one class. In this situation, it is quite difficult for a teacher to handle the variety of learners; computer-based tools, however, could support the teacher in achieving progress with all learners.

A third possibility of turning science more engaging is to integrate doing science into meaningful contexts where decontextualized subject-oriented settings are replaced by authentic societal problems in which inquiry is used to find solutions. In recent years, Responsible Research and Innovation (RRI) has been an important focus in the European Commission policy of rendering science more meaningful to young citizens (Regulation (EU) No 1291/2013, 2013). Several large-scale projects have been financed to study the possibilities of achieving better understanding of what RRI is and how it could be realized. For example, in the RRI Tools project (http://www.rri-tools.eu), 26 partners have joined their forces to reach out to 30 countries while developing a set of digital resources to advocate, train, disseminate and implement RRI. Likewise, the Ark of Inquiry project seeks to promote RRI awareness and skills among learners. The overall aim of the Ark of Inquiry project is to create a "new science classroom" that provides more challenging, authentic and higher-order learning experiences and opportunities for learners to participate in scientific practices and tasks, using the discourse of science and working with scientific representations and tools. In the Ark of Inquiry project, a platform is developed through which carefully selected inquiry activities will be made widely available across Europe and beyond. This platform will bring together inquiry activities, learners and supporters (teachers, university students, researchers, staff of museums and universities). To support teachers, the Ark of Inquiry project will provide face-to-face trainings for teachers so that they will be able to support and motivate the learners in their inquiry activities.

Although RRI is widely acknowledged in the EU policy documents, the term is currently not well defined, and the theory of RRI has not been developed in depth yet (Stahl, McBride, Wakunuma and Flick, 2014). Therefore, the aim of this paper is to show how RRI could be related to and promoted by computer-based inquiry learning. Next, we will introduce the concepts of RRI and inquiry learning and show how these have been combined in the Ark of Inquiry project.

2. Inquiry learning

Inquiry learning is an educational approach of discovering new knowledge, often in a format of causal relations through formulating hypotheses and testing them by conducting experiments and/or making observations (Pedaste, Mäeots, Leijen, & Sarapuu, 2012). In inquiry learning, active and self-directive participation and a strong learner's responsibility for discovering and constructing new knowledge is central (e.g., De Jong & van Joolingen, 1998; Wilhelm & Beishuizen, 2003). Inquiry learning is usually divided into phases of scientific thinking that together make up the inquiry cycle. A variety of inquiry cycles can be found in the literature, such as the 5E model by Bybee et al. (2006) that lists Engagement, Exploration, Explanation, Elaboration, and Evaluation. White and Frederiksen (2000) also specified five inquiry phases: Question, Predict, Experiment, Model, and Apply. A systematic literature review was conducted by Pedaste et al. (2015) in order to identify and summarize the core features of inquiry cycles. The outcome of this review is an inquiry cycle that combines the strengths of all existing inquiry learning frameworks. According to Pedaste et al. (2015), inquiry learning can be described through five major phases that are in some cases divided into sub-phases:

- In the Orientation phase, curiosity about a topic is stimulated, which should then result in a problem statement.
- In the Conceptualization phase, research questions and/or hypotheses are stated. This phase is divided into Questioning and Hypothesis Generation sub-phases.
- In the Investigation phase, empirical data is gathered and processed to resolve the research questions or hypotheses. This phase is divided in either Exploration or more structured Experimentation. Both Exploration and Experimentation provide learners with data that should be analyzed in the Data Interpretation sub-phase.
- In the Conclusion phase, research findings from the inquiry are reported and justified by the results of the investigation.

- In the Discussion phase, partial or completed outcomes of the inquiry as well as reflective processes are communicated to regulate the learning process. This phase is unique because of its constant connection to all the other inquiry phases. It is also particularly important because it teaches learners the discursive nature of science. Discussion contains the Communication and Reflection sub-phases.

3. Responsible Research and Innovation

The term "Responsible Research and Innovation" (RRI) was first employed in the European Commission's 7th Framework Programme and is now an integral part of the 8th Framework Programme Horizon 2020. RRI is fundamentally an attempt to re-imagine research and innovation so as to seek inputs and contributions from a variety of social actors (termed stakeholders) and, at the same time, redefine the relationship between the social sciences and humanities, on the one hand, and the technosciences (namely, medicine and engineering), on the other (cf. Felt 2014; Levidow and Neubauer, 2014). Such a necessity – primarily perceived at the level of European institutions – is supposed to bring about and support a broader vision of science as a public good.

The current research on RRI evolved from the definition provided by René von Schomberg from the Directorate General for research at the European Commission. According to von Schomberg (2011), RRI is defined as "a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view on the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)" (p.9).

Other researchers have contributed to the conceptual development of RRI by pointing to a number of dimensions that would indicate the breadth of RRI and clarify its broader significance (cf. Owen et al., 2012). Those dimensions are fundamentally revolving around the idea of research governance, which is inclusive, anticipatory and responsive. In a nutshell, it implies principles for research based on 1) democratic participation of all stakeholders in the definition of desired outcomes – what innovation and research should aim at – and 2) the adoption of a more responsive attitude so as to anticipate possible negative outcomes already at an early stage of development. The European Commission has described six dimensions of RRI: engagement, gender equality, science education, ethics, open access, and governance (Regulation (EU) No 1291/2013, 2013). Stahl (2013) concentrated on the practical implementation of these dimensions and therefore talked about actors, norms and activities. In addition, several authors have referred to the work of Pellizzoni (2004), which described four dimensions that could also be used to characterize RRI: liability, accountability, care, and responsiveness. Later, Stilgoe, Owen and Macnaghten (2013) specified four dimensions that emerged through public debates: anticipation, inclusion, reflexivity, and responsiveness.

Promoting RRI awareness is one of the key factors of the Ark of Inquiry project. In the Ark of Inquiry, the way in which RRI could be reasonably implemented was a major concern – i.e. how to integrate RRI into inquiry-based science education to help learners become more aware of the RRI aspects of scientific inquiry. Having in mind the goal of educating a new generation of citizens to participate in the processes and contents of scientific inquiry, a working definition of RRI awareness was developed in the Ark of Inquiry project. RRI is defined in the project as "the attitude and ability to reflect on, communicate and discuss processes and outcomes of inquiry in terms of its relevance, consequences and ethics for oneself, others and society". In this definition, three main RRI actions are mentioned: reflection, communication, and discussion. The act of reflection is dedicated to developing the attitude and ability to individually think through the relevance, consequences and ethics of inquiry. The act of communication refers to the attitude and ability to present and explain the relevance, consequences and ethics of inquiry to an audience. And the act of discussion refers to the attitude and ability to further question and discuss the relevance, consequences and ethics of processes and outcomes of inquiry with an audience.

In the Ark of Inquiry project, RRI awareness has been promoted through several means (listed below) that are described in detail in the following sections.

- First, a Framework of Inquiry Proficiency was developed that enables teachers and learners to assess their skillfulness in doing scientific inquiry; RRI aspects are included in the Discussion phase of the framework.

- Second, an Evaluation System was developed that allows teachers and learners to formatively and summatively assess learners' progress across the levels of proficiency. This promotes becoming more RRI aware, as the Evaluation System will assess the metacognitive awareness of the process of scientific inquiry and advance learners' first RRI awareness through presentation and discussion.
- Third, an Award System was developed. This is particularly aimed at promoting RRI awareness and skillfulness.
- Fourth, support is provided to teachers for promoting RRI activities in the existing inquiry activities by a Pedagogical Scenario that helps them recognize, add or redesign RRI assignments.

4. Ark of Inquiry pedagogy and platform

In the Ark of Inquiry project, we have developed a pedagogy that helps to link RRI to computer-based inquiry learning and makes it possible to apply learning analytics for supporting personalized learning. Therefore, a Framework of Inquiry Proficiency, Evaluation System and related Award System as well as Pedagogical Scenarios for supporting teachers have been developed. Finally, these ideas have been implemented in designing an online platform for learning at which existing inquiry activities are collected and disclosed for learners for the purpose of learning science and learning to do science.

4.1 Inquiry proficiency levels

In the Ark of Inquiry project, learning analytics is operationalized through the framework for characterizing learning tasks and analyzing learners' capabilities – the Framework for Inquiry Proficiency that shows how inquiry activities can be categorized so that a learner's inquiry capabilities (e.g., novice, basic, advanced) match the level of challenge offered by the inquiry activity. Matching a learner to an appropriate inquiry activity is required to effectively facilitate the improvement of inquiry skills and RRI awareness across a wide variety of learners. If a task is too simple or too demanding for a learner, it might decrease their motivation to learn. The Framework for Inquiry Proficiency provides a common reference point that will help maintain consistency in the development of different pillars in the Ark of Inquiry project.

The Common European Framework of Reference for Languages is a useful starting point for creating a system of proficiency levels (Council of Europe, 2011). This internationally recognized system provides 'can do' descriptors to help learners self-assess their level of proficiency and divides language learners into three broad levels (A, B, and C), corresponding to basic speaker, independent speaker and proficient speaker, respectively. The main dimension determining proficiency is how well a speaker can achieve everyday goals. The proficiency frameworks, however, are used for supporting learning analytics in several contexts, e.g., in assessing student teachers core practices (Hunt, Leijen, Malva, Slof and van der Schaaf, 2015; Krull and Leijen, 2015). In a similar way, a system for inquiry proficiency was developed to distinguish three inquiry levels: A (novice), B (basic) and C (advanced). These three levels categorize inquiry activities according to how well they challenge a learner to exhibit inquiry behavior.

In the Ark of Inquiry, the degree of challenge presented by an inquiry activity is determined by three dimensions: problem-solving type, learner autonomy, and learner awareness of RRI. The problems to be solved or questions to be answered in an inquiry activity can be divided into two different types: well-defined or ill-defined (Robertson, 2001). A well-defined problem has a clear path from which to reach a solution, and the solution itself has been thoroughly established as a scientific fact. An ill-defined problem, on the other hand, does not suggest an obvious path to reach a solution, and a 'correct' solution is not necessarily prescribed beforehand. Increased proficiency according to this first dimension moves from well-defined to ill-defined problems in order to challenge inquiry learners.

The second dimension used to characterize increased inquiry proficiency is the degree of learner autonomy. In case of novices, inquiry is initiated and led by the teacher and/or by the materials

(for instance, computer-based platforms that provide structural scaffolding), so that learners become familiar with the method. However, even at this level learners are not given the results directly but are supported to engage in inquiry processes to discover and understand what they are doing and learning. As inquiry learners progress, a teacher guides the process less and less and instead begins to provide the learner with professional feedback on the outcomes of different inquiry processes. The learner moves from structured inquiry to guided inquiry and finally to open inquiry (see Colburn, 2000). Thus, progress in inquiry is characterized by learning that proceeds from teacher-initiated to learner-led. This progression is associated with self-regulated learning, where learners take control of and direct the learning process for themselves. Other researchers have pointed out the gradual difference in the forms of inquiry learning (Banchi and Bell, 2008).

The third dimension used to characterize increased inquiry proficiency is learner awareness of RRI. Inquiry activities should gradually expand the amount and type of interaction learners have with important stakeholders in the research and innovation process in order to include different perspectives. For example, basic inquiry activities might take place within the school setting involving only a teacher and peers, but progression in inquiry requires gradually expanding the scope of societal stakeholders a learner interacts with, for instance, through work visits on off-school premises or social media platforms. A developed sense of RRI allows a learner to communicate the relevance of research and research findings to people and society.

Based on the three dimensions for characterizing progress in inquiry activities, a Framework for Inquiry Proficiency (Table 1) was created to relate those dimensions of progress to the inquiry phases described earlier. The Framework for Inquiry Proficiency shows how different inquiry and RRI skills vary across proficiency levels. Table 1 gives a general description of the three proficiency levels.

Table 1. Framework for Inquiry Proficiency

INQUIRY PHASE	INQUIRY PROFICIENCY LEVEL		
	A (novice)	B (basic)	C (advanced)
ORIENTATION	Learners are introduced to a problem within a well-defined problem space.	Learners are introduced to a problem in a semi-structured problem space.	Learners identify a suitable problem in an open-ended problem space.
CONCEPTUA-LIZATION	Learners are led to common questions and/or hypotheses that will be studied in the investigation.	Learners formulate questions and/or hypotheses through guidance.	Learners explore and formulate meaningful questions and hypotheses.
INVESTIGATION	Learners collect and analyze data according to prescribed procedures and fixed instruments.	Learners collect and analyze data in semi-structured steps and formats.	Learners operationalize procedures and formats through which they collect and analyze data.
CONCLUSION	Learners reach an understanding of fixed conclusions.	Learners reach conclusions through (semi-)structured procedures.	Learners reach conclusions and explain the process.
DISCUSSION	Learners present in fixed formats to teachers and/or peers.	Learners present and communicate in semi-structured or self-chosen formats to teachers and/or peers.	Learners present and discuss at appropriate times and in applicable formats with diverse stakeholders.

4.2 Evaluation and awardance of inquiry proficiency and RRI awareness

In the Ark of Inquiry, the evaluation system needs to serve both the learner (where do I stand, where am I going) and the teacher (where do they stand, where are they going). Given those demands, the evaluation system is built on three design principles outlined below: personalized learning, self-

regulation, and community of learners. From these principles, three forms of evaluation emerge that together build the evaluation system: self-assessment in self-report, peer feedback, and teacher assessment through formative dialogue. The three forms of assessment come together in a portfolio in which the learner collects all the input and outcomes of the assessments. The portfolio assesses the learner's progress in inquiry skills, in scientific awareness of the process of inquiry, and in becoming a responsible researcher that knows how to communicate and discuss processes and outcomes of scientific inquiry.

The principles of the Ark of Inquiry evaluation system derive from recent research about self-regulated learners. Traditionally, the teacher is seen as responsible for assessment. However, formative assessment activates learners as owners of the learning processes and stimulates metacognition (Hacker, Dunlosky and Graesser, 1998) and motivation (Ryan and Deci, 2000). Recent reviews show evidence that formative assessment indeed steers students' learning (e.g., Bennett, 2011; Sluijsmans, Joosten-Ten Brinke and van der Vleuten, 2013). In the Ark of Inquiry, emphasis is put on formative assessment. The function of the evaluation system in the Ark of Inquiry is twofold. First, the evaluation system monitors the progress learners make in doing inquiry, using activities on different inquiry proficiency levels (novice, basic, and advanced). Across those levels, learners become better in the so-called transformative inquiry skills, such as formulating hypotheses, collecting data, and interpreting those data to reach evidence-based conclusions (Pedaste and Sarapuu, 2014). Second, the evaluation system seeks to evaluate scientific inquiry awareness in the form of regulative (metacognitive) skills such as planning, monitoring and evaluating the inquiry process (De Jong and Njoo, 1992).

Below, the three principles of the evaluation system and the evaluation forms that spring from them are described.

- The first principle is personalized learning. Personalized learning can be defined as an emerging pedagogical learning theory that takes differences between learners as a starting point to tailor education to their needs. Personalized learning aims at solving some structural problems in the educational system that are often associated with standardized learning settings, such as low effectiveness and success rates, low motivations, and underestimation of talents (e.g., Hargreaves & Shirley, 2009; Robinson, 2009). Following from this principle, the evaluation system emphasizes formative assessment and uses a format for formative dialogue. The purpose of the dialogue is to see what the inquiry activity was about, how the learner performed according to his or her own perceptions, and what the learner needs next to proceed in order to bridge the gap between the current and desired situation.
- The second principle in the Ark of Inquiry evaluation system is self-regulation, which can be defined as 'a systematic process of human behaviour that involves setting personal goals and steering behaviour toward their achievement' (Zeidner, Boekaerts and Pintrich, 2000, p. 751). The underlying assumption is that behavior in the context of learning is goal-directed and controlled by some form of feedback. Self-regulation is about giving control to the learner, and it is claimed by research that feeling control and/or autonomy is beneficial for a learner's motivation and, subsequently, for his or her learning outcomes (e.g., Ryan and Deci, 2000). Self-regulation involves a number of sub-processes, such as planning, choosing strategies, monitoring, time management, evaluation, and reflection. Following from this principle, the evaluation system uses self-report. This one aims at describing the nature and quality of the inquiry process as perceived by the learner. In the self-report learners write down what they have been doing, what they have learned and which questions they have after finishing the inquiry activity. They also indicate what they think the next step should be.
- The third principle is becoming part of a community of learning. The Ark of Inquiry will be used by thousands of learners. This creates a community of learners across countries. A community of learning can be defined as a group of learners that share a learning purpose and meet (ir)regularly either live or through a platform to share and support each other (see Barab, Kling and Gray, 2004; Wenger, 1998). The sense of community springs from a feeling of membership and from participation in shared events. Communities of learning are often interdisciplinary so that new opportunities for collaboration and learning arise. In this large community of learning, learners follow their own personal paths towards proficiency. Their first sense of community will spring from their own classroom mates who are also joining the Ark of Inquiry or from learners in their own regions and countries. Following from this

principle, the evaluation system uses peer feedback, where the quality of both the process and product of the peers will be evaluated by providing feedback on parts of the inquiry process or an inquiry product.

The evaluation system sets the stage for structured and formative reflection on the process and outcomes of scientific inquiry. Parts of the learner's portfolio will concern presentations and reports of inquiry outcomes and inquiry processes stimulating the learner's first RRI awareness. On top of that, an award system is embedded in the Ark of Inquiry that explicitly promotes and celebrates RRI activities and products. Through the award system, learners that explore the relevance, consequences and ethics of scientific inquiry can get nominated and awarded. Awards include a star and diploma for individual reflection and presentations to small audiences and subsequently a bronze, silver and gold medal for excellent large-public debates on the RRI aspects of the research. The award system uses the portfolio as evidence for nomination and awarding.

4.3 Pedagogical scenarios

The pedagogical scenarios developed in the Ark of Inquiry project were designed to help teachers (and others) to implement, adapt and reuse inquiry activities in their classrooms in the context of the other principles of the Ark of Inquiry project. The need for the scenarios stems from the fact that the focus within the Ark of Inquiry project is on pre-existing inquiry activities, which have not been designed specifically for the Ark of Inquiry. In this respect, the pedagogical scenarios can be considered as means (or pedagogical tools) of bridging the gap between the existing inquiry activities and the requirements for their use in the context of Ark of Inquiry. The underlying idea of the pedagogical scenarios is that teachers should be supported in taking ownership of the activities and in developing professional competencies in order for them to be able to adapt the activities to their (unique) educational goals. So far, six initial pedagogical scenarios have been developed:

- Introduction to the Inquiry Model of the Ark of Inquiry Project,
- Changing the Proficiency Level,
- Adding Inquiry Phases,
- Improving Gender Inclusion,
- Overcoming Language Barriers, and
- Enhancing RRI in Applying Inquiry Activities.

The first scenario introduces the inquiry model of the Ark of Inquiry and, in particular, its inquiry cycle and shows how different inquiry models (that might be familiar to the teacher) can be linked to the inquiry cycle used in the Ark of Inquiry. Therefore, using the Ark of Inquiry activities should not pose any obstacle, as the Ark of Inquiry cycle seems to map quite comprehensively with the other inquiry models.

The second scenario is for changing the difficulty level of a particular inquiry activity. If the difficulty level should be raised, the teacher can reduce the structure and scaffolding around the activity and make it more open-ended, thus giving more initiative to the learners. In case the difficulty level should be simplified, the teacher can make the learning activity more structured and give some specific hints.

The third scenario is for improving the existing inquiry activities by adding missing phases. Rutten (2014), for instance, found that teachers sometimes felt themselves restricted by structured resources resulting in less inquiry and less learner-centered activities in the classroom than without using the resource. This highlights two important aspects about the use of resources by teachers, namely that teacher ownership is important and that the possibility of teachers amending the inquiry activities is a prerequisite for this successful ownership. Apart from the fact that adding phases leads to more complete activities, doing so also adds to teachers' feeling of ownership of the activities.

The fourth scenario is supporting one of the goals of the Ark of Inquiry project: attracting more women to science and science careers. Girls' negative views and low self-efficacy of science are often associated with characteristics of the learning environment that do not motivate and engage girls (e.g., Kim and Lim, 2013) or even lead them to underachieve (Spearman and Watt, 2013). Many programs, including different types of tutoring or scaffolding systems, emphasize cognitive aspects of learning. However, in order to engage girls in science, motivational and emotional processes should be taken into consideration as well. There are two ways in which the Ark of Inquiry activities do or

can provide affordances in that direction and hence empower girls in science: the first way is providing active learner-centered learning environments that connect activities to environmental, societal and everyday-life contexts and the second providing female role models and mentors in or around the activities.

The fifth pedagogical scenario of using the Ark of Inquiry materials is meant for overcoming the language dependency issues – e.g., to use materials that are in Greek with Estonian students who do not speak Greek. The first collection of the Ark of Inquiry platform inquiry activities has shown that the language dependency of activities widely varies, but whether this is a problem depends on language and the approach to language of teachers and schools. Doing the foreign-language activities might not actually require much knowledge of the given foreign language, and, furthermore, teachers and schools could actually use the foreign-language activities as an opportunity to integrate content learning and second language learning through the Content and Language Integrate Learning (CLIL) approach. The advantage of this approach is that the exposure to and use of the second language is increased without the need for allocating extra hours in the curriculum. As such, the activities become an opportunity for fostering a more flexible attitude towards foreign languages by integrating second language learning with content learning in a different subject.

The sixth scenario focuses on linking the existing inquiry activities with the RRI approach. Because the inquiry activities used in the Ark of Inquiry platform already exist, they do not always explicitly incorporate RRI – the RRI aspects could be elaborated on or made more explicit in some activities. This means that teachers have to be able to recognize the RRI aspects in the existing activities and should be supported in adding or elaborating on an RRI aspect in the existing activities (e.g., by giving examples of RRI assignments, public debates or videos). Third, teachers should be guided in adapting the RRI aspects in the existing inquiry activities (e.g., individual activities become collaborative or the activities promote thinking through cultural differences/international perspective on inquiry outcomes).

4.4 The Ark of Inquiry platform

Within the Ark of Inquiry platform, 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 select an activity based on keywords attributed to the activity from a word cloud.
In addition, teachers can suggest or assign activities to learners based on their pedagogical approach and expected levels of proficiency. The characteristics of the inquiry activities that were specified through the Ark of Inquiry pedagogical principles are used within the platform to describe the activities in detail. Therefore, all activities that are included in the platform are in line with the pedagogical framework of the Ark of Inquiry – the teachers that are using the inquiry activities are provided with activities that support RRI, and, thus, they do not need to make choices about these aspects when selecting activities. The information on each activity that will be available to the Ark of Inquiry users includes the following: title of the activity, description, location (web-based or physical location), domain or domains, topic or topics, language or languages, proficiency level of the activity (evaluated as a whole or by inquiry phases covered), inquiry phases covered, age range, learning time, materials needed for the activity, evidence on the success of the activity, evidence description (which objects are needed for the learners to prove they have completed the activity), copyright information and other restrictions, and keywords.

The initial version of the Ark of Inquiry platform consists of a total of 68 selected activities. These can be accessed through the platform and implemented, adapted and reused worldwide in classrooms, at home and in science centers and museums. The repository of activities represents a good coverage of the central components of the project and thus provides a fruitful baseline for a small-scale implementation pilot. The feedback from piloting will determine the future directions regarding activities and support mechanisms. From this moment onwards, the list of inquiry activities available to teachers and learners across the globe will be constantly updated until the finalized set of inquiry activities in the context of the Ark of Inquiry is published and regularly updated by the community.

Conclusion

In conclusion, we can say that the Ark of Inquiry project aims at finding a new pedagogy to link inquiry learning with RRI in the context of computer-based education. We propose that this is possible if we provide learners with engaging inquiry activities that are categorized according to the framework of inquiry proficiency that moves from novice to advanced inquiry and supports teachers and learners in choosing challenging new activities according to their present abilities.

The Ark of Inquiry seeks to promote activities that include RRI aspects and helps build a community of learners and supporters that become increasingly aware of and discuss the relevance, consequences and ethical issues of those activities. Teachers are a key factor in reaching the goals of the Ark of Inquiry project. Therefore, our efforts in the near future will focus on supporting teachers in starting to use the Ark of Inquiry in their classrooms in two ways. First, teachers will be provided with web-based materials helping them orient to inquiry and inquiry learning in general and RRI in particular. Through the web-based materials, teachers get to learn the framework of inquiry proficiency and the evaluation system that are at the core of the Ark of Inquiry project. The web-based materials aim at helping teachers *adopt* the Ark of Inquiry. Second, teachers are invited to take part in teacher training sessions to learn to use the Ark of Inquiry in their classrooms. The teacher training comprises three parts that focus on (1) inquiry learning in general, (2) inquiry activities and evaluation in the Ark of Inquiry, and (3) adaptation of the Ark of Inquiry activities to tailor education to their learners' needs. The teacher training aims at helping teachers successfully *implement* the Ark of Inquiry in their own classrooms. In the long run, the Ark of Inquiry project seeks to equip teachers with the necessary skills and knowledge in order for them to become designers of classrooms in which young people can practice inquiry learning and scientific reasoning as well as become responsible citizens who are able to take into account the relevance, consequences and ethical issues related to scientific discovery and innovations for themselves, others and society.

The Ark of Inquiry project aims at learning from best practices across the globe and is willing to share the learning platform, pedagogy and inquiry activities with interested researchers and educators worldwide. Therefore, the project team welcomes all international contributions. More information can be found on the project website http://www.arkofinquiry.eu/.

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