Trust in Science: Developing a Learning Environment to enable Public Understanding and Support for Evidence-based Information for Senior Secondary School Students and Students in Higher Education

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Abstract.

Drawing upon international, multidisciplinary expertise and the experience of participation in a pan-European hackathon, the authors describe the development and implementation of an online learning environment. Their hackathon project, named "*Trust in Science*", recognised the importance of confidence in academic knowledge in the context of current societal transformations and constitutes an extension of education on the processes and principles of research integrity (RI). RI is described here as the quality of honest and verifiable methods and adherence to professional norms in research. The authors participated in the hackathon in response to the COVID-19 pandemic and the consequent suspension of classroom education. The emerging principles presented in this report may have more general application in current educational transitions.

Keywords: COVID-19, fake news, online learning environment, research integrity, storytelling.

1. Introduction.

John Amos Comenius (1592-1670) took the European societal transformation from the Renaissance to the Enlightenment into account when he published his encompassing principles for education in *Didactica Magna* (1910). In a similar way, this report looks at the societal transformations flowing from the COVID-19 pandemic and reflects on learning in the

online world. It reviews interrelations between current pedagogical needs, design processes, and learning objectives in this field.

In doing so, we build upon both

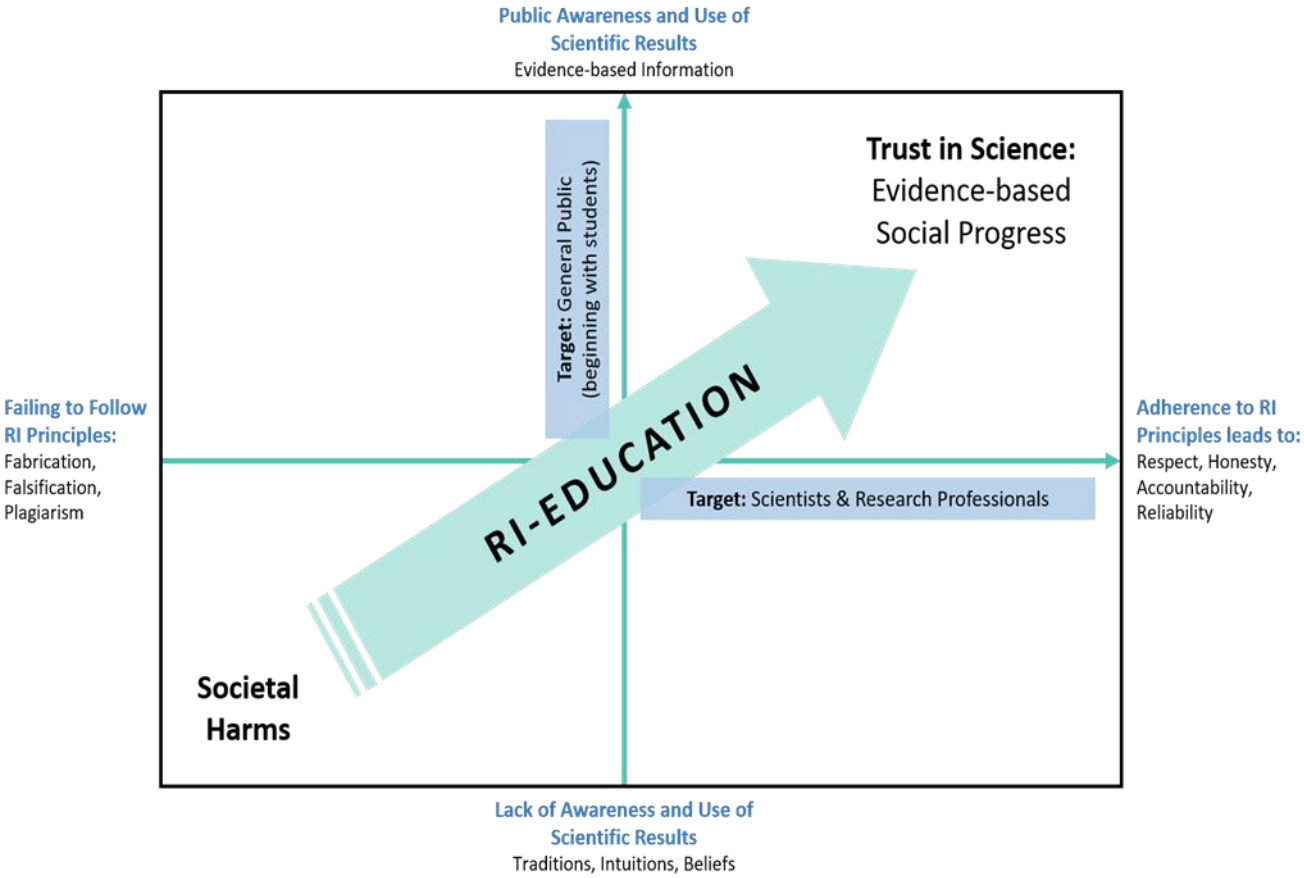
1. our personal expertise in supporting efforts to learn science, to learn about science, and to learn how to conduct science: specifically, in the context of Path2Integrity (P2I), a three-year EU Horizon 2020 funded project charged with developing innovative educational methods to build a research integrity culture in Europe; and
2. our recent experiences in responding to societal demand for open-source learning environments, for the use and understanding of evidence-based information, for accessibility through remote learning, and for citizen engagement and information exchanges.

2. Trust in Science and Research Integrity.

A corollary of the COVID-19 pandemic has been the widespread dissemination of fake news (disinformation and misinformation) that is proving to have a damaging effect on public perception, confidence and courses of action (e.g. Pan American Health Organization, 2020; United Nations News, 2020). This practice is generating considerable confusion as to the veracity of information and the nature of information sources. In this environment, advice that is informed by scientific principles, practices, and research can be hard to identify. Determining the reliability of information sources may be one of the hardest public challenges of the pandemic and is leading to widespread mistrust of information (Nyilasy, 2020).

As illustrated in Figure 1, the tendencies underpinning distrust in science build on our willingness to base decisions on intuition, tradition, and long-held beliefs. However, through education, we can enhance our ability to appreciate the value and nature of information founded upon evidence and professional practice (Fallace, 2018; Hodson, 2014; Huber, Wetzstein & Aichberger, 2019; Jack, Lee, Yang & Huann-Shyang, 2016; Priess-Buchheit (*in press*); Roberts & Bybee, 2014).

Figure 1: How Research Integrity (RI) education can support evidence-based social progress



We can overcome biases, for example, through education about Research Integrity (RI): the requirements of good, trustworthy science and its link to the principles of respect, honesty, accountability, and reliability (Priess-Buchheit, Aro, Demirova, Lanzerath, Stoev, and Wilder, 2020). Education on these principles and awareness of their application in the production of quality research not only helps individuals identify reliable information, but it can also bolster confidence in societal decisions founded upon such information (Holbrook and Rannikmäe, 2009).

Scientific output that is firmly tied to RI requirements has a higher potential value to society. When this output is coupled with public trust in science, the result can be a wider support for policy and operational decisions based on sound information and the best available knowledge.

Strong public confidence in science is particularly important for the successful deployment of

technologies to combat COVID-19. It is essential to encouraging and ensuring acceptance of complicated policies such as social distancing, personal protection, and many other measures that impact the daily lives of all.

The team thus used the term 'Trust in Science' in Figure 1 to refer to public engagement with the reliability, truth, and strength of scientific findings that flows from awareness of the principles of research integrity and the nature of academic research that is conducted in a responsible way (Steneck, 2006; Kalichman, 2015). The promotion of 'Trust in Science', so defined, therefore is supported by instruction on RI concepts and methods that meet the relevant professional and institutional standards.

Such instruction also stresses the importance of research with integrity to evidence-based decision-making and to society. This is embedded within promotion and education around the broader concept of "*scientific literacy*" (Siarova, Sternadel and Szőnyi, 2019) which embraces a contextual understanding of science.

3. Teaching Research Integrity.

The P2I project mentioned above was launched in January 2019 in recognition of weaknesses in RI training that relies on simple, unidirectional information transfer and Question and Answer evaluations focused on the recitation of rules and policies (Watts, Medeiros, Mulhearn, Steele, Connelly & Mumford, 2017; Marusic, Wager, Utrobicic, Rothstein & Sambunjak, 2016). Therefore, P2I, like many European pre-COVID-19 projects seeking to foster a culture of RI (such as INTEGRITY and VIRT2UE), sought to innovate to encourage greater engagement.

For this reason, P2I focused on the creation of products and approaches that engage learners in rotatory role-playing and dialogical experiences in the classroom. The P2I members crafted storytelling tools and learning cards before evaluating them in classroom settings. One early finding from the classroom testing of P2I learning tools suggested that secondary school students and undergraduates in Germany, Belgium and Denmark were less motivated by the opportunity to learn new skills relevant to science and scientific research as they were by the linkages between good science and societal concerns (Priess-Buchheit, in press, for details see Häberlein and Claas, 2020).

3.1 Impact of COVID-19 and the #EUvsVirus Hackathon.

The COVID-19 pandemic had two acute impacts. First, the suspension of onsite meetings disrupted in-class RI training and evaluation, and second, the social context has, as described above, amplified the importance of buttressing the integrity of research and increasing confidence in academic knowledge.

In response to pandemic-generated issues such as these, experts from education, technology, project management, and ethics teamed up to participate in the #EUvsVirus Hackathon (April 24-26, 2020). The Hackathon was a pan-European exercise led by the European Commission to connect civil society, innovators, partners, and investors to develop innovative solutions to pandemic challenges (Brereton, 2020).

Through a concerted effort, different expertise, enthusiasm, and creativity, the 'Trust in Science' team started with the goal of developing an innovative learning environment for senior secondary students and those in higher education. The team ended the three-day Hackathon exercise with a winning product that can help satisfy society's need to enable public understanding and support for evidence-based information.

The learning environment (accessible via www.trustinscience.org pursued the above-described goal with the specific objective of creating a learning environment that: encourages undergraduates and secondary school students in transition to recognise, understand, and appreciate research integrity, and empowers students to argue a case with reference to reliable research results.

3.2 Trust in science project and innovation online.

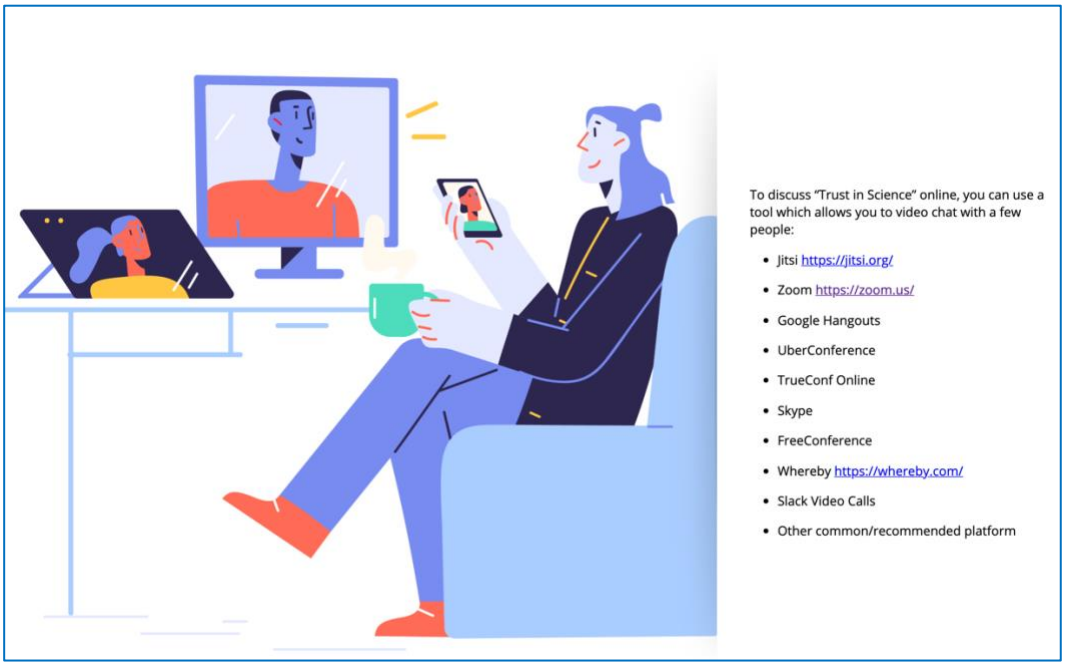
Faced with the constraints of the hackathon time frame, the team's first response was to take materials designed for a classroom setting and try to replicate that physical learning environment in a basic online format.

However, in attempting to recreate such learning environments within standard technological platforms, the 'Trust in Science' team realised, with guidance from hackathon participants' expertise in technology and remote learning (Brereton, 2020), that this approach had limitations and, furthermore, that no single tool existed to fulfil the identified 'Trust in Science' objective.

This realisation prompted the team to consider repackaging and redeveloping its research integrity educational content within a novel and entertaining multi-media platform (Manual.to) typically used to create interactive instruction manuals. Manual.to is an online tool designed to quickly generate training documents from a variety of media including video, photos, graphics, text and more, automatically translated into 64 languages. It is a particularly effective tool in training participants from different countries not only because of its language options but also because it is a platform that presents information visually and in small, digestible chunks. All of this promotes learner engagement as well as information recall and accessibility by more diverse age groups.

However, to achieve the above cited goal for 'Trust in Science', it was necessary to augment the basic Manual.to platform with video chat tools (see Figure 2) that provide an interactive discussion component essential to the RI learning process.

Figure 2: Trust in Science Video Chat Options



By using

1) learner-focused methods and content (e.g. Priess-Buchheit and Häberlein 2019)
2) in conjunction with the Manual.to tool
3) and video chat capacities,

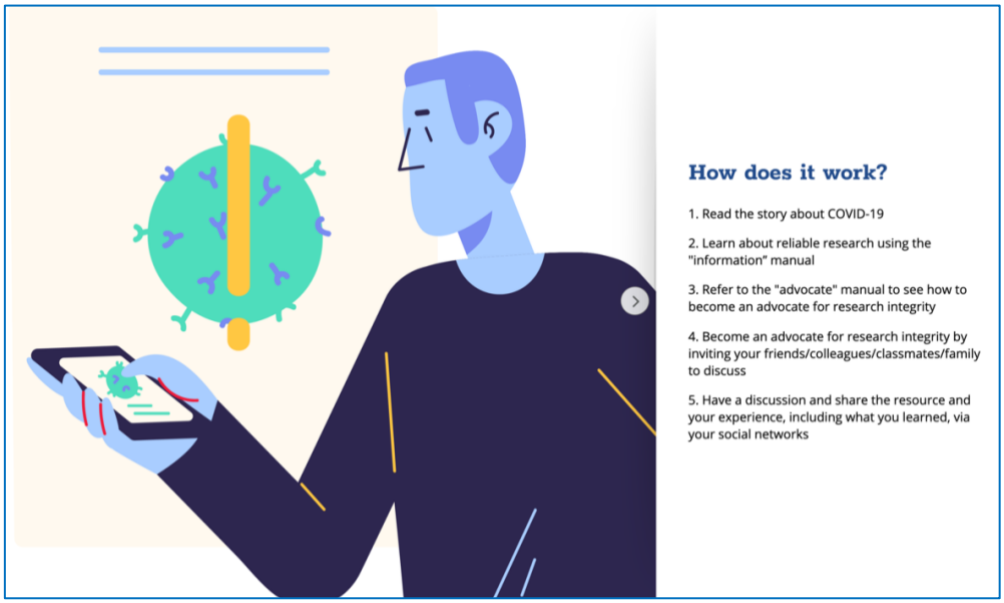
'Trust in Science' was able to quickly develop a package that promises to support sustainable, beneficial learning by not only informing learners, but also encouraging them to construct and articulate their own perspectives.

The combination of instruments and the input of the varied hackathon participants led to a new and functioning learning environment within the allotted time frame that earned recognition as a hackathon prize winner in its category.

As illustrated in Figure 3, 'Trust in Science' gives users access to information about research integrity as well as instructions for mediated group discussions. In this format, learners can discuss evidence-based decisions and the reliability of research results. The learning environment is open source, offers self-paced one-to-one dialogue options, and facilitates online group discussions. At the same time, it is visually appealing with attractive graphics and text presentation formats while adapted to storytelling and dialogic teaching strategies.

Storytelling, which has been used across cultures, languages, and eras to communicate and share valuable lessons, values, and experiences, is a key element of the tool. In fact, storytelling has also proven useful for conveying research integrity topics (Melcer, Ryan, Junius, Kreminski, Squinkifer, Hill & Wardrip-Fruin, 2020). Therefore, while it is only one method that allows the learner to relate and engage with the information, it creates, when augmented with imagery, deep connections and conveys relevance to the human experience.

Figure 3: Trust in Science process



Storytelling as employed in ‘Trust in Science’ strives to help learners to "*venture beyond narrow group loyalties and to consider the reality of distant lives*" (Nussbaum, 1997, p.10). This ability can entail learning a new perspective, understanding the principles of lesser-known habits, or immersing oneself in a different culture. Early feedback from students and other users indicates a heightened awareness and sensitivity to evaluating news and information in general and recognising and accepting evidence-based information.

> *[Trust in Science] is a user-friendly, visually richly ornamented platform for sharing knowledge to identify non-scientific information about COVID-19. It provides a step-by-step guide that allows you to recognise scientific integrity and at the same time gives you the opportunity to discuss with others on topics related to COVID-19 on a scientific and sound basis.”* (Comment from Student User).

3.3 Storytelling in asynchronous format.

The ‘Trust in Science’ self-paced (asynchronous) format taps the potential of storytelling and builds on it through (synchronous) mediated discussion groups. The learning environment empowers users with a new capacity to discuss and confront major issues with references to identify fake news and to appreciate research with integrity, allowing them to better engage with family members, friends, colleagues, and students. Its varied capacities can also reach across borders in efforts to judge the reliability of facts and foster more cohesive and functional societies. It ultimately leads participants to become agents for research integrity.

In summary, this online learning environment delivers information concerning the nature of reliable research, supports discussions, questioning, and evaluation of individual perspectives, and uses storytelling to make the topic as relevant as possible to the target group.

‘Trust in Science’ is still a work in progress. Currently, it targets undergraduates and aims to reach society in general.

> *"In my own environment, I have noticed that I am more critical with information through what I have learned and also, for example, I question video clips that are published on social media for the time being and inform myself first of all after more detailed backgrounds [research] before I form an opinion about them."* said one student after a learning session.

‘Trust in Science’ hands responsibility to its learners and emphasises learners' autonomy and critical thinking.

4. Conclusions.

The 'Trust in Science' learning environment is currently used by teachers and lecturers across the world. It is open-source with as few restrictions as possible; supports individual learning progress through self-paced, one-to-one dialogue, enables citizen engagement in its virtual group discussions, and advocates for evidence-based information. Beyond the technological features, it also may be considered a model for others seeking to transfer classroom education and face-to-face training systems to the online, remote-learning world.

To this end and taking the latest societal transformation processes and this #EUvsVirus Hackathon experience into account, it is recommended that future efforts in online training, notably those that seek to enable public understanding and support for evidence-based information, consider the following principles:

1) Be as open as possible to contributions from as many people as feasible.

- A multidisciplinary approach is required as a diversity of skills, information sources, and experiences are needed to build an innovative and novel learning environment such as the adapted Manual.to tool used here.

2) Ensure equitable access to as many people as practical.

- COVID-19 is, for example, a disease of humanity, and it is essential that all of humanity be part of, and benefit from, solutions. Yet given the technological nature of new learning environments, extra care must be taken to consider the varying technological capacities of potential users to ensure equitable access and to ensure different points of view and information inputs are considered.

3) Include mechanisms for rational dialogue.

- This is essential to support evidence-based thinking and decision making, as well as ensuring mutual understandings. To encourage rational dialogue, this initiative, for example, provided platforms and tools for mediated discussion groups.

4) Be relevant to each individual in their circumstances.

- Relevance ensures learning engagement and understanding. 'Trust in Science' uses storytelling, dialogical approaches, and visualisation to target our identified student

audience to relate the information to each participant's personal experiences and priorities.

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Projects:

INTEGRITY: www.h2020integrity.eu

Path2Integrity (P2I): https://www.path2integrity.eu/

VIRT2UE: https://www.embassy.science/wiki/Guide:Bbe860a3-56a9-45f7-b787-031689729e52

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