

## Introduction

# **An Interdisciplinary Approach to Connectivity, Networks, and Flows**

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The role of the sciences and humanities in the modern world is undergoing significant changes. Up until 70 years ago, the idealized image of great men predominated academia, heroes who unearthed new insights and thus propelled the progress of humanity. Accordingly, research institutions globally were largely centered around (mostly male) individuals.

It became apparent that this kind of science was unsustainable for research, particularly in the field of natural sciences, in the period no later than the Second World War – with the Manhattan Project often mentioned as the turning point. Throughout the twentieth century, hypotheses and measurements, as well as their interpretations and publications, became increasingly complex, leading to a greater necessity for collaborative work. This is evident primarily in the natural sciences, which were progressively becoming increasingly collaborative. In contrast, the humanities remained more focused on individual researchers for a longer, although there are some examples of collaborative research in the humanities as well, for example, in the context of the Macy Conferences from 1941 to 1969 (Pias 2016). However, since the turn of the millennium, there has been a noticeable increase in collaborative research in this field as well (Wagner 2018).

A key reason for this development lies in the necessary bundling of expertise in academia in general, which almost by requirement becomes ever more complex – and especially so in recent decades. The advantages that come with full autonomy, which individual authors have when writing their articles and books, or when designing and conducting their experiments, is often outweighed by the significant gain that results from the combined expertise of several authors. Even in highly specialized fields of research, a single person can hardly hold all the knowledge nor consider all aspects of the topic. The chances of omitting crucial aspects are strongly reduced if two or more authors collaborate on their research and pool their efforts in the pertinent publication. Additionally, different perspectives may complement each other well and lead to entirely new insights. Thus, conducting research collaboratively ensures that the fundamental objectives of science can be efficiently achieved. The institutions which en-

able scientific achievements in the modern world, such as universities or similar research institutions – these days often all labelled together as “academia” – all have such a goal at least in principle. The term “university” itself was primarily intended to capture the holistic concept of a broad science, with the ideal since the reforms by Wilhelm von Humboldt in the early nineteenth century being the mutual inspiration of the various sciences and disciplines. From faculties to departments and to research groups, this layered structure has as an important aim to ensure expertise while promoting collaboration.

The main task of science and scientific research is to broaden our understanding of the universe from subatomic to cosmic dimensions, attempting to answer fundamental questions about nature, the cosmos, life, and human existence. Another objective of science, arising directly from this original task, is its assignment of competent problem-solving; and this can be observed from the establishment of academies in Europe from the mid-seventeenth century. This has become significantly more pronounced in recent years. Science today is seen as playing a crucial role in addressing global crises such as climate change, health crises, food security, sustainability of energy supply, and societal problems such as conflicts, war, social inequalities, and many more. The pervasive skepticism – and sometimes even outright rejection – regarding the potential of science in times of accelerated climate change or the challenging management of the COVID-19 pandemic should not obscure the fact that the central problem-solving competence for these issues is undisputedly still – and for the foreseeable future will remain to be – sought in science and among the experts that represent it. This dominance in ascribed competences is achieved through a rigorous method, fundamentally underlying all sciences. By strictly adhering to high plausibility, science provides a coherent, consistent, and cohesive framework for understanding the world based on empirical evidence and logical reasoning. It delivers reliable information and insights for public policy, decision-making processes, and societal debates. While the sciences anchored at universities are not primarily interested in applied knowledge, it is undeniable that this is a central “byproduct” of research, especially in the natural and life sciences. Hence, these fields of science derive a significant part of their relevance and even legitimacy from this potential.

Related to this is the common goal of all sciences to promote critical thinking, to foster curiosity, and as a result lead to a deeper understanding of the world also by non-scientists. An important concern of science in this regard is divulging critical thinking to the broader public, achieved through conveying complex knowledge in a generally comprehensible form. This also leads to processes of interaction with a broader audience, which mostly revolve around ethical questions associated with the techniques and possibilities provided by science.

We believe that the collaboration between the natural sciences and the humanities is particularly fruitful at the intersection of research with reflections about applying new insights and the potential ensuing repercussions for society at large. As soon as

collaboration between the disciplines becomes interdisciplinary, new challenges but also new opportunities arise. As technological innovation usually goes along with societal change, it is often up to the humanities to interpret, evaluate and sometimes even tackle all the following challenges, which we face as social beings in present-day societies and the contemporary globalized world. The humanities can provide the natural sciences with important catalysts and inspirations – and sometimes also point out possible limitations of various kinds, such as ethical, legal or historical ones.

The issues related to the role of sciences in the modern world provide the starting point for this book. In October 2022, a group of young scientists from the Johanna Quandt Young Academy, all representing diverse disciplines, met for their *Study Day* in Erfurt. They set themselves the task of producing a book that responds to the current challenges of science, its goals and its tasks. This book should also explicitly address the general public to share insights into our current research. In this context, one of our main goals is to establish an interdisciplinary dialogue. To this end, a team of authors was assigned various concepts and terms to explore and write about, working collaboratively in groups of two or three from different fields of research.

These concepts and terms provided starting points for in-depth reflection from a scientific perspective. The selection of terms was based on the criterion of relevance. Themes like “translation” or “migration” are perennial topics not only of modern times and are consequently subject to continuous public discussion – with a corresponding response from the media. Conversely, topics like “artificial intelligence” or “profiling” have a much younger genesis and have thus been prominently represented in the media only in recent years.

In the process of selecting concepts and terms for our publication, their public relevance to contemporary society was not our sole criteria. It was crucial to align them with both, the annual theme of the Johanna Quandt Young Academy, which is *Connectivity. Networks. Flows*, and our current research priorities. Therefore, our aim is not to simply add to a media debate that will continue to evolve autonomously on its own terms. Rather, our goal is to reflect on these terms, their contents, and their usage from the perspective of science and its various disciplines. We seek to contribute our own interdisciplinary examination of these terms, thereby adding greater depth to the public discourse surrounding them. Through intensive interdisciplinary work alone, we hope to have gained a greater understanding and offer a new perspective of the terms presented individually in this publication.

The volume consists of ten chapters, each introduced by an artistically designed cover page. These cover illustrations are further explored in an interview with Sophie Nolden, the creator of the artwork in this book, conducted by Javier Ortiz-Tudela and Susanne Fehlings. In addition, the book features a special section about the JQYA, which contains a chapter entitled “The JQYA: Connectivity and Networks in Action”, written by Katharina Welling, an overview of the academy’s scientific work from 2021–2023, and an interview with Hartmut Rosa, former Distinguished Senior Scientist of the JQYA.

In the first chapter (1) “Knowledge”, Kevin Liggieri and Marco Tamborini address the question of what “knowledge” actually is in our modern technological society and in doing so, they encounter sub-epistemological and anthropological problems. The chapter seeks to contribute to both understanding and improving modern society, be it with regard to work (i. e. industry 4.0) or living environments (i. e. smart homes) by examining the connectivity, circulation, and transformation of knowledge of the “human” (anthropological knowledge) in human-technology interaction from the perspective of anthropological and epistemological philosophy. They discuss how and to what extent anthropological knowledge is becoming part of the digital world and technological networks; and ask these questions: How are qualities of sentient human beings turned into machine-readable data and informational flow and what epistemological and ethical problems arise from this quantitative formalization? How is technology and anthropological knowledge connected? In the hyperconnected era in which we find ourselves, we (as natural systems) are moving permanently “in-between” technological systems. This relationship between human and technology strongly pivots on the interdependence between usability and anthropological paradigms. But how do technology-oriented scientists take on anthropological knowledge and translate it into technological models? How does quantified knowledge and the image of the “human” change when artifacts are integrated into technological environments (for example smart homes or smart factories, machine learning, AI)?

In their chapter (2), Stanislaw Paulau, Laura Otto and Sebastian Eckart examine “Matters of (In-)Visibility” and explore phenomena that are not immediately visible or perceptible to humans, but yet have a significant relevance. In religious studies, the concept of invisibility is relevant in the context of belief in deities or other supernatural entities that are believed to be beyond the limits of human perception; or in the idea that certain spiritual practices or states of consciousness can enable a person to perceive the invisible world. Research on both visibility and invisibility in cultural anthropology studies actors who are not visible per se, such as viruses, that co-produce the world we live in, and analyzes, on the other hand, practices of making certain phenomena (in)visible. In physics, invisibility is often associated with the ability of an object or substance to transmit, absorb, or scatter light in such a way that it is not visible to the human eye. In the natural sciences, however, there are numerous examples that demonstrate the existence of phenomena that the human eye alone cannot perceive. X-ray imaging is an easily recognizable method for observing such unseen properties, as it utilizes electromagnetic radiation that is not visible to the human eye. Additionally, other techniques, such as momentum spectroscopy, also allows for the observation of otherwise invisible phenomena. Against this backdrop, the authors of this chapter ask: How can the visible be made invisible and how can the invisible be made visible? To approach these questions, they present several examples of (in)visibility-making. The first example from religious studies grapples with an intriguing question: How are seemingly utterly secular areas of our modern societies, like economics and human

rights, connected with a religious understanding of invisibility? The second example from cultural anthropology discusses how harmful algal blooms in the Caribbean are made (in)visible. From the perspective of physics, the two examples are critically discussed and commented on with regard to (in)visibility. The chapter illustrates that (in)visibility is multifaceted and has wide-ranging implications for understanding the world we live in.

Magnus Ressel's and Susanne Fehlings' chapter (3) on "Mobile Trade" compares mobile trade practices in the eighteenth and the early twenty-first century. By describing two different groups of traders, namely, a) the group German and Italian traders in central Europe of the eighteenth century, and b) post-Soviet shuttle traders, known as "chelnoki", who travelled between the Caucasus, Central Asia, Russia and other post-Soviet countries and China, the authors provide glimpses into the activities and role of mobile traders in two diverging historical, social, political, and economic contexts. Due to their frequent mobility, both groups of traders have been described as "itinerant" and "shuttle" traders. Such groups are well known throughout history. They could be found everywhere in premodern Europe and before the 1800s might have even accounted for the largest share by volume of trade. In the past, they constituted vast networks of migrants, and were one of the most important vectors in the dissemination of new forms of consumption; and until today, itinerant and shuttle traders supply the Global South, East and periphery with consumer goods, many of which would not be accessible to local populations without these mobile merchants. In their contribution, the authors try to identify "timeless" aspects of the phenomenon of mobile trade, respectively itinerant and shuttle trade, and underpin their hypothesis that the phenomenon of mobile trade is not a relic of the past, but a contemporary practice that is well suited to addressing future changes in the global economy.

In their chapter (4) "If You Keep Asking (the Same) Questions, You Will Get the Same Answers: Linking the Quantum Zeno Effect and Psychological Anchoring", Javier Ortiz-Tudela and Sebastian Eckart look at two seemingly unconnected phenomena. Their text explores the intriguing conceptual similarities between quantum mechanics and human decision-making. Specifically, they compare the Quantum Zeno Effect in physics – where repeated measurements can "freeze" a particle's position – with the Anchoring Effect in psychology, where human estimations gravitate towards recently processed information. Both phenomena can be mathematically described using probability distributions, where measurements collapse the probability density to a single value and thus bias future measurements. In the chapter, this abstract link is explored, its potential implications discussed, and predictions derived from this common understanding are outlined. The text also discusses the limits of this analogy, acknowledging the idiosyncratic explorative and motivational aspects of human behavior.

Rikki Dean, Tamara Ehs and Javier Ortiz-Tudela, in chapter 5 "AI in Politics", examine whether the neural networks of AI agents can help redress some of the disconnections that are disfiguring the contemporary democratic system. AI agents use neural

networks to process massive amounts of information and summarize it to try to find the optimal solution to any problem potentially surpassing human capabilities with sufficient data. So, could AI agents help disconnected citizens decide who to vote for, or help divided politicians agree on the common good solution? In this chapter, the authors identify several tensions between the most AI works and how democracy is conceived that raise significant barriers to AI agents playing a meaningful role in solving these problems. Political decision-making is characterized by contested outcomes with no universally optimal solutions. This special characteristic differentiates it from the more technical or strategic game-playing decisions on which AI excels. It poses unique challenges for the development of AI agents for democratic politics, because these agents can never sit outside politics but will always themselves be subject to politicization in their operations. In addition, AI's "black box" nature obscures how decisions are made, conflicting with democratic values that decision-makers should be accountable for their actions and their decisions should be publicly justifiable and intelligible to all. It seems that (at least till of this writing) artificial neural networks will not replace human networks. Moreover, careful regulation is necessary to ensure AI agents align with democratic principles and do not further drive political disconnection.

Susanne Fehlings, Magnus Ressel and Sofia Iris Bibli compare in their chapter (6), "Exploring Flows in Bodies and Bazaars", the dynamics of blood flow within the human body with the flow of information in the social sphere, more particularly in the realm of the human economy. Building on a long tradition of bodily metaphors to describe societal and economical processes, the authors try to leave the metaphoric level to attain a more practical level of comparison. One fundamental difference between biological systems and societal systems seemingly lies in their mode of operation and control. Biological systems, such as the human body, typically function in an unsupervised and unconscious manner, driven by autonomous processes governed by genetics, physiology, and evolutionary principles. In contrast, societal systems operate within human societies and are – at least to some extent – subject to conscious decision-making, regulation, and intervention. The authors challenge this apparently obvious distinction by highlighting societal rules, which work without monitoring and steering. Initially, an introduction to both fields of enquiry is made: 1) with a description of the human circulatory system and 2) with an introduction to human economy from a social and cultural anthropological perspective. In a second step the chapter focuses on laminar and turbulent or disturbed flows and their consequences in the two separate contexts. Finally, the chapter compares the role of networks and circulation – within the body and in the bazaar economy – and discusses some commonalities and differences.

In their chapter (7) "Translation", Magnus Ressel and Caroline Sauter point out the complexities, the potential, and the limits of translation, drawing in detail on one of the most paradigmatic, influential, and yet most contested examples in the history of



translation: Bible translation. In Bible translation, the question of cultural appropriation poses itself: unlike Judaism, Christianity is a proselytizing religion, and Bible translation has been a major tool in Christian missions, as pointed out. Yet, the chapter demonstrates how overseas endeavors of Bible translation within the framework of Christian missions, have also shaped secular research within European academia. The translation of Bible history is therefore an entanglement of mutual connectivity, networks, and flows.

Chapter 8 “Profiling”, by Daniele Di Mitri and Catherine Whittaker, explores a highly debated concept prevalent in contemporary discourse. Traditionally, profiling has been linked with the negative practice of categorizing individuals based on superficial attributes, a practice often contested by anthropologists due to its potential to reinforce stereotypes and perpetuate racism. The historical prevalence of “othering”, often resulting in essentialist thinking with negative consequences, has been a major concern within the field of anthropology. Many anthropologists have hence stressed the importance of their discipline in advocating the acceptance of human diversity. However, could anthropology’s reluctance towards profiling inadvertently lead to its own set of problems? Categorization is often seen as a prerequisite of any scientific method, take for example Niklas Luhmann and his influential systems theory. We may even go further and see it as inescapably human. As the cognitive psychologist Eleanor Rosch famously remarked, “we categorize experiences and thereby reduce the infinite complexity of the world to the manageable”. Examining the more positive connotations of profiling in fields like computer science and human-computer interaction necessitates a close examination of anthropology’s critical stance. In the field of information technologies, profiling involves modelling user preferences and traits, such as preferred genres on streaming platforms or fitness levels on smartwatches. While both computer science and anthropology acknowledge the potential for profiling to reinforce stereotypes and generate negative experiences, they also recognize the opportunity to refine profiles to better align with individual needs. Contrary to some pessimistic apprehensions, profiling in computer science has sometimes demonstrated more benefits than drawbacks, allowing for personalized approaches that have the potential to be sensitive to diverse needs. The chapter therefore advocates for a nuanced perspective that acknowledges both its risks and potential advantages. Embracing this complexity creates space for accommodating a broader range of identities and experiences, fostering a world that embraces and celebrates human differences. Therefore, a judicious use of profiling with the assistance of information technologies may offer a perspective that sidesteps the pitfalls of “othering” while retaining the benefits of categorization within science.

Sophie Nolden and Bojana Stojanova look at the human ability to cope with the unknown, in their chapter (9) “Change, Uncertainty, and Scientific Thinking” from an evolutionary and ecological perspective, change and uncertainty drive species adaptation, the emergence of new species, and the preservation of biodiversity in ecosystems.

On an individual level, change and uncertainty can drive development, creativity, and learning. The dynamic of adaptation to change and uncertainty is what shapes ecosystems, cognitive systems, and society through the maintenance of a dynamic equilibrium which constantly requires new adjustment strategies. Yet, in the past 200 years or so, human-mediated actions aiming at maintaining a stable environment have dramatically intensified, be it through landscape management, urbanization, and resource exploitation, pest and disease control, increased sanitary regulations, or stricter migration policies. These actions have led to an increased sense of safety in society, as well as a perceived control and an efficiency in routines. There are, however, also unplanned consequences of aiming to maintain stability. For example, the required level of adaptation to the environment may easily go beyond one's comfort zone if stability is strongly prioritized over change and uncertainty. The individual response to such challenging situations can range from trying to restore a previous state to trying to embrace change, to see it as an opportunity. While there may not be a generally valid ideal response to challenging situations, the probability of a successful adjustment increases when individuals and groups have a wide range of possible responses available, similar to having a good selection of tools in a tool kit. It is argued here that scientific thinking and general natural scientific knowledge train our minds to focus on and to cope with the unknown and the uncertain. Promoting education and knowledge of the scientific method may thus be useful for accepting uncertainty, and to increase resilience to the sudden onset of stressors.

In their chapter (10) "Clouds", Prashant Singh and Oliver Völker look at the physical objects that we designate with this term and the resonance they evoke in our minds. Clouds are hybrid beings in their material composition as perpetually shifting aggregations of minute water drops. Located in an intermediate position between earth and sky, they seem to question clear-cut distinctions between the ontological categories of physical object and temporal process, physical formation and disintegration, individual body, and the encompassing system of the atmosphere. The first part begins with the role of clouds in European poetry and meteorology from around 1800. Published in 1803, Luke Howard's early meteorological paper *On the Modification of Clouds* introduced a taxonomic classification of cloud phenomena into four basic types: cirrus, cumulus, stratus, and nimbus, with corresponding intermediate and composite forms. This search for recurring patterns and shapes in what seemed to be indeterminate and formless had a significant impact on contemporary poetry. Poems from the time depict clouds as communicating, mobile, and ever-shifting entities that connect different parts of the Earth and its atmosphere. At the same time, this mobility and constant metamorphosis provided a model for the understanding of poetry. The second part connects the role of meteorological phenomena in the history of poetry with the perspective of contemporary meteorology. The ability of clouds to moderate the flow of life-giving sunshine while also controlling temperatures and precipitation is crucial to the delicate balance of our planet's environment. Clouds also help us understand how



the Earth's ecosystem changes over time by guiding our predictions of weather patterns and our research into long-term climate shifts. In sum, clouds provide an important perspective for understanding poetry and the practical mechanics that regulate our environment. As Singh and Völker argue with respect to the current situation of the Anthropocene, in which the distinction between the natural and the artificial have become blurred, the multilayered appearance of clouds can also become eerie and disorienting.

The JQYA fosters, as one of its key objectives, interdisciplinary collaboration and research projects. Its hope is to develop new perspectives on manifold topics in science and academic research. We are convinced that interdisciplinarity in academia offers several benefits even though it comes with substantial challenges as developing a common language is not always straightforward. A more holistic understanding allows us to approach complex problems from multiple perspectives, leading to a more comprehensive understanding of highly diverse phenomena. We are further convinced that a multi-faceted approach is beneficial to innovation, which in turn enables us to address the great challenges of our times. In this book, we not only present many problems associated with the concepts being discussed, but also show their potential.

The concepts and terms “knowledge”, “invisibility”, “mobile trade”, “quantum mechanics and psychological anchoring”, “artificial intelligence and democracy”, “flows”, “translation”, “profiling”, “change/uncertainty” and “clouds” all in their own way have strong relevance to the needs and debates of present-day society. Looking at them from an interdisciplinary perspective and presenting our thoughts and results to a larger readership will show the potential that science and academic research have in one of its key tasks: the improvement of society by means of reflection and investigation via the critical method of science. If this goal is advanced by what follows, then we have already achieved our main objective.

## References

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## An Interview About the Artwork in This Book **Art Meets Academia**

SOPHIE NOLDEN / JAVIER ORTIZ-TUDELA /  
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**Fig. 1:** Unintended flow © Sophie Nolden.

When the idea of this edited volume was born Sophie Nolden, as one of its future contributors, offered to illustrate a cover page for each of the submitted articles. The editors were thrilled by this suggestion and Sophie started to communicate with the groups of authors published in this book. It was from these conversations that Sophie created abstract paintings, which subtly introduce each article's topic, transforming it into a visual experience.

In the following interview we asked Sophie about her artistic work, about how she combines art and science, about her opinion concerning the relationship between art and science, and about how the topic of connectivity, networks, and flows may be tackled in both spheres.

As an outcome this interview itself reveals connections, networks and flows. Sophie talks about linking art and science, about how inspiration flows from one approach to the other and how connections, networks and flows may stimulate but equally challenge us.

*How long have you been actively painting? Can you give us a bit of background about your artistic activity and career? Have you worked on similar projects before?*

I am generally very much attracted to beauty in life, and I have always enjoyed arts and crafts. From time to time, I create artistic illustrations for my work as a cognitive neuroscientist. For example, I designed the layout of my slides for my thesis disputation, which contained sound waves that transformed into brain waves, culminating in a depiction of a brain with the auditory cortex highlighted. I became more deeply involved in creating artwork during the COVID-19 pandemic when I worked extensively from home and had to limit social contact. Creating artwork helped me immensely in managing my work-life balance during the pandemic, as it requires intense focus and refreshes the mind, much like the experience one may have when engaging in sports or playing music. Thus, as an autodidactic artist, I naturally gravitate towards creating visual art in the flow of my life and in connection with my experiences. While I have worked on many different topics before and have been asked to create some very specific pieces, this is the first time I am working on illustrations for a book. What I particularly enjoyed about this project was its overarching theme, and yet, there were numerous approaches to approach it.

*How does being an artist influence your approach as a scientist? Does being a scientist influence/shape your artistic creativity?*

The cognitive neuroscientist in me would argue that I do indeed have only one brain, and all its areas are interconnected, implying dependencies! I firmly believe that working in empirical sciences demands a great deal of creativity, too, much like creating art. It is essential in both areas to maintain focus and possess a mindset that allows me to explore different perspectives. However, human lives are multifaceted and complex, and there are numerous other aspects of my life that may impact both my work as a scientist and my illustrations.

*Do you think your background as a scientist influenced the process of creating these particular paintings?*

To a certain extent, yes, because my extensive knowledge in my field may have influenced my choice of certain approaches. For instance, I started my career as a trainee in Auditory Cognitive Neuroscience and so it made sense to me to associate some chap-

ters with waves. However, many other factors influence me, as I have diverse interests beyond arts and science. Moreover, I share my passion for the arts with numerous friends, many of whom do not have a scientific background. Consequently, I draw inspiration from various sources, with science being just one of them.

*Can science gain something from art? Does art add something that science lacks, for example?* These are big questions, and I will share a bit about my personal experience (others may have different experiences) to keep the response short. Creating illustrations for this book required significantly less effort, time, and individual steps compared to crafting a scientific article, particularly an empirical one. This was refreshing, as it provided a quick sense of accomplishment and completion – a rarity in the ever-evolving realm of science, where we are never really done, we are just reaching little milestones on a big journey. Illustrating satisfied my hedonistic side far more than scientific work, which instead fulfills my curiosity and fascination with the human mind.

*Can you give us an overview of your general process for creating these pieces?*

*Have you used a common approach to all of them? (Materials, techniques, style?)*

I did not initially adopt a common approach, but I found myself gravitating towards using watercolor extensively, which went well with the aspect of flow. Typically, I began by envisioning an illustration that encapsulated the essence of the topic. Then, in the second step, I deliberated on the best method to bring it to life. I found the chapter topics very appealing, making the process thoroughly enjoyable. I infused a healthy dose of humor into crafting the specific illustrations, adding an extra layer of enjoyment to the work.

*How was the communication with the article authors? Are there some interesting stories that arose from your exchanges with the authors? Is there something to be said about the artistic interpretation of scientific contents?*

The communication was amazing. As scientists, we are accustomed to collaborative work, and so the authors freely offered specific suggestions and proposed ideas that had not crossed my mind. I am genuinely thankful for all the input I received. Initially, when I worked independently on the illustrations, I had very specific ideas in mind – some depicting concrete objects, others more abstract. It was wonderful to learn about the perspectives of others on these creations.