



Ark of Inquiry: Inquiry Activities for Youth over Europe

Deliverable D1.3

# **Description of the system of Inquiry Awards that foster responsibility**

Editor	Bregje de Vries (HAN)
Date	25.02.2015
Dissemination Level	Public
Status	Final

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under Grant Agreement No. 612252



## The Ark of Inquiry Consortium

Beneficiary Number	Beneficiary name	Beneficiary short name	Country
1	TARTU ÜLIKOOL	UT	Estonia
2	ELLINOGERMANIKI AGOGI SCHOLI PANAGEA SAVVA AE	EA	Greece
3	TURUN YLIOPISTO	UTU	Finland
4	UNIVERSITY OF CYPRUS	UCY	Cyprus
5	UNITED NATIONS EDUCATIONAL, SCIENTIFIC AND CULTURAL ORGANIZATION (UNESCO) REGIONAL BUREAU FOR SCIENCE AND CULTURE IN EUROPE, VENICE	UNESCO	France
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11	KATHOLIEKE HOGESCHOOL LIMBURG VZW	KHLim	Belgium
12	KUTATO TANAROK ORSZAGOS SZOVETSEGE	HRTA	Hungary
13	SIHTASUTUS TEADUSKESKUS AHHAA	AHHAA	Estonia

## Contributors

Name	Institution
Margus Pedaste	UT
Leo Siiman	UT
Mario Mäeots	UT
Koen Veermans	UTU
Tomi Jaakkola	UTU
Marios Papaevripidou	UCY
Zacharias Zacharia	UCY
Aliki Giannakopoulou	EA
Ilona Schouwenaars	HAN
Tamara van Schilt - Mol	HAN
Bregje de Vries	HAN

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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 sharing engaging inquiry activities in STEM domains across Europe and providing learners with meaningful feedback to improve their inquiry proficiency. The project seeks to motivate pupils to get engaged in a community of inquiry learning and take next challenges on their way to inquiry proficiency. In addition, it stimulates pupils’ abilities to reflect on, communicate and discuss the importance and implications of STEM research in society.

As described in D1.2 an *evaluation system* is built into the Ark of Inquiry to systematically evaluate learners’ development in their inquiry proficiency across three levels. A portfolio of collected products, self-reports, peer feedback and dialogue reports assesses the learner’s progress in inquiry skills and in scientific and RRI awareness. Complementary to the evaluation system an *award system* is designed that seeks to challenge and stimulate pupils to become responsible researchers and innovators (RRI). The award system (Table 1) consists of five awards: at stage 1 an inquiry star and diploma celebrate the ability to individually reflect on the relevance, consequences and ethics of processes and outcomes of inquiry for oneself, others and society. At stage 2 bronze, silver and gold medals celebrate excellent communication and discussion about the relevance, consequences and ethics of inquiry processes and outcomes for oneself, others and society with an audience. Pupils can obtain up to all five awards during the time they participate in the Ark of Inquiry. Together with their teachers pupils take active roles in getting nominated. Granting is organized by a national jury consisting of teachers, teacher educators and experts. The process of awarding is coordinated by a national administrator.

**Table 1.** General structure of the award system

Award	Stimulate	RRI aspects
<i>Stage 1: Star (50%)</i>	reflection	Relevance: which aspects seem useful for yourself, other people and/or society
<i>Stage 1: Diploma (20%)</i>	reflection	
<i>Stage 2: Bronze medal (10%)</i>	communication / discussion	Consequences: what would be the consequences (positive and/or negative) of usage for yourself, others and/or society
<i>Stage 2: Silver medal (5%)</i>	communication / discussion	
<i>Stage 2: Gold medal (1%)</i>	communication / discussion	Ethics: which aspects could be hard or unpleasant for yourself, others and/or society

In this deliverable the theoretical background and the concrete instruments and procedures of the award system are discussed. In a conclusive chapter recommendations for the implementation of the award system in primary and secondary school are presented.

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# 1. Introduction

The Ark of Inquiry 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 engaging inquiry activities across Europe. Teachers are trained to motivate and support their pupils in doing inquiry.

In D1.1 a framework for inquiry proficiency is described. This framework explains inquiry proficiency as developing across three levels from novice (A level) to basic (B level) and advanced inquiry (C level). The levels are defined according to three perspectives: problem-solving type (from well-defined to ill-defined), level of autonomy (from teacher-led to pupil-led), and RRI awareness (from small audience presentations to large audience discussions). The framework of inquiry proficiency has been worked out for all phases of inquiry: orientation, conceptualisation, investigation, conclusion and discussion.

In D1.2 the evaluation system is described. The evaluation system aims at following pupils' developments in inquiry proficiency in both transformative skills and metacognitive awareness of scientific inquiry as a process. The evaluation system triangulates three ways of assessment to formatively and summatively assess pupils' inquiry proficiency: self-assessment, peer feedback and teacher assessment. For the purpose of assessment the framework of inquiry proficiency as described in D1.1 is worked out in D1.2 to contain skills and assessment criteria at all levels for each phase of inquiry. The skills of the pupils are assessed while they learn, practise and master a level of inquiry. Central to the assessment procedures is the use of a portfolio in which the outcomes of the inquiry activities and assessment activities are collected and stored.

Besides promoting general inquiry proficiency and awareness of the process of scientific inquiry, the Ark of Inquiry aims to raise pupils' awareness of the importance and impact of science in general and STEM research in particular on people's lives, future professions, and society. Therefore, in addition to the evaluation system an award system is built into the platform. This award system is aimed at motivating and celebrating pupils' excellent performances in light of Responsible Research and Innovation (RRI).

In this deliverable the award system is described and worked out in ready-to-use instruments and procedures. First, the role and benefits of awarding in education in general and science education in particular are introduced (section 2.1). Next, the principles of the award system are described. Its aims and theoretical background are explained to set the stage for the award system (section 2.2). Then, these principles are translated into an award system that encompasses five RRI awards divided into two stages (section 2.3). Finally, the instruments and procedures are presented (section 2.4, and appendices). Recommendations for the implementation of the award system are given in the third and final chapter of this deliverable.

## 2. The Ark of Inquiry award system

### 2.1 Introduction to the award system

To award somebody means that a prize is given to someone or something for being excellent or for doing something that is admired. Award-winning persons or projects are rewarded for work done and paid honour for the purpose of recognition and follow-up. Awarding is associated with a fair amount of competition: often the process of awarding develops along a phase of submission of candidates, of which sometimes a short list of potential winners is produced, to an announcement of a few winners according to a highly-recognized jury. Gaining an award is the result of a more or less strong process of selection that starts with minimum requirements for nomination.

Often, large companies who are in search for talent announce competitions to discover new breed. Also, many competitions in which awards can be won are present in the field of education world-wide. In many countries in Europe there are large-scale national science contests, for instance, the Olympiads in physics, chemistry, mathematics, and biology. These competitions are in search for talent, excellence and remarkable (academic) progress amongst students and pupils in the context of higher or secondary education. The competitions and granting programmes in the STEM domains seek to promote entrance of new pupils to STEM studies and jobs. In Table 2 some examples of award competitions are presented.

**Table 2.** *Examples of award competitions world-wide*

<b>Title</b>	<b>Domain</b>	<b>Awards</b>	<b>Scope</b>
Skills Talents	Technics, Engineering, Design and innovation, Media & communication	Proof of participation; Certificate of excellence; Best teams awards.	Netherlands
Science Olympiads	STEM, Geography, Earth Science, Informatics, Astronomy	Gold/Silver/Bronze, Honourable mention, Certificate of participation for all students	National in many countries
Big Science Competition	Science skills, science as a human endeavour	Certificates for High Distinction, Distinction, Credit, and Participation (all students).	Australia / International

Awarding is not just because of the fun of it. Many researchers have found that – under the right circumstances and with a fair amount of challenge – competition motivates learners to push their efforts to new limits. Awarding and competition have been claimed to promote learning in the zone of proximal development and to lead to better performances and higher satisfaction, especially when the competition is between teams (e.g., Good & Brophy, 2007; McLaughlin, 1981). However, other research has shown that not all learners benefit from competition. For instance, learners with lower self-esteems can get demotivated and experience anxiety by (too much) competition (e.g., Ames, 1984; Wang & Yang, 2003). Gifted pupils do not always benefit from competitive tasks either (Cropper, 1998). In addition, it has been found that more complex problem-solving tasks do not benefit from competition (Clifford, 1972). Moreover, Deci, Koestner and Ryan (1999) have found that different kinds of rewards have different effects on learners' intrinsic motivation. Some kinds of rewards decrease a learner's sense of autonomy and as a result lower his or her motivation. Summarized, it is often concluded that although competition can motivate and challenge, it should be embedded in classrooms with care and under the right circumstances to have positive effects (Johnson, Maruyama, Johnson, Nelson & Skon, 1981). Increasingly, in school practices classroom competition is evolving into more individualized rewarding systems in which learners set personal challenges. It is argued that by focusing on personal academic goals and individualized progress reports, pupils are encouraged to do their personal best, as opposed to competing against peers.

Whereas the central goal of the evaluation system is to follow and evaluate learners' development in their inquiry proficiency and scientific and RRI awareness, the central goal of the award system in the Ark of Inquiry is to stimulate and promote responsible research and innovation (RRI) skills. The award system starts where the evaluation system ends and seeks to take pupils' awareness of and attitude towards RRI further by starting a challenging competition on RRI proficiency and excellence. In general, RRI can be defined as

'all societal actors (researchers, citizens, policy makers, business, third sector organisations etc.) to work together during the whole research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of European society' (Science with and for Society, 2014).

RRI has been put on the agenda of EU governments because of the fact that societies face many new scientific and technological opportunities, which confronts those societies with new questions and dilemmas: for instance, concerning DNA manipulation, privacy issues related to new technologies, and food and health industries. Inquiry-based science education is viewed to play an important role in stimulating and helping young people to become "scientific citizens" by educating them in the processes and contents of scientific inquiry, and let them think about ethical and global issues related to this. Inquiry based science education is expected to promote open discussion in the classroom that is needed to raise responsible researchers and innovators for the future. To support RRI the award

system of the Ark of Inquiry is dedicated to stimulating and celebrating good examples of open inquiry in which learners think through the processes and outcomes of the inquiry they are doing. RRI in the context of the Ark of Inquiry is defined 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 needed to individually *think through* the relevance, consequences and ethics of inquiry. The act of communication refers to the attitude and ability needed 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 needed to *question* the relevance, consequences and ethics of processes and outcomes of inquiry with an audience. The award system relates its awards to these three acts.

In general, the award system seeks to stimulate pupils to take new challenges, proceed in the Ark of Inquiry activities, and remain intrinsically motivated to become responsible researchers in the STEM domains.

## 2.2 Principles of the award system

The award system is strongly related to the evaluation system, which is defined in D1.2 as a system for the evaluation of inquiry skills and scientific and RRI awareness through three ways of mainly formative evaluation: self-assessment, peer feedback, and teacher assessment. The portfolio is presented as the main instrument for assessment in which pupils collect the different forms of assessment as ongoing proof for their level of mastery and input for formative assessment conversations with the teacher in order to select new challenges. Complementary to this evaluation system, the award system is aimed at building on pupils' increasing RRI awareness by challenging them to improve their skills to perform RRI activities. The principles of the award system overlap with the principles of the evaluation system: personalized learning, self-regulation, and community of learning. In addition, the award system is based on the idea that future education should be (partly) based on teaching 21<sup>st</sup> century skills. Below, the four principles of the award system are shortly described and explained.

The first principle is *personalized learning*, which is defined in D1.2 as taking differences between pupils as a starting point to tailor education to their needs. Pupils can differ in many ways, for instance gender and social backgrounds, general learning capacities and levels of mastery, interests and preferences for certain topics, and preferences for ways and moments of learning. When learning and teaching processes are personalized, 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) are expected to be resolved. Implementing personalized learning ranges from individualized learning programmes providing individual instructions in a linear curriculum that is the same for all learners to settings in which learners themselves are in charge to select preferred learning objectives.

In D1.2 it is argued that the role of assessment in personalized learning is formative and aimed at making visible a pupil's progress in order to determine the next step to take. Likewise, in the Ark of Inquiry the goal of the evaluation system is for learners and teachers to be able to view their progress and collaboratively decide which challenge to take next. For the award system, the theory of personalized learning means that the award system should make it possible for all learners to gain awards. Since personalized learning accepts differences between pupils as fundamental to teaching and learning, the award system should not be based on absolute standards but tailor its standards to the possibilities of different learners. In the Ark of Inquiry, all pupils are viewed to have the potential to gain awards. As favoured by the principle of personalized learning the award system sets *relative criteria* for its awards so that all pupils get a fair chance to *celebrate personal success*.

The second principle is *self-regulation*, which is defined in D1.2 as 'a systematic process of human behavior that involves setting personal goals and steering behavior toward their achievement' (Zeidner, Boekaerts & Pintrich, 2000, p.751). In line with the principle of personalized learning, self-regulation is about giving control to the learner which has been found to be beneficial for a learner's motivation and subsequently for his or her learning outcomes (e.g., Kuhl, 2000; Ryan & Deci, 2000). In D1.2 it is argued that self-regulation involves a number of skills that need to be learned. Therefore, learners at the A level of the Ark of Inquiry start to practice self-regulation by observation and imitation, whereas pupils at the B and C level are increasingly expected to show their self-regulation capabilities while doing inquiry activities.

In D1.2 self-regulation is translated to instruments and procedures of self-assessment through which learners judge both the quality of the inquiry process as well as what is achieved (Boud & Falchikov, 1989). In relation to the award system, we expect pupils to gain insight in their rate of success and excellency by self-assessment. In combination with the formative judgments of the teachers and the peer feedback they receive, learners will start to see what they did in light of performances of others and in light of earlier performances of themselves. Pupils then become their own judge of nomination for awards. Hence, the award system translates self-regulation to routings of awarding in which learners themselves are the main actors. With the help and support of teachers and peers learners decide if and when they are nominated.

The third principle explained in D1.2 is becoming part of a *community of learning*. The Ark of Inquiry makes up a community of learners across thirteen European countries in which thousands of pupils are involved in doing inquiry. A community of learning can be defined as a group of learners that share a learning purpose and meet (ir)regularly either live (within classrooms) or through a platform (across classrooms, schools or even nations) to share knowledge and support each other (meta-)cognitively (e.g., Brown & Campione, 1990). From the perspective of evaluation, the community of learning provides a context for creating a motivating and supportive culture in which pupils give each other feedback. In addition, awarding is expected to strengthen pupils' sense of community because there is a shared effort to strive for awards, and award winning pupils and products can further stimulate new learners to take the challenge to become excellent (RRI) inquirers themselves. The award system helps to build and make visible *a shared repository* of inquiry activities and products, which is one of the founding elements of a strong sense of community (e.g., Wenger, 1998).

The fourth principle underlying the award system is the educational approach towards the so-called 21<sup>st</sup> century skills. It is generally assumed that future generations of people living in the knowledge society are in need of new skills that prepare them for a life in which information production and sharing, communication and collaboration, and discussing ethical and social values are important (Ananiadou & Claro, 2009). These new skills are called 21<sup>st</sup> century skills, and a review on the implementation of those skills in educational systems worldwide showed that embedding the 21<sup>st</sup> century skills in school practices is still premature (Voogt & Pareja Roblin, 2012). The Ark of Inquiry seeks to promote Responsible Research and Innovation (RRI). This means that pupils are challenged not only to become good researchers but also to reflect on their inquiry activities in light of ethical and social realities. Furthermore, RRI seeks to promote communication and discussion about research questions, processes and outcomes in order to find relevant and practically acceptable solutions to problems. Educating 21<sup>st</sup> century skills supports the focus of the award system on RRI.

Summarized, four principles have been described that together form the design principles for a system of awarding in which pupils get motivated to do their best, and their successes are made visible and celebrated. The award system aims at turning the potential for inquiry present in every learner into visible products and processes that show the potential of new generations of responsible researchers. For that purpose the award system is built in such a way that it addresses the potential in every learner to become active in self-awarding and showing successes in a shared repository of inquiry processes and products that witness RRI awareness and proficiency.

## 2.3 The award system

### 2.3.1 General structure of the award system

The award system contains five awards: a star, diploma, bronze medal, silver medal, and gold medal. The awards can be obtained cumulatively by individual learners. This means that an individual learner can obtain all five awards during the time (s)he spends in the Ark of Inquiry if (s)he stays long enough and has the right ambition to become excellent in inquiry and RRI and get nominated for the awards. It also means that the awards can only be obtained in a fixed order. To obtain a gold medal, a learner has to obtain all other four awards first. The award system starts with collecting a star and a diploma, next the three medals can be obtained: bronze, silver, and gold. It is therefore expected that many pupils will succeed in obtaining a star and/or diploma; to a lesser extent, pupils will obtain medals. The following quantitative guideline has been set for the amount of awards the system hands out: 50% of the pupils will gain an inquiry star, 20% of the pupils gain a diploma, 10% a bronze medal, 5% a silver medal, and only 1% a gold medal. The awards a pupil obtains are collected in the passport that all pupils receive once they have entered the Ark of Inquiry (see D1.2). Furthermore, the award winning names are published on the website of the Ark of Inquiry, in the Hall of Fame. In this Hall of Fame the pupils' successes are shared to inspire other pupils to become motivated and raise their inquiry and RRI skills. If and when pupils collect awards highly depends on their time spent in the Ark of Inquiry and their ambition to become good, better, and best at responsible research and innovation. Some pupils may never be nominated for an award, some pupils will collect all the awards during primary school at A level, while others obtain awards while progressing from A to B or even C level. Two cases illustrate how the award system may work differently for individual pupils:

#### *Example 1*

*“Teresa is a primary school pupil aged 11 when she enters the Ark of Inquiry community. She starts at A level and after a while is nominated for an award (star). Now Teresa has become really enthusiastic and in no time she is nominated again (diploma). In the next two years Teresa starts secondary education and continues working in the Ark of Inquiry. Over the years she succeeds in progressing through B level of proficiency gaining a bronze medal during one of the activities, and as a fifteen-year-old she finishes working in the Ark of Inquiry at C level, at which she even obtains both the silver and gold medal. All the awards and levels are added to Teresa’s passport.”*

## Example 2

*“John is a primary school pupil aged 8 when he enters the Ark of Inquiry community. John starts at A level and practises regularly by conducting inquiry activities. Although his proficiency in inquiry increases, he is not yet very capable of reflecting on his work. When he is 11 years old he takes the summative assessment activity and gets his ‘stamp’ for A level. Over the years he continues progressing through B level of proficiency. At the age of 13 he succeeds doing the summative assessment activity for B level and he starts working at C level. At this point he gets very enthusiastic about doing research and his capabilities of reflecting on doing research increase at a high speed. In no time he is nominated for a star and a diploma. He starts wanting to share his findings with a large audience and at age 15 he is nominated for a bronze medal. At the age of 16 he leaves school, having obtained a star, diploma, and bronze medal.”*

The five awards are grouped in two stages. The first stage awards – inquiry star and diploma – focus on the development of the attitude and ability to individually reflect on inquiry activities. These awards seek to challenge and motivate pupils to develop a critical attitude towards inquiry and start to think through RRI issues related to inquiry activities. The first stage awards serve the goal of making pupils truly enthusiastic about the RRI perspective on inquiry. The first stage awards are granted for endeavours that pupils undertake to individually think through the relevance, consequences and ethics of processes and outcomes of the inquiry activity for themselves, others and/or society in a reflective report. Teachers can support their pupils to write reflective reports or create reflective products about inquiry activities according to the guidelines of the award system (see 2.4). Pupils play a central role in getting nominated: during the assessment procedures (see D1.2), pupils can propose to be nominated for first stage awards. The pupil and teacher fill in an award nomination form (see 2.4), and the teacher submits the nomination to an Ark of Inquiry jury.

The second stage awards – bronze, silver and gold medal – focus on the attitude and ability to communicate and discuss processes and outcomes of inquiry. These awards are reserved to stimulate ambition and competition between pupils to become good, better, and best at (scientific) inquiry in light of RRI. The awards can be obtained because of special performances aimed at communication and discussion of the relevance, consequences and/or ethics of the processes and outcomes of an inquiry activity with an audience. Teachers nominate pupils for a medal and motivate the nomination by filling in the award nomination form with the help of the pupil. The teacher submits the nomination to the Ark of Inquiry jury. Table 3 gives an overview of the award system.

**Table 3. Overview of the award system**

<b>Award</b>	<b>Stimulate</b>	<b>Nomination by</b>	<b>Granting by</b>
<i>Stage 1: Star (50%)</i>	Individual reflection	Pupil	Ark of Inquiry jury
<i>Stage 1: Diploma (20%)</i>	Individual reflection	Pupil	Ark of Inquiry jury
<i>Stage 2: Bronze medal (10%)</i>	Communication and discussion	Teacher and pupil	Ark of Inquiry jury
<i>Stage 2: Silver medal (5%)</i>	Communication and discussion	Teacher and pupil	Ark of Inquiry jury
<i>Stage 2: Gold medal (1%)</i>	Communication and discussion	Teacher and pupil	Ark of Inquiry jury

The Ark of Inquiry jury comprises administrators of each country. Per country the national administrator receives nominations and makes sure the stage 1 nominations are judged by a teacher or teacher educator and the stage 2 nominations by a teacher or teacher educator *and* an expert. For this purpose, each country will organize a national pool of jury members. Teachers and teacher educators involved in the Ark of Inquiry judge each other's nominations, and experts can be recruited from science centres, universities, and educational research institutes.

### **2.3.2 Promoting inquiry and RRI: criteria for excellence**

So far, RRI has been defined as the attitude and ability to reflect on, communicate and discuss the relevance, consequences and ethics of scientific inquiry for oneself, others and society. The first two awards (stage 1) stimulate and reward pupils who *individually reflect* on the relevance, consequences and ethics of inquiry processes and outcomes for themselves, others and society. The three medals (stage 2) stimulate and reward *communication and discussion with an audience* about the relevance, consequences and ethics of inquiry processes and outcomes for themselves, others and society. This general definition is worked out in criteria for nomination and criteria for granting.

The nomination criteria (Table 4) are formulated as check list items with the help of which pupils and teachers can see if they meet the required criteria and could further prepare the nomination. The nomination criteria function in the process to get nominated as a (final) check if everything needed is there. But before that moment, the nomination criteria could also help pupils to start and develop RRI activities. Since not all inquiry activities in the Ark of Inquiry promote RRI and encompass RRI related activities, teachers should encourage pupils

to develop RRI activities themselves. For this purpose, the nomination criteria serve as a point of reference to strive for.

**Table 4.** *Nomination criteria for stage 1 and stage 2 awards*

	Stage 1 – individual reflection: think through and describe	Stage 2 – collective discussion: explain and question
Relevance: which aspects of the inquiry activity seem to be useful for yourself, other people and/or society	The pupil (1) describes applications, existing or fictional; and (2) illustrates these with existing or fictional examples taken from his or her own life.	The pupil (1) explains applications, existing or fictional; (2) illustrates these with existing or fictional examples taken from his or her own life, others’ lives and society, and (3) uses sources to justify the explanation.
Consequences: what would be the consequences (positive and/or negative) of (large-scale) usage for yourself, others and/or society	The pupil (3) describes effects of usage, existing or fictional, and (4) illustrates these with existing or fictional practices taken from his or her own life.	The pupil (4) explains effects of usage, existing or fictional, (5) illustrates these with existing or fictional practices taken from his or her own life, others’ lives and society, and (6) uses sources to justify the explanation.
Ethics: which aspects of the inquiry activity could be hard or unpleasant for themselves, others and/or society	The pupil (5) describes ethical issues, existing or fictional, and (6) illustrates these with practices taken from his or her own life.	The pupil (7) explains ethical issues, existing or fictional, (8) illustrates these with existing or fictional practices taken from his or her own life, others’ lives and society, (9) uses sources to justify the explanation, and (10) reaches a conclusion by balancing perspectives.

The stage 1 awards can be obtained if pupils individually reflect on several aspects of the inquiry activity. First, pupils reflect on the relevance of the inquiry activity for themselves, others and the society as a whole by answering the question ‘Which aspects of the inquiry activity seem to be useful for yourself, other people and/or society?’ Next, pupils reflect on the consequences of the inquiry process and/or outcomes by answering the question ‘If the inquiry activity is useful for people, what would be the consequences (positive and/or negative) for themselves, others and/or society?’ Finally, the pupils think through ethical aspects related to the inquiry activity by answering the question ‘Which aspects of the

inquiry activity could be hard or unpleasant for themselves, others and/or society?’ The stage 1 awards aim to motivate and stimulate pupils to become responsible and innovative researchers. The awards seek to promote pupils thinking through the inquiry activity they have been doing. They do not have to be excellent RRI inquirers yet but need to prove that it becomes natural to not only do the inquiry activity but think about the effects it has or could have for people. The general format for nomination is a reflective report. Because the stage 1 awards have stimulation and motivation as their primary goal, the exact format of the reflective report can be chosen (and invented!) by the pupils themselves. Possible formats are a written report, an oral videotaped statement, an autobiographical story, an annotated mindmap or other visual representation, and so on. The reflective report needs to consider all the above mentioned questions – relevance, consequences, and ethics – from an individual and personal perspective.

The stage 2 awards can be obtained if pupils organize and perform an activity in which they explain the process and outcomes of the inquiry activity to others, and invoke a discussion in which the process and outcomes of the inquiry activity are questioned. The guiding questions about relevance, consequences and ethics are the same as for the stage 1 awards, but now the pupil addresses these questions from multiple perspectives and reconsiders multiple meanings, applications and pros and cons to balance different views of himself or herself, other people and the overarching society as a whole and come to a conclusion/recommendation. The general format for nomination is a communication product consisting of a report on the presentation and discussion. Formats to think of are a publication in a school paper or local paper, a Powerpoint or Prezi with a discussion report, an annotated video-registration of an event, an annotated design with a discussion report, and so on. Creativity and originality is rewarded if pupils explain why certain formats are chosen and illustrate the impact of this choice. The format chosen should give insight in the presentation held (explanations given), the way(s) the discussion was organized, the nature of the audience, and the nature of the discussion and its outcomes.

The granting criteria (Table 5) are derived from the nomination criteria to help teachers and other persons in the Ark of Inquiry jury decide if nominations should be approved or denied. They make explicit which quality is expected to obtain awards.

**Table 5. Granting criteria for stage 1 and stage 2 awards**

	Stage 1 – individually reflect	Stage 2 – collective discussion
Criteria	<p>The reflective report is</p> <p>Complete: addressing all 6 items</p> <p>Scope: a personal view on things</p> <p>Opinion-making: developing meaning</p> <p>Original: challenging innovation</p>	<p>The communication product is</p> <p>Complete: addressing all 10 items</p> <p>Scope: multiple perspectives represented</p> <p>Opinion-making: balancing and conclusive</p> <p>Original: challenging innovation</p>

The criteria ensure that all the required elements are present and that the nominations follow several general criteria: the stage 1 nominations need to address 6 items, whereas the stage 2 nominations need to address 10 items (completeness). Next, although both nominations are individual products (awards are always granted to one pupil, not a group of pupils), the stage 1 nominations give insight in a personal view on things, whereas the stage 2 nominations need to represent multiple perspectives on a matter (scope). Next, the nominations differ in the way they contribute to opinion-making. Stage 1 awards collect personal meanings that each on itself can be viewed to feed the global debate on RRI issues, whereas stage 2 awards need to explicitly contribute to decision-making by giving different perspectives and balancing them towards new conclusions and/or recommendations (opinion-making). Finally, the general criterion of originality challenges pupils in both stages to present materials in new ways and come up with creative solutions for innovation (originality). The general criteria are applied to all the nomination criteria, so that the relevance, consequences and ethical issues the pupils address are qualified for their completeness, scope, contribution to opinion-making, and originality (see 2.4 and Appendix 2 for more details).

### **2.3.3 Promoting RRI: criteria for excellence**

The award system is expected to contribute to a community of inquiry learning across and within the thirteen participating countries. The award winners are announced and presented on a web page part of the website of the Ark of Inquiry called the Hall of Fame. This way the award system helps to build a shared repertoire of good, better, and best practices of responsible and innovative scientific inquiry, and sets examples for other pupils to follow and take further.

In building this community of inquiry learners through the award system, the roles of teachers, pupils and others (teacher educators, experts, and parents) are deemed important in five ways. First, teachers need to actively stimulate and promote award nomination. Since

not all inquiry activities will activate RRI, it will not be self-evident that pupils produce reflective reports or communication and discussion products for which they can be nominated. The nomination criteria can be viewed as an additional assignment completing an existing inquiry activity which invites pupils to either make a reflective report (stage 1 awarding) or a communication product (stage 2 awarding). It is essential that teachers recognize this opportunity and challenge their pupils.

Second, teachers should help their pupils to go for an award by giving them the time and opportunities to write reflective reports, organize events, prepare presentations, contact and invite external others, and so on. The activities that pupils need to develop to get nominated require a floor, and school time and materials should be reserved for this. By facilitating this, teachers help their learners to develop their 21<sup>st</sup> century skills and become responsible researchers at the same time. The expectation is that teachers are aware of this and willing to stimulate and help their pupils.

Third, both teachers and pupils can be the initiators for nomination. In general, pupils will not be used to award systems, being their own judges and nominating themselves. However, both the evaluation system (D1.2) and award system explicitly state that pupils need to learn to self-assess their performances and become aware of their knowledge and skills. They are stimulated to collect feedback from peers and triangulate their own judgments with the teacher's view on their skills. This is expected to lead to increasing insights in their own excellence, for which they can nominate themselves. In the beginning, teachers might need to stimulate pupils to nominate their work, but gradually the pupils will see their own and each other's potential and start to take the initiative themselves.

Fourth, teachers, teacher educators and experts take active roles in a national Ark of Inquiry jury to grant awards. The nominations are collected by a national administrator, who will further organize the process of awarding. Pupils will not be judged by their own teachers. Instead, the administrator contacts a teacher from the Ark of Inquiry community working at another school to judge the nomination. Stage 1 nominations are only judged by a teacher, but to grant stage 2 awards an additional judgment of an expert is needed. For that purpose, teachers are encouraged to build and maintain a local network with parents, experts (from universities, science centres, etc.), and teacher educators. This local network can help the teacher to collect a second independent opinion leading to either approval or denial of the award.

## **2.4 Instruments and procedures**

In this section we describe the instruments and procedures of the award system. In the next four paragraphs we subsequently describe the award nomination form, the award granting form, letters for approval/denial, and the general awarding procedure. Each instrument/procedure can be found as an appendix at the end of this deliverable.

### **2.4.1 Award nomination form (Appendix 1)**

Some inquiry activities in the Ark of Inquiry may have formulated explicit questions and/or assignments dedicated to reflection, communication and discussion of relevancy, consequences, and ethical issues. For instance, an inquiry activity might end with the assignment to make a presentation about the inquiry process and outcomes or to write a report in which also ethical issues are addressed. This results in evidence that can be put in the portfolio (see D1.2) and used to be nominated for an award. However, there will also be many inquiry activities that do not pay attention to RRI aspects and do not require any reflection, communication or discussion about relevance, consequences, and ethics. In these cases, teachers can stimulate pupils to work on that on their own initiatives. For that purpose, central to the award system is the award nomination form. The award nomination form works in two ways: (1) it provides teachers and pupils with the criteria for nomination, and they can use the form as a checklist to see if all that is needed to get nominated is present; and (2) it provides teachers and pupils with guidelines to start working on an RRI assignment, and they can use the form to formulate a plan for an RRI activity.

The award nomination form consists of some personal information including names, level of proficiency and explication of the award one applies for. Next, the form asks to indicate which evidence is attached to proof RRI skills. Finally, the form shows the stage 1 and stage 2 criteria and asks to tick the boxes if the criteria are met. If all the criteria are met, the teacher is asked to sign the nomination and send it to the national administrator.

### **2.4.2 Award granting form (Appendix 2)**

The award granting form is used by the jury members to either approve or deny the award. After the national administrator has received the nomination one or two jury members are contacted: a teacher and – in case of stage 2 awards – an expert.

The granting form consists of some personal information and tick boxes to indicate the evidence that was used to come to a judgment. At the core of the form are the criteria for

stage 1 and stage 2 awards. For each criterion the jury member indicates if it can be found in the evidence and of which quality it is. The quality is measured by a continuum ranging from insufficient (1) to good (2) to excellent (3). The jury member chooses the quality rate per criterion and gives a short explanation. 'Insufficient' means that the criterion can be judged because its evidence is present but is not good enough. Reasons to indicate insufficiency can be severe misinterpretations of sources, unable to follow a line of reasoning, wrong conclusion, and so on. 'Excellent' means the opposite and is used when the quality of the line of reasoning is so outstanding, innovative, complex and so on that the work of the pupil deserves special attention as an example of RRI skilfulness. Note that the differences between insufficient, good and excellent are gradual. Gaining experience and piloting the award system can help to build typical examples of all categories to help increase the consistency and objectivity of judgments across and within the thirteen nations.

Since the first check on completeness and soundness is already expected to be done by pupils and teachers themselves before they get nominated, an insufficient rating is not expected to occur frequently. Especially in the stage 1 awards, which seek to stimulate and motivate RRI, insufficiency is meant to be rare and the effort pupils make to take the RRI challenge should be rewarded rather than met with overly strict quality demands. In stage 2 awarding, however, the stakes are higher and pupils should be challenged to become better and best. The judgments should be corresponding and demand high quality in reasoning and in presentation formatting.

Granting awards is based on the total amount of insufficient, good and excellent ratings for the criteria. No insufficient ratings should occur, so if one or more criteria have been rated insufficient the award is denied. If all the criteria are rated good, the award is approved. If some or all of the criteria are rated excellent, special attention will be paid to the award winner in the Hall of Fame.

### **2.4.3 Letter of approval/denial (Appendix 3)**

After being judged the pupil and teacher receive the outcome in the form of a letter and a short jury report. The jury report consists of the award granting form, which indicates the ratings for each criterion, the total judgment, and a short explanation. In case of denial, the explanation gives concrete starting points for improvement so that the pupil is motivated to try again.

## **2.4.4 General awarding procedure (Appendix 4)**

Awarding is not a daily business in most schools. It is expected that both teachers and pupils will need time to get used to the possibility. In addition, teachers need to promote RRI activities because some but not all inquiry activities that are present in the Ark of Inquiry will contain RRI related activities or assignments. The general procedure of awarding seeks to support teachers and pupils in making use of the award system by giving a step by step overview of the procedure. This way, teachers and pupils understand what needs to be done in what order.

The award system will need to be functional in thirteen countries and in primary as well as secondary education. This means it should be easily accessible, with clear procedure, not too time-consuming, and it should be a rewarding effort to undertake.

## 3. Conclusions

### 3.1 Summary

This deliverable presented an award system that works complementary to the evaluation system in the Ark of Inquiry. The evaluation system stimulates inquiry proficiency and awareness of scientific inquiry and RRI. The goal of the award system is to challenge pupils to translate this emerging awareness into the attitude and ability to reflect on, communicate and discuss the relevance, consequences and ethics of scientific inquiry for oneself, others and society. This definition is further worked out into criteria for excellent RRI. The award system is based on four principles: personalized learning, self-regulation, community of learning, and 21<sup>st</sup> century skills. These principles result in an award system that contains relative criteria so that each pupil can feel challenged, and a system in which the pupils themselves have active roles in getting nominated. The general structure of the award system is as follows:

- The award system consists of five awards: star, diploma, bronze medal, silver medal, and gold medal. The awards can each be obtained at every level. However, pupils can only obtain them once, and up to a maximum of five awards. They can, for instance, obtain them while progressing to another level.
- The awards are divided into two stages. The stage 1 awards (star, diploma) reward individual reflection on relevance, consequences and ethical issues of inquiry activities. The stage 2 awards (medals) reward communication and discussion on the relevance, consequences and ethics of inquiry with an audience. For each stage separate criteria have been developed.
- The processes of nomination and granting have been described, and a nomination and awarding form have been developed. Pupils and teachers prepare the nomination collaboratively. An independent jury of one or two members coordinated by a national administrator approves or denies the nomination.
- If an award is obtained this is celebrated in two ways: the pupil's name is added to the online Hall of Fame on the website of the Ark of Inquiry; and the award is added to the pupil's passport.

## 3.2 Recommendations for implementation

Awarding is not daily business in most schools. Teachers and pupils have to learn to work with it. Therefore, the award system will be explained and promoted in several ways: through the support system (D1.4), on the website and in other promotion materials, and in teacher training and web-based teacher training materials (WP4).

The actual use of the award system can be promoted in a number of ways. First, teacher training and teacher training materials can help teachers to become aware of and acquainted with the instruments and procedures of the award system. Teachers need to become aware of the three aspects of inquiry proficiency (inquiry skills, scientific awareness, and RRI awareness), get acquainted with RRI the way it is defined in the Ark of Inquiry and see good examples of RRI performances of pupils. Then teachers will know what to strive for. Since some but not all inquiry activities collected in the Ark of Inquiry will contain RRI related activities, teachers need to promote extra RRI activities through the award system.

Second, teachers need to get trained to stimulate learners to become creative and critical researchers. In fact, teachers need to become good examples of RRI themselves, for instance, by organizing and/or facilitating classroom dialogues in which reflection on and communication and discussion about inquiry are practised frequently and set an example of how learners can organize their own RRI activities.

Third, teacher training could help teachers see that out-of-school sites and experts are needed to create an environment in which societal issues can be communicated and discussed with an audience. The stage 2 awards are in need of a learning environment in which external stakeholders (for instance, experts, parents, etc.) can be invited, visited, interviewed, and so on. Teacher training needs to support teachers in becoming active networkers who build their own local community for inquiry learning.

To further facilitate and support successful implementation of the evaluation system, piloting of the instruments and procedures presented in this deliverable is planned. Two phases of piloting are planned within the next year. First, a small group of teachers and pupils of primary and secondary schools will be asked to participate in paper walk-through sessions in which the teachers and pupils are asked to think aloud while reading and looking through the instruments and procedures and while thinking about concrete use in their own classrooms. The questions and comments of the teachers and pupils will be collected and analysed to help us fine-tune the instruments and procedures before their first actual use. The main research questions of the paper walk-through relate to the *perceived* relevance and practicality of the instruments and procedures by primary and secondary school teachers and pupils and their expected frequency of use. Special questions to focus on are the usability of the instruments and procedures of the award system in different settings (primary/secondary education, different countries) as well as other possible supporting

materials that might be needed to further promote RRI performances, for instance, best practices of RRI performances, worked out examples of pupils getting awarded, and more structured formats for RRI products to stimulate creative reports.

Next, in the second half of the year the award system will be evaluated in a small scale pilot in seven countries (WP6). Five schools with at least three teachers per country will use the Ark of Inquiry and award system. The outcomes of this pilot will be used to improve the instruments and procedures. The main research questions of the small scale pilot relate to the *realized* relevance and practicality of the instruments and procedures by primary and secondary school teachers and pupils and the realized frequency of their actual use.

Based on the paper work-through sessions and small scale piloting an update of this deliverable will be presented in Month 24.

## 4. Appendices

### 4.1 Appendix 1 – Award nomination form

Name:

Age: Boy / Girl

School and country:

Level of inquiry proficiency:

Applies for a stage 1 award: STAR DIPLOMA

Applies for a stage 2 award: BRONZE SILVER GOLD

**The following evidence is attached to this form (tick one or more boxes):**

- report on an inquiry activity
- presentation (Powerpoint, Prezi, etc.)
- publication (article, flyer, etc.)
- report on a presentation and/or discussion
- photo / video materials (including Youtube)
- design or product description / manual
- peer feedback
- expert feedback
- stakeholders feedback
- other: .....

**Stage 1 criteria (tick boxes if present) - The pupil:**

- (1) describes applications, existing or fictional
- (2) illustrates these with existing or fictional examples taken from his or her own life
- (3) describes effects of usage, existing or fictional
- (4) illustrates these with existing or fictional practices taken from his or her own life
- (5) describes ethical issues, existing or fictional
- (6) illustrates these with practices taken from his or her own life

**Stage 2 criteria (tick boxes if present) - The pupil:**

- (1) explains applications, existing or fictional
- (2) illustrates these with existing or fictional examples from his or her own life, others' lives and society

- (3) uses sources to justify the explanation
- (4) explains effects of usage, existing or fictional
- (5) illustrates these with existing or fictional practices from his or her own life, others' lives and society
- (6) uses sources to justify the explanation
- (7) explains ethical issues, existing or fictional
- (8) illustrates these with existing or fictional practices from his or her own life, others' lives and society
- (9) uses sources to justify the explanation
- (10) reaches a conclusion by balancing perspectives

**This nomination is approved by:**

**Name teacher:**

**School:**

**Signature:**

# 4.2 Appendix 2 – Award granting form

Name nominated:

Age: Boy / Girl

School and country:

Level of inquiry proficiency:

Applies for a stage 1 award: STAR DIPLOMA

Applies for a stage 2 award: BRONZE SILVER GOLD

Name Ark of Inquiry jury member 1:

Name Ark of Inquiry jury member 2: (only with stage 2 nominations)

### The following evidence has been judged (tick one or more boxes):

- report on an inquiry activity
- presentation (Powerpoint, Prezi, etc.)
- publication (article, flyer, etc.)
- report on a presentation and/or discussion
- photo / video materials (including Youtube)
- design or product description / manual
- peer feedback
- expert feedback
- stakeholders feedback
- other: .....

### Stage 1 criteria (tick box if present, judge the quality and explain judgment per criterion) – 1 = insufficient 2= good 3 = excellent

#### The pupil:

- |  |   |   |   |
|--|---|---|---|
| <input type="radio"/> (1) describes applications, existing or fictional                            | 1 | 2 | 3 |
| <input type="radio"/> (2) illustrates with existing or fictional examples from his or her own life | 1 | 2 | 3 |

- |   |   |   |   |
|---|---|---|---|
| <input type="radio"/> (3) describes effects of usage, existing or fictional                         | 1 | 2 | 3 |
| <input type="radio"/> (4) illustrates with existing or fictional practices from his or her own life | 1 | 2 | 3 |
| <input type="radio"/> (5) describes ethical issues, existing or fictional                           | 1 | 2 | 3 |
| <input type="radio"/> (6) illustrates these with practices taken from his or her own life           | 1 | 2 | 3 |

**Stage 2 criteria (tick box if present, judge the quality and explain judgment per criterion) –  
1 = insufficient 2= good 3 = excellent**

**The pupil:**

- |  |   |   |   |
|--|---|---|---|
| <input type="radio"/> (1) explains applications, existing or fictional   | 1 | 2 | 3 |
| <input type="radio"/> (2) illustrates with existing/fictional examples from own life, others' lives and society  | 1 | 2 | 3 |
| <input type="radio"/> (3) uses sources to justify the explanation  | 1 | 2 | 3 |
| <input type="radio"/> (4) explains effects of usage, existing or fictional                                       | 1 | 2 | 3 |
| <input type="radio"/> (5) illustrates with existing/fictional practices from own life, others' lives and society | 1 | 2 | 3 |
| <input type="radio"/> (6) uses sources to justify the explanation  | 1 | 2 | 3 |
| <input type="radio"/> (7) explains ethical issues, existing or fictional   | 1 | 2 | 3 |
| <input type="radio"/> (8) illustrates with existing/fictional practices from own life, others' lives and society | 1 | 2 | 3 |
| <input type="radio"/> (9) uses sources to justify the explanation  | 1 | 2 | 3 |
| <input type="radio"/> (10) reaches a conclusion by balancing perspectives  | 1 | 2 | 3 |

## Judgment

Total      insufficient:      good:      excellent:

This nomination is **approved / denied** (delete one of the options)

*Explanation:*

**Signature jury member 1:**

**Signature jury member 2 (stage 2 only):**

## 4.3 Appendix 3 – Letter of approval / denial

Dear [ name pupil ],

with great interest did we take a look at your work. We are happy that you took the challenge to nominate for [ name award ]. We are even more happy to inform you that your nomination has been approved! You have done a very good job! You can be proud of yourself! Attached you find the report of the jury.

Now that you have obtained [ name award ] the following steps can be taken:

1. The administrator will add your name and award to the Hall of Fame.
2. Ask your teacher to add [ name award ] to your passport.

We hope you will take the next challenge and hope to hear from you again!

On behalf of the jury, [ name national administrator ]

Dear [ name pupil ],

with great interest did we take a look at your work. We are happy that you took the challenge to nominate for [ name award ]. Unfortunately, the nomination has been denied. Attached you find the report of the jury so that you can see why the nomination was denied and find some suggestions on what you can do to get nominated again.

We really hope you will try to obtain [ name award ] again and hope to hear from you again!

On behalf of the jury, [ name national administrator ]

## 4.4 Appendix 4 – General awarding procedure

### Step 1 – Getting nominated

Nomination in most cases is prepared by the pupil and teacher collaboratively. Concerning the stage 1 awards the pupil takes the initiative, whereas in the stage 2 awards the teacher might take the initiative more often. But in all cases the pupil is actively involved in getting nominated by filling in the nomination form with the teacher and collecting and providing the evidence. After filling in the form

- the nomination form and evidence is digitally sent to the national administrator;
- a confirmation of nomination is received; the jury judges the nomination within two weeks.

### Step 2 – Being judged

The national administrator contacts a teacher from another school to be the judge of the nomination. In case of a stage 2 award the national administrator also contacts a second judge (sometimes via the teacher). The jury members independently judge the nomination by filling in the award granting form. After filling in the form

- the jury members send their reports to the administrator;
- the administrator prepares a letter of approval or denial; in case the two judges differ in their conclusion (approval and denial), the administrator organizes a short discussion (either by mail, Skype, phone, or live) to come to an agreement;
- the teacher receives a letter of approval or denial which the pupil adds to his or her portfolio;
  - in case of approval the award is put in the passport of the pupil (by the teacher), and the pupil's name appears in the Hall of Fame (by the administrator) – a webpage on the Ark of Inquiry website on which all award winners are published;
  - in case of denial the teacher and pupil are well-informed and motivated to improve the nomination for a retrial later.

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