Inquiry in University Mathematics Teaching and Learning: The PLATINUM Project
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CHAPTER 5

Origins and Implementation of the Project

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When it is obvious that the goals cannot be reached,
don't adjust the goals, adjust the action steps.
Confucius

5.1. Introduction

The main theme of the book about the PLATINUM project is inquiry-based mathematics education and, in general, inquiry as a form of exploration and discovery in the classroom. In this chapter, we inquire into the following important issue: How did it happen that the project became the reality? How did the project evolve and what was its impact on the individuals who worked together on the project? It is not very common to see mathematicians and mathematics educators collaborate productively in a large-scale joint educational project (see Mohn, 2018). Therefore, we would like to provide the reader with an honest insiders' account of what might bring mathematicians and mathematics educators to the collaboration in a joint project about teaching and learning mathematics. Our narrative might surprise those who believe that a project should always start with a concrete idea—for us it did not begin with an idea, our starting point was a heterogeneous group of university teachers and researchers interested in the collaboration in a project on university mathematics teaching. At the outset, let us briefly review the key characteristics of the PLATINUM project.

Nature. PLATINUM is an educational project within the Erasmus+ framework (Erasmus Strategic Partnerships). It is a developmental and innovative project in Mathematics Education with the focus on inquiry-based learning and teaching in higher education.

Purpose. The purpose of the project is to bring together academics with expertise in mathematics and mathematics education who wish to jointly explore the applicability of the main principles of Inquiry-Based Mathematics Education (IBME) to their own practice and share the experience with other academics expanding eventually the community beyond the project.

Goals. In the project proposal, we set the following concrete goals:

a) communicate sound inquiry-based principles of teaching and learning of mathematics;
b) develop our own teaching, and that of our colleagues, through communities of inquiry in local settings;
c) design inquiry-based tasks and mathematical units using digital media for blended learning providing resources for mathematics teaching and learning;

d) design induction workshops and seminars which introduce lecturers to inquiry-based practices in teaching and learning;
e) extend the model of inquiry-based learning to modelling activities which engage students with real problems in industry and society;
f) design assessment procedures and integrate them into the activity itself, to gain a realistic view of what the project is achieving.

Composition of the PLATINUM consortium. The project partners are eight universities in seven European countries:

- University of Agder (UiA) – the coordinator of the project
- University of Amsterdam (UvA)
- Masaryk University (MU)
- Leibniz University Hannover (LUH)
- Loughborough University (LU)
- Complutense University of Madrid (UCM)
- Brno University of Technology (BUT)
- Borys Grinchenko Kyiv University (BGKU)

As the PLATINUM project developed, several academic institutions supporting the ideas of IBME joined the consortium as external partners: The University of Auckland and Auckland University of Technology in New Zealand, Swinburne University of Technology in Australia, and Ternopil Volodymyr Hnatiuk National Pedagogical University in Ukraine. The new partners participated in PLATINUM events and promote inquiry in their daily teaching and research.

To support our narrative, in this chapter we occasionally quote the PLATINUM team members who kindly answered the questionnaire explaining the reasons why they joined the project and their expectations from it as well as the feedback from the surveys distributed during the project implementation period.

5.2. Formation of the Consortium

We start by describing how the initiative group came into being, from the very first contacts between the initiative group members and reflect about the motivation and common interests of individuals who played a key role in the formation of the project team. In mathematical terms, in the beginning the structure of the initiative group resembled an undirected simple graph with several disjoint and loosely connected components. Apparently, the idea of a joint project can be viewed as an attempt to connect these components with a common idea and goals. The overall essence and spirit of the initial stage can be described by the authors as an attempt to explore what do we all have in common and what can we do together. In simple words, we started with a group of enthusiastic and motivated people, rather than with a big unifying idea.

In the beginning not all the members of the group knew each other well enough, and some did not even meet. It was well visible and quite understandable that there were certain differences in perspectives of mathematicians and mathematics educators. On the one hand, it might be difficult for a mathematician to embrace at once the theory-grounded viewpoints of mathematics educators on teaching and learning of mathematics. On the other hand, it might be equally difficult for a mathematics educator to take seriously the intuitive views of professional mathematicians on the use of didactics and pedagogy in mathematics teaching.

In the summer 2020, halfway through the project, we conducted a brief survey collecting the PLATINUM team members' views on their participation in the project

asking them to recall retrospectively what motivated them to remain in contact and bring forth the idea of a joint project in mathematics education, the reasons for joining the project preparation process and expectations from the project. The survey comprised of the following three questions:

(1) Why did I decide to join the initiative group which later has become the project consortium?
(2) When did I join the group?
(3) In the beginning, before writing the project proposal has started, what was originally my idea of what would/could be the project about?

Fifteen respondents from six partner institutions and one associate partner institution answered the questionnaire. In responses to the first question concerning motivation to join the initiative group, the following reasons were mentioned most frequently:

- I wanted to become a better teacher/improve my own teaching,
- I liked the idea of collaborating with the colleagues involved in the project,
- I wanted to do in the project something related to what I was already doing or planning to do,
- I wanted to explore principles and applicability of IBME in higher education.

In the responses regarding the preliminary idea of the project, the following issues were indicated:

- inquiry-based mathematics education;
- professional development of mathematics teachers;
- blended learning, ICT tools in mathematics teaching;
- learning approaches and teaching styles based on student's and teacher's personality.

Next, we briefly recall workshops, meetings, and other initiatives from the very early stages when the idea of joining efforts in a project was conceived to the day when the proposal has been awarded the EU funding. The purpose of this part is to give the reader an idea of how much time and effort did it take for the partners to prepare a successful project proposal. This part contains rather detailed information about all events where the future partners in the PLATINUM consortium discussed possibilities of a joint project proposal, including special project-dedicated meetings where much of the proposal has been built up and shaped. We also reflect on both processes of reshaping of the consortium and finalising of the proposal for submission.

For easy referencing, we list all preparatory meetings (PM1-PM9) including abbreviations for the institutions represented in the meetings.

PM1. Kristiansand, Grimstad, and Bergen – May/June 2015: UiA, LU, BUT, UvA, UCM
PM2. Loughborough – September 2015: LU, UiA, UvA, LUH, BUT, MU
PM3. Trondheim – November 2015: UiA, UvA, LU, BUT, MU
PM4. Brno – February 2016: BUT, MU, UiA, UvA, LU, UCM
PM5. Loughborough – September 2016: LU, UiA, BUT, MU
PM6. Prague – December 2016: UiA, BUT
PM7. Kristiansand – February 2017: UiA, LU, UvA, BUT, MU
PM8. Amsterdam – March 2017: UvA, UiA, LU, LUH, UCM, BUT, MU
PM9. Kristiansand – February 2018: UiA, LU, UvA, LUH, BUT, MU, BGKU

We gratefully acknowledge the crucial role played in the formation of PLATINUM consortium by the Centre for Research, Innovation and Coordination of Mathematics Teaching (MatRIC) at the University of Agder and its support of the project proposal from the very beginning. MatRIC organised many events where the discussions took

place and supported financially the process of the formation of the consortium and proposal shaping. MatRIC also contributed significantly to the writing and submission of the proposal (see Section 5.3) and the implementation of the project (see Sections 5.4 and 5.5).

The first contacts between the members of the initiative group were facilitated through their participation in a sequence of events organised by MatRIC starting with PM1. The idea of a joint project has been suggested for the first time by Professor Barbara Jaworski at PM2 where representatives of most of the project partners met on a joint MatRIC-MEC meeting. The first discussion about the joint project took place at PM3, with no specific outcome. The next meeting PM4, largely supported by the project METMAS funded by Norway Grants, brought more concrete ideas related to the call topic "Science Education Outside the Classroom" within the pillar "Science with and for Society" of Horizon 2020. Presentation of this call initiated discussion of *formal*, *non-formal* and *informal education* and possible topics for the joint project. Based on this discussion, the first outline of draft describing basic goals of the intended proposal has been prepared.

However, there was insufficient support for such proposal within the initiative group, perhaps because the ideas were too big and not focused enough. After the meeting in Loughborough (PM5) that did not bring any significant changes in this respect, a survey was launched to map the interests of the initiative group in the list that suggested 18 possible topics. The following three topics attracted most interest:

(1) Look for projects/initiatives/activities promoting mathematics, try to collect data and evaluate the outcomes (10 votes of 12);
(2) Identify, study, and evaluate already existing activities, routines and material elements that are used for mathematics education outside the formal educational systems (8/12);
(3) Consider what are the disadvantaged groups in mathematics education (7/12).

However, the results of the survey were not further discussed. It seemed difficult to fit the group's interests within the Horizon 2020 programme and it became obvious soon that there is too little interest within the initiative group to continue along this way.

The situation changed for better after the Closing conference of EEA and Norway Grants "Czech scholarship programme EEA and Norway Grants (CZ07)" that took place in Prague (PM6). Feedback to the joint presentation of the project PLATSUM by UiA and BUT was very positive, so the coordinator-to-be took the initiative and arranged two meetings (PM7 and PM8) where the future consortium partners were invited to work on the project proposal. One of the most significant outcomes was the change of the focus from Horizon 2020 to Erasmus+ programme. The latter seemed to be a better fit for initiative group's interests. During the meeting PM7 in Kristiansand, the initiative group had the possibility of a helpful online consultation with the Norwegian national agency, SIU (later renamed to DIKU[1] and lately merged with several state agencies into HK-dir,[2] The Norwegian Directorate for Higher Education and Skills).

Another interesting moment was a very useful Skype conversation with Professor Katja Maaß, the founding director of ICSE (International Centre for STEM Education) hosted by the University of Education in Freiburg, Germany, during PM8 in Amsterdam. Professor Maaß successfully coordinated many large-scale European projects fostering innovation in STEM education like PRIMAS, MaSciL, COMPASS,

[1] https://diku.no/
[2] https://hkdir.no/norwegian-directorate-for-higher-education-and-skills

MaSDiV, and her valuable recommendations were useful for the initiative group. The initiative group transformed into the core of the project consortium sometime between PM7 and PM8. We describe the process of shaping of the first proposal in more detail in Section 5.3.

Writing the proposal was a tough work, partly assisted by the engagement of the experienced external consultants hired by UiA. The first proposal was successfully submitted in March 2017. In the end of June, we received a message from SIU that the proposal scored 71 points from 100 possible and was not granted funding. However, the score was quite high, and we were encouraged to resubmit an improved and updated proposal the following year.

To address properly the critique, we first asked SIU for a more detailed feedback and started working on the improvement of the proposal along the lines indicated in the evaluation and further clarifications received from SIU. Unexpectedly, we had to reshape the consortium because one of the key persons in the project left for Australia. To complete the team in one of the IOs, a new partner—BGKU—was invited. Colleagues from BGKU met other partners at PM9 where the proposal has been modified in line with the detailed feedback from the reviewers. The proposal has been resubmitted and our hard work was finally rewarded: this time we scored a total of 82 points and the project was granted funding!

Together with the overall excitement about the success of the application there was an unpleasant surprise: the approved budget was by 5% lower, and no explanation was provided. We asked DIKU for the clarification and learned that apparently no expenditures in the suggested project budget were cut. Checking carefully the submitted proposal, we discovered that the amount asked for was exactly that allocated to the project, which confirmed what DIKU told us. Unfortunately, in the excitement of the last-minute submission of the proposal we did not check the budget details and the funding for some items of the total value of more than 30,000 EURO got lost! That was a very serious issue. However, with a kind help of the Director of the International Office at UiA, we negotiated additional financial support managing to convince the leadership of the Faculty of Engineering and Science and MatRIC to co-fund the project from their resources. What a happy start for the PLATINUM project!

5.3. Choosing the Project's Format and Focus

From the very beginning, it was very clear that the project would focus on the use of innovative approaches to teaching mathematics and on students' learning and understanding. This would have reflected the experience of the educators from seven European countries who were already engaged in the development of mathematics teaching at the university level and were keenly interested in methodologies aimed at students' more efficient learning of mathematics. One important reason for such focus was that the most frequently reasons for joining the project mentioned by the colleagues was related to their interest in becoming better teachers or in improving own teaching. We all genuinely believe that mathematics teaching is interesting, motivating, creative, adaptive to needs, fostering understanding, applicable to the real-world problems around. Teaching mathematics should be supported by the relevant educational experience and resources which many of us were looking for. As our team members recall, they joined the project led by their individual interests in teaching. Several reasons for joining the project mentioned included interest in inquiry-based approaches to teaching, general interest in university mathematics education, and interest in improving own teaching practices.

The initiative group was aware of the fact that despite many successful attempts to shift mathematics instruction from teacher- to student-centred, "a learning paradigm equalling instruction to content delivery, seems to dominate teaching practices in higher education" (Børte et al., 2020, p. 4). Our views on the changes in traditional teaching practice were well aligned with the idea of active learning introduced by Bonwell and Eison (1991, p. 2) as "anything that involves students in doing things and thinking about the things they are doing." In case of mathematics teaching, active learning places more emphasis on the development of students' skills and conceptual understanding; it engages students effectively into higher-order thinking which includes analysis, evaluation, and creation. This is usually achieved through instructional approaches that promote exploration, collaboration, and discussions rather than by passive transfer of new information from instructors (Lee et al., 2018), and this is not a simple task. As one of our team members pointed out "I recognise the complexity of teaching and learning mathematics on the university level from different perspectives. Especially teaching non-mathematician students I see as a big challenge."

From our own practice, we knew about common barriers to instructional change identified in the report of Bonwell and Eison (1991)—the powerful influence of educational tradition, self-perceptions and self-definition of roles, the discomfort and anxiety that change creates, and limited incentives for faculty to change. A recent review paper (Børte et al., 2020) classifies the main difficulties with the engagement of students into active learning as related to (i) leadership and organisation, (ii) teaching competence, (iii) individual training and professional development needs, and (iv) the availability and use of technology all these factors. Those difficulties were experienced by many of us in different combinations to a larger or lesser extent. As a matter of fact, several chapters in Part 3 of this book provide examples of various challenges and difficulties that arose at partner institutions during the implementation of the project.

Partner universities in PLATINUM have different historical and cultural traditions, institutional structures, educational routines, as well as different academic priorities. Educational research suggests several perspectives on how teaching and research at university should be combined distinguishing four main categories: research-led, research-oriented, research-based and research-informed teaching (Griffiths, 2004). Our understanding of research in this chapter is as "an investigative method that teachers can use to make teaching the object of systematic inquiry to improve own teaching practice or teachers can use it in their teaching to promote student active learning" (Børte et al., 2020, p. 3). This is how the PLATINUM project was implemented, firmly based in recent educational research with the scope of improving students' learning, own teaching, and contributing to the advancement of knowledge. For the preparation of the application and successful implementation of the project in the case the external funding were provided, it was necessary, on the one hand, to optimally use the experience of the partners and, on the other hand, to carefully match the interests, ambition and expectation of all individuals and academic institutions they represented. The task was very challenging, and it took almost two years to shape the proposal and finalise the first application for Erasmus+ funding in 2017. Nevertheless, partners-to-be were keenly interested in teaching in general and in gaining new collaborative experience, learning from each other how one can improve own teaching by applying relevant contemporary research-based educational methodologies. This motivation was strong during initial discussions, the whole process of the preparation of the application and during project implementation.

When we came to the choice of the funding framework for the proposal during PM7 (see Section 5.2), it was not a very difficult task. The initial idea to search for

research funding within the Horizon 2020 programme was dismissed since none of the program options really suited our interests. Similarly, possible participation in the Marie Skłodowska-Curie actions did not fit well enough what we had in mind. The core project-to-be team quickly figured out that Erasmus+ was the best fit to the team's interests and the most suitable format for the first collaborative attempt to seek for external funding; this took the initiative group further to the discussions on the goals and context for the project.

After we decided to concentrate the efforts on the preparation of the proposal within the Erasmus+ programme, some time was spent on the analysis of most recent documents of the European Commission and European Council on education. One of the communications from the European Commission (2016) highlighted the quality of teaching as a key factor in improving the quality in higher education indicating that

> greater efforts are needed to invest in the pedagogical training of academic staff, which is an area that has traditionally been less valued than research output. In particular, the status and quality of teaching in higher education needs to be improved. This requires progress in developing, recognising, and rewarding high-quality teaching. In addition, the increasing diversity of the student population makes professional teaching ever more urgent. Teachers need to be well prepared and trained for being able to cater for students with diverse backgrounds, expectations and needs.
> (COM(2016) 941 final, p. 6)

One of the first ideas for a possible project supported also by both authors originated from the presentation *Students in academia are different. Who do we talk to?* by Solve Sæbø, professor of statistics at the Norwegian University of Life Sciences (NMBU), at the MatRIC modelling colloquium in May 2015. The results of an empirical study at NMBU reported at the MatRIC event[3] demonstrated that traditional organisation of teaching at universities with lecturing of large classes in big lecture halls with limited possibilities for collaboration and discussions, rigid curriculum structure and not very flexible assessment methods tend to disfavour students capable of 'out-of-the-box' thinking. Professor Sæbø conjectured that if similar tendencies were confirmed at universities worldwide, academia and society might have benefited much more from the implementation of the adaptive teaching methodologies.

The partners-to-be that attended this talk agreed with the speaker's message that "one size doesn't fit all students." Once again, we focused attention on traditionally disadvantaged categories of learners, this time, on students with various forms of learning difficulties, ranging from mathematical anxiety to visual and hearing impairment. The expectations included students' increased interest in mathematical disciplines, improved performance in mathematics and its applications, and testing of innovative learning techniques and digital solutions to teaching. The idea of a project about learning approaches and teaching styles that would take personality of a student into account looked attractive. It was based on an ongoing joint project between the Brno University of Technology and the University of Agder but did not receive sufficient support. However, the discussion of possible exploration of connections between personality type and mathematics learning left an important trace in the history of the current project which inherited a nice abbreviation PLATINUM. We kept it by rephrasing the working title *Personality, Learning And Teaching IN Undergraduate Mathematics* to *Partnership for Learning And Teaching IN University Mathematics.*

With the unchanged focus on students' more active engagement into mathematics learning and innovative approaches to teaching, the initiative group decided to follow the suggestion of Professor Jaworski to root our developmental activity in a three-layer

[3] `https://bit.ly/38m5PlP`

model of inquiry-based learning and practice with associated pedagogy and didactics and, wherever possible, with the educational research into key questions. The three-layer model had grown from previous developmental research projects at UiA and Loughborough University and was already reported and discussed in research literature (see Chapter2 for more details) as well as at several preparatory meetings, see Section 5.2. Professor Jaworski was motivated to lead a developmental project in which all participants would learn more about inquiry-based teaching and learning in university mathematics by engaging practically in our own institutions, sharing our experiences communally and learning from each other.

The partners agreed that exploring how the three-layer model of inquiry activity can be implemented across different institutions in different countries would fit our developmental needs and experiences. However, it was necessary not only to discuss in depth how well the new idea meets the interests and needs of each partner institution but also how the project should be shaped in line with Erasmus+ criteria and expectations. All partners agreed to share the inquiry-based methodology and contribute to the project development by bringing own expertise and experience in tackling the needs and issues relevant to the project, as well as to work together exploring the differences in the ways of conceptualising learning and teaching from didactic and pedagogic perspectives. We expected that cultural and intellectual diversity of the consortium will provide a rich basis on which project's intellectual outputs will be built. It was very important that Professor Jaworski, the academic leader of the PLATINUM project, and other partners in the initiative group had substantial previous experience with mathematics education research and developmental projects.

From the very beginning, a distinctive feature of the PLATINUM community was its heterogeneity; this, on the one hand, created certain collaboration difficulties rooted in different educational, cultural, epistemological, and professional backgrounds but, on the other hand, it was setting a very rich and promising background for a large scale longitudinal case study. In fact, one of the team members described the team as "a heterogeneous group of people with extensive teaching experience, ready to design material and ponder their teaching techniques." During different stages of preparation and implementation, the project brought together more and less experienced mathematicians and mathematics educators whose primary intention was to reflect on own teaching and improve it on the basis of (assisted) self-analysis and discussions with colleagues. In the very beginning several colleagues were curious what IBME is and how it can be implemented in tertiary education and wanted to become more experienced in inquiry teaching approach. Nevertheless, the idea of inquiry was not completely new to several team members. One of them, for instance, related ideas of IBME to his previous experience matching the inquiry-based teaching and learning with the concept 'badatelsky orientované učení' used by Czech teachers at basic and secondary schools. Ukrainian and Dutch teams were familiar with other approaches to inquiry in science education and acquired relevant experience.

Although from the very beginning the partners were agreeing on many grounding principles, some discussions were emotional and rather heated. The first episode when the partners had quite divergent views on how the project should be shaped regards to the role of technology in the project and related terminology issues. Our Dutch colleagues had extensive experience with the use of technology in teaching related to the need to teach large groups of students and use computer tools for learning mathematics in order to enable support of individual students in large groups. Colleagues at UvA looked forward to the development of an introductory mathematics course for students in biomedical sciences following a blended learning approach, with the online

environment SOWISO[4] for the online learning and teaching. This would have fitted the blended learning policy of the University of Amsterdam and the course development work at the Faculty of Science using an environment or online learning, teaching, and assessing of mathematics in large groups of students.

Although some mathematics educators clearly recognised the important role of technology in the project, they did not initially agree on the use of an unfamiliar term blended learning in the project description. Known already from the late 1990s, the term blended learning "could still be characterised as pre-paradigmatic, searching for generally acknowledged definitions and ways of conducting research and practice" (Hrastinski, 2019, p. 564) and thus might not have been accepted equally well by all team members, especially if blended learning does not become one of the corner stones for the institutional educational policy as at UvA. On the other hand, the 'three-layer model of inquiry-based mathematics education' and the concept of 'critical alignment' were new to most of the Dutch colleagues and opened a new dimension in the conceptual understanding of mathematics and a new perspective on learning communities. Considering that "the breadth of conceptualisations means that essentially all types of education that include some aspect of face-to-face learning and online learning are being described as blended learning in the literature" (Hrastinski, 2019, p. 568), many PLATINUM partners already used it in a variety of formats, perhaps without acknowledging, and this was one of the reasons that the use of the terminology in the project description was acceptable for all in the end. However, as fairly noticed by Hrastinski (ibid), "since blended learning seems to mean many things, it is important that researchers and practitioners carefully describe what blended learning means to them" and use "a more specific, descriptive term as a complement or replacement to blended learning when appropriate." This problem with the terminological ambiguity and epistemological differences was eventually overcome through several rounds of discussions and willingness of all parties to compromise in the end. The agreement was eventually reached and the tensions in the team eased as the parties recognised similarities with the ideas they were familiar with and became prepared to fully embrace the three-layer model, clearly acknowledging an important role of computers in teaching and learning in the second version of the project proposal.

Another issue where the partners' views significantly split was related to the suggestion of the Ukrainian team to develop stronger connections with business and industry through the development of the *university business incubators* (UBIs) similar to the one at the Borys Grinchenko Kyiv University (BGKU). The concept of UBI is widely recognised as a strategy for promoting the development of new research/technology-based companies and is believed to provide a nurturing environment for new business start-ups (Mian, 1996). UBIs positively impact the economy bringing "the non-financial resources of the university's infrastructure extensively in the form of tangible (research equipment and premises), and intangible assets (faculty time, scientific knowledge and contacts)" (Barbero et al., 2012, p. 893). Recently, BGKU decided to make their UBI a part of the educational process for several study programs including mathematics. Colleagues at BGKU wanted to connect the project participants with business structures through the collaboration on the analysis of market needs, design of authentic modelling tasks, organisation of student training at the incubator and formation of entrepreneurial competences. Unfortunately, the idea of developing UBIs at other partner universities during the project did not receive much support as not fitting well the goals of the project. Therefore, it remained in the project on

[4] `https://sowiso.nl/en/`

a smaller scale as a local initiative of the BGKU within the mathematical modelling work package (see Chapter 8).

Looking back to the discussions, we recognise that it was not easy to choose the methodology, describe expected intellectual outputs, and define the core activities in the project. Nevertheless, temporary difficulties were overcome, mainly due to partners' clear initial intention to collaborate on improving own teaching and, respectively, students' learning of mathematics. Although during the development stage there were many different possibilities, very intense and emotional discussions did not affect much the foundational ideas. We are also pleased to acknowledge that despite occasional divergence of opinions and approaches, management troubles and misunderstandings, the members of the PLATINUM consortium were not disappointed during the preparatory work with the application and later on during the implementation of the project. A member of the UvA team says:

> I expected that much of the work in PLATINUM case studies at UvA would be about course design, implementation and evaluation, and about the use of ICT in these processes. The project would provide me and my colleagues with extra food for thought, learning from what partners think and do. This also happened in reality.

Remarkably, every partner institution and every individual were primarily engaged in the activities of their choice and contributed to intellectual outputs sharing own expertise and experience. This led to a wide panorama of interesting deliverables.

Prior to submission, the proposal was shaped to better align with the concern of The European Commission regarding the quality of higher education by improving the quality of teaching in university mathematics. The three priorities in the project were chosen to match the project idea and the experience accumulated by the partners with the current educational needs of the EU.

Our intentions fitted well the initiative of the European Commission (2016) to "improve the interaction between research and teaching ensuring that teaching is based on state-of-the art knowledge and adequately recognised and that graduates have strong analytical and problem-solving skills" (COM(2016) 941 final, p. 7) and the first project's priority "Ensuring education and research are mutually reinforcing, and strengthening the role of institutions in their local and regional environments." The project as a whole was conceived with the goal to promote the inquiry-based approach to teaching and learning of mathematics in higher education through the design and use of inquiry-based tasks. We planned to improve mathematics teaching at partner institutions through a developmental process based on the state-of-the-art research in mathematics education. By informing initially mathematics lecturers about possibilities and challenges of inquiry in teaching and providing the relevant training, we wanted to involve lecturers in local communities into the design of inquiry-oriented tasks and their use in the class with the consequent self-reflections on teaching supported by the feedback from local communities of inquiry at other universities. Our ambition was that the spread of knowledge about inquiry-based learning approach and our good practice would positively influence the education at our universities. We were also willing to contribute to further improvement of professional competence of a wider community of university lecturers and students across Europe.

Matching the second priority "Developing, implementing and testing the effectiveness of approaches to promote creativity, entrepreneurial thinking and skills," our plan was to collect during the project time the evidence from our own practice that the inquiry-based approach to teaching stimulates students' creativity by strengthening their interest and curiosity in learning mathematics and fostering deeper understanding of the importance of mathematics in real-life applications. The reflection of this

ambition is the PLATINUM volume you read right now. With the central role played by mathematics within STEM disciplines, the project also aimed to contribute to the development of entrepreneurial skills through interdisciplinary education approaches including design of authentic mathematical modelling tasks coming from industry, business, public sector.

We planned to contribute to the third priority "Supporting the use of digital technologies to improve pedagogies and assessment methods" by combining partners' expertise in inquiry oriented approaches to mathematics teaching and blended learning including the use of digital tools for active learning and professional development of STEM lecturers in the integration of novel technological and pedagogical tools for effective course design. The empirical research clearly points towards better integration of new technologies in the classroom and corresponding adjustment of teaching practices for a more efficient teaching. Regretfully, the current situation in the area was that "New technologies are adapted to the tradition instead of challenging the tradition. Hence, the *what* being taught in school and higher education is changing, but the *how* of teaching—the pedagogy—is remarkably stable" (Børte et al., 2020, p. 3, emphasis in original). Different aspects of the use of digital technology to improve the pedagogy and assessment in mathematics teaching are discussed throughout this volume.

5.4. PLATINUM Intellectual Outputs and Project Management

For convenient referencing, we list all Intellectual Outputs of the project. Abbreviations for the institutions are included, leading organisation being the first. We refer to relevant intellectual outputs as IO1-IO6.

IO1. Framework for inquiry communities in mathematics teaching and learning through a reflexive developmental methodology: LU, LUH, UCM, UvA.

IO2. Learning about teaching: Case studies for dissemination of community of inquiry developmental practices: LUH, UiA, UvA, MU, LU, UCM, BUT, BGKU.

IO3. Teaching units for student inquiry: UvA, UiA, MU, LUH, LU, UCM, BUT, BGKU.

IO4. Methods and materials for professional development of lecturers: UCM, UiA, LUH, LU, UvA.

IO5. Mathematical modelling teaching resources from real-world problems in business, industry and society: BGKU, UiA, BUT.

IO6. Guidelines and recommendations for quality assessment in Inquiry Based Learning environment: UCM, UiA, UvA, MU, LUH, LU, BGKU.

Already during the final stage of the preparation of the application, partners shared the inquiry-based aims of the project as the conceptual foundation for the project and agreed to bring relevant experience and know-how in tackling various related issues in mathematics and mathematics education. We have chosen the inquiry-based approach to mathematics teaching and learning as the main theme of our project because of its growing record of encouraging developments which foster students' conceptual understanding of mathematics and emphasise the applicable nature of mathematics that is learned. Our goal in the project was to explore both didactic and pedagogic processes and practices blending various methods and resources for the achievement of progress both in the teaching of and in the learning of mathematics. It was expected that the practices involved in the three layers of the model will vary according to the strengths and needs of the participating groups as well as the project

as a whole. The main organisational idea was to share the responsibilities for IOs with most experienced members of the consortium taking the lead and other partners contributing to IOs in various locations. From the very beginning it was clear that all contributions to IOs were intended for partners' use across the project and beyond.

In view of the three chosen priorities and the preferences of the PLATINUM team members, the consortium partners distributed the responsibilities to achieve maximal efficiency and optimise the efforts. For example, in IO1, partner universities worked under the leadership of LU on defining the concepts of the project and inducting members of the project team and their colleagues. This is described in more detail in Chapter 2.

In IO2, LUH led the process of developing inquiry communities of practitioners in seven countries and monitored their developments in practice (see Chapter 3). All partners developed communities of inquiry among lecturers to explore their own practices and identify important issues for future practice. The insider's accounts of the evolution and activities of local communities of inquiry can be found in Part 3 of this book.

Important practical contributions of the PLATINUM project are made in IO3, by UvA. For this output, partners designed inquiry-based mathematical units and tasks that were piloted and tested within the project and prepared for dissemination and use beyond the project (for more details, we refer to Chapter 6). The design of many tasks assumes possibilities of using digital resources for their solution and/or assessment; partners explored how these tasks contribute to the learning and teaching of mathematics and discussed the ways of making tasks available to other partners in the seven countries and beyond. All consortium members were involved in the design of tasks and mathematical units related to specific programmes and needs. In addition, colleagues from the Teiresias Centre at MU focused specifically on the mathematics education of students with special needs or disadvantages, including students with visual and hearing disparity. They shared expertise in particular areas with the Eureka Centre at LU which offered complementing experience relating to certain special needs such as dyslexia and dyscalculia, see Chapter 4. MU and LU verify the accessibility of inquiry-based tasks designed in IO3 and IO5 and provide advice on the adaptation and adjustment of tasks for students with special needs. Furthermore, to assist the listeners with hearing disparity, speech-to-text captions to all presentations were provided by the specialists from the Teiresias Centre during the three PLATINUM webinars organised in spring 2021.

Parallel to the development of local communities of inquiry, UCM, LUH, and UiA were developing in IO4 the "support package" for setting up the professional development programme for lecturers/practitioners interested in establishing their own inquiry-based reflective practice. The three local communities started by piloting in their locations necessary steps to be made both by the consortium members in PLATINUM and by the eventual followers beyond the project. The work included the collection of data from local communities, consequent reflection on data and analysis of developing practices within collaborative groups. The main purpose was to identify important issues in learning and teaching and advance practical advice addressing these issues, see Chapter 7.

In IO5, the PLATINUM consortium pays special attention to real life applications of mathematics. For this reason, in addition to inquiry-based teaching units in IO3, partners at UiA, BGKU and BUT in collaboration with the Swinburne University in Australia, worked in a dedicated package IO5 on the development of tasks and

activities which focus on mathematical modelling, including realistic tasks linked to local communities, businesses, and industry, see Chapter 8.

UCM, LUH, UiA, UvA, LU, and MU worked in IO6 on the provision of guidelines and recommendations for monitoring processes of implementing and advancing IBL and inquiry-oriented learning environments. The purpose of this IO is to ensure the quality of teaching units and materials for professional development of mathematics lecturers developed in the project. We refer to Chapter 9 for more details.

The organisation of the productive work on the deliverables in all six intellectual outputs required efficient management. The general project management and daily management routines were organised as follows. The project as a whole is coordinated by the UiA where the first author, the Project Coordinator (PC) is employed. The second author is employed at BUT and acts a Deputy Project Coordinator (DPC) assisting PC with all managerial issues. The Academic Coordinator (AC) Professor Barbara Jaworski is employed at LU and partly at UiA, which facilitates the management of the intellectual outputs of the project. Each of the partner universities has the Community Leader that coordinates the local activities and takes part in regular biweekly Project Management Leadership Meetings prepared and led by the PC, DPC, and AC. Each of the six IOs has at least one leader from the partner organisation responsible for the deliverable but may also have one or two Deputy Leaders if needed. For some partner institutions, more experienced individuals combine several leadership positions; this, on the one hand, puts more pressure on selected team members, but, on the other hand, facilitates daily management routines. The communication links within the PLATINUM consortium work reasonably well and community members receive the news in a timely manner by email and directly from Community Leaders.

Daily management routines in the project rely to a large extent on regular biweekly online management/leadership meetings which contribute greatly to the successful development of the project. Webex has been used as a communication platform for online meetings during the first two years of the project; we smoothly switched to Zoom afterwards. These meetings serve as a platform for discussion of all important issues related to the functioning of the PLATINUM consortium, organisation of events and continuous work towards the delivery of Intellectual Outputs. However, the most important decisions within the consortium are usually made at the Transnational Project Management Meetings (TPMMs) which, whenever possible, are combined with Learning/Teaching/Training Activities (LTTAs) and Multiplier Events (MEs). By the moment this chapter was written, we had the total of four regular face-to-face meetings running until January 2020. Due to the travel restrictions caused by the Covid-19 pandemics, the TPMM scheduled for May 2020 has been replaced with the first virtual two-days meeting on Zoom; all consecutive events are being currently rescheduled to the online format until the epidemic situation across Europe improves.

After each TPMM, participants were asked to answer a detailed questionnaire about the overall organisation of the meeting and about every particular session or activity. Usually questions were paired, one of a multiple-choice type and another with the open answer. In most cases the first question asked to evaluate the session/activity choosing one of the possible answers. For instance, "To what extent did the session succeed to meet the goals? Very well – Well – Satisfactory – Poorly - Very poorly - Not applicable (in case the respondent did not attend a particular session)." This information provided quick and detailed statistical evaluation of the event with a very high percentage for the first two answers. The second question sounded like "Please explain your answer to the above question and suggest possible improvements (optional)" and served well as a reliable source of criticism and suggestions. The

feedback was initially critically assessed by the PC and DPC and then discussed in the next Project Management Leadership Meeting. In addition to live community discussion in the TPMMs, reflections on the meetings in the questionnaires and feedback were very important for the improvement of the project management. Critical feedback from the participants was especially important at the initial stages of the project; it helped to organise the meetings and associated events more efficiently, especially with respect to the content and time management. In the beginning, many requests were addressing the organisation of discussions, in particular, the need for efficient time management. Participant A: "The small groups were a very good idea. The discussions were inspiring, and we have done a lot of progress. The recap was a repeating of the discussion. This could be more effective." Participant B: "I think we need more time for discussions in future. It happened several times that we started discussing something during the presentation and in the end the next presentation had to be slightly shorter." Participant C: "We managed to answer some of the questions, but not all. Either more time or less questions would fit better. Anyway, the ideas discussed were important for PLATINUM." As a rule, most participants were satisfied with the organisation of the meetings, yet the project coordinators were very attentive to constructive criticism. The reduction of the number of critical comments about the organisation of forthcoming events was clearly signalling the improvements in the project management and the organisation of the events.

The core of the PLATINUM community was composed of mathematicians and mathematics educators many of whom already knew each other, including the colleagues who had previous experience of collaboration in mathematics education research and educational projects. This also had a positive effect through their participation in preparation of the project (see Sections 5.2 and 5.3). However, not all PLATINUM team members and especially new colleagues joining the community during the project were well informed about inquiry based mathematics education. In line with the project proposal, the first three TPMMs were combined with LTTAs where the members of a larger PLATINUM community explored foundations of Inquiry-Based Mathematics Education (IBME); these events were very helpful for the formation of the PLATINUM Community of Inquiry. The feedback from the participants was very positive, as can be seen from the answers to the questionnaire distributed after the third LTTA/TPMM in Brno (see Section 5.5, list of meetings). Participant A: "Our activity in designing tasks and trying them out with students is one manifestation of inquiry in teaching. We need to reflect – to ask: What have I learned from this? What might I do differently?" Participant B: "This gave me the very nice first insight. In further discussions with our national group of inquiry we raised some questions and received answers so the presentation met the goals for sure." Participant C: "Together with an example presented by Paola Iannone it gave me a good insight how the community of inquiry can be created in our university and mainly it doesn't need to be too big in the beginning."

Although the overall project management ran quite smoothly, we faced now and then certain difficulties. They were mostly related to setting the dates for events and online meetings, unfortunate delays with the responses to important letters from AC, PC and DPC, delays with response to the surveys conducted after the joint events, and with the delivery of requested documents and materials, including the preparation of the chapters for this book. Since partners at different universities had different academic calendars and teaching schedules, it has been always difficult to choose the day and time for biweekly project management meetings satisfying the expectations of 8-10 team members. Even minor details were important, as for instance, the time

choice since the PLATINUM consortium works in three different time zones in Europe. Unevenly paced academic calendars at different institutions disturbed a bit the continuity of the workflow for the intellectual outputs because the teaching duties and exam periods were spreading over several months. Consortium partners experienced in the very beginning certain difficulties with the understanding of important budget and financial rules but there were no serious problems with the financial discipline. Orchestrating the work of eight local teams in seven European countries in three time zones was quite challenging, but we are very pleased to acknowledge that this turned out to be a realistic and doable task. It was especially useful to use a 'duet PC-DPC' rather than PC alone, as suggested by Erasmus+ regulations, for the strategic management and coordination of the entire project since the volume of the work to organise and monitor was very large.

With regard to the fulfilment of the work promised in the project proposal, one of the main challenges for the consortium was related to the organisation of the process of collection and submission of the project deliverables. Different partner institutions had different regulations with regard to what data should be collected and where could it be stored and, in particular, one of concerns was about the treatment of personal data that should be protected by the GDPR law. The second challenge regards the project's impact and creation of a global Community of Inquiry with the members outside the partnership. The first multiplier event in Madrid was planned in June 2020 and it became clear during the spring that it won't be realistic to have it because of Corona pandemic. Since then, the dissemination of project results required new formats we were not prepared for in the beginning.

The sequence of virtual events planned for 2021 was aimed at resolving this issue to some extent. By summer 2021, PLATINUM organised three webinars. The first Webinar "Inquiry in University Mathematics Teaching and Learning" took place on March 9, 2021. Founding MatRIC director Professor Simon Goodchild skilfully led the online event whose main goal was to present the PLATINUM team and the main intellectual outputs of the project. An invited keynote address on important aspects of Inquiry-Based Mathematics Education was delivered by the well-known mathematics education researcher Professor Michèle Artigue (Paris Diderot University). The academic leader of the project, Professor Barbara Jaworski (Loughborough University) introduced the inquiry basis of PLATINUM, and the team members outlined all six project's intellectual outputs. In the second part of the webinar five examples of inquiry-based mathematical tasks were presented. Several questions and answers sessions were organised during the event and participants were invited to ask questions and also leave feedback using the PADLET tool.[5] The event concluded with a panel discussion moderated by the MatRIC director Professor Thomas Gjesteland. For the second webinar "Bringing Inquiry into One's Mathematics Classroom" on May 7, 2021, we invited Professor John Mason (Open University, UK) whose important work on inquiry in mathematics is widely acknowledged. The PLATINUM community members Barbara Jaworski and André Heck started the webinar with the Introduction to inquiry-based mathematics tasks and teaching units. Then Professor Mason invited participants to engage in a sequence of challenging tasks designed to stimulate discussion about getting students to explore mathematical ideas. As in the first webinar, former and current MatRIC directors led the webinar and the panel discussion in the end. When this chapter is being written, the PLATINUM team is preparing for the third two-day webinar "Creating Communities of Inquiry: Focus on

[5] https://padlet.com/

Students with Special Needs and On Mathematical Modelling" organised on June 9-10, 2021. The webinar focuses on three main themes: (1) Communities of inquiry formed by university teachers of mathematics; (2) Design of inquiry tasks suitable for university students with special needs; and (3) Inquiry and mathematical modelling. Although online webinars allow to reach the audience from different continents (we had attendees from European countries, Middle East, North and South America, Australia, and Asia), proper organisation of such events is quite demanding and requires a very good coordination of the efforts of all participants and organisers. The first two webinars were hosted by the partners from Masaryk University in Brno and the third one by the partners from Borys Grinchenko Kyiv University. Expert team from Masaryk University helped us to assist the listeners with hearing disparity by providing speech-to-text captions to all presentations during the webinars. The programmes and recordings of all webinars are available on the PLATINUM website.[6]

Unexpectedly, we experienced certain difficulties with the maintenance of the project website and overall tracking of the promotion of the project. Many consortium members were taking part in various national and international events, both educational and research, and were talking about the project or at least mentioning it in formal presentations and informal discussions. Most of these occasions have found their reflection in project materials. However, it would have helped a lot to have one dedicated team member taking care of the dissemination and promotion through the web page and social media and coordinating relevant partners' efforts.

5.5. PLATINUM Community Meetings and Lessons Learned

We summarise now how the consortium evolved after the proposal has been accepted including the information about all physical meetings organised during the project implementation period.

For the purpose of easy referencing, we list all physical project meetings and events that will be referred to as E1-E7 in the text that follows:

E1. Kristiansand, September 2018: TPMM followed by LTTA (co-funded by UiA) – 30 participants.
E2. Madrid, February 2019: TPMM followed by LTTA - 33 participants.
E3. Brno, June 2019: LTTA followed by TPMM - 28 participants
E4. Madrid, November 2019: AC visit to local CoI (funded by MatRIC).
E5. Amsterdam, December 2019: AC visit to local CoI (funded by MatRIC).
E6. Brno, December 2019: AC visit to local CoIs (funded by Erasmus+).
E7. Loughborough, January 2020: TPMM (22 participant + 2 guests).

Although the development of the project consortium and the shaping of the project idea resembled at times a roller-coaster ride (see Sections 5.2 and 5.3), there was something that remained constant all the time: comprehensive understanding of our needs and unfailing support from MatRIC and UiA. This unfailing support was made well visible already during the first kick-off event in Kristiansand (E1) where over thirty participants discussed the three-layer model of inquiry-based mathematics education and intellectual outputs (work packages) of the project and continued through the project implementation period. Discussions related to the fundamental model and IOs continued during the meeting E2 in Madrid. At this event a new important component of the workshop has been introduced: small groups discussions. This modification of the meetings format reflected the feedback received to the survey on the first meeting

[6] https://platinum.uia.no/

E1; small groups discussions also featured in the programme of the next event E3 in Brno.

The three workshops were crucial for the shaping of the PLATINUM community's idea of IBME. They also fostered development of new ideas and deliverables related to IOs. Despite overall success of the workshops, they did not bring opportunities to reveal the nature of the local CoIs, partially because not all PLATINUM CoI members could be present at the events. This was one of the reasons for the AC's visits to local CoIs in the end of 2019 (E4-E6). There were more visits planned for the beginning of 2020, but unfortunately, they could not be realised due to the unexpected COVID-19 outbreak.

Having at that time no idea about what would happen only a few weeks later, most of the PLATINUM CoI members participated in the last physical meeting in Loughborough (E7). Again, a new component has been introduced at this meeting: invited speakers external to the PLATINUM CoI. This new element was evaluated rather positively, but it also brought challenging questions: How could the PLATINUM CoI look like in the future? How could collaboration with the colleagues outside the project consortium be arranged? These questions still remain open, and we have no clear answer or recommendations yet.

There is no doubt that the epidemic outbreak affected the PLATINUM community and had significant impact on the future developments in the project. We continued to meet online with the same regular frequency, but the face-to-face meetings planned in the project proposal could not be arranged. This reduced possibility of direct interaction between the CoI members had unexpected consequences. The need for more interaction within the partnership community resulted in the organisation of a two-day virtual event in May 2020 replacing the physical meeting planned to be held in Hannover during the same period. This became first PLATINUM virtual event arranged on Zoom; it was attended by almost 30 participants from the 8 partner universities. The pandemics also brought changes to the management routine. Unlike previous year, the regular online meetings continued during the summer. This seemed to be a good practice as the community members kept working on the deliverables, in particular on this PLATINUM publication. All of this we see as a confirmation of the success of the project.

Intensive work on the PLATINUM book, which started in spring 2020, also had significant impact on the community. First, there was a need to decide on the editorial board of the book. That provided an opportunity for the inclusion of a few less experienced community members who could learn more about the editorial work from more experienced colleagues. Another positive effect of the PLATINUM book preparation is related to the formation of cross-disciplinary trans-institutional teams that worked on the book chapters featuring project's deliverables and the functioning of the local CoIs. Again, we see this as a big success of the project.

Another activity that influenced the PLATINUM CoI development was the organisation of the PLATINUM webinars. Three webinars have been organised before submission of this chapter:

(1) March 9, 2021: "Inquiry in University Mathematics Teaching and Learning" hosted by MU – 193 registered participants.
(2) May 7, 2021: "Bringing Inquiry into One's Mathematics Classroom" hosted by MU – 90 registered participants.
(3) June 9-10, 2021: "Creating Communities of Inquiry: Focus on Students with Special Needs and on Mathematical Modelling" hosted by BGKU – 111 registered participants.

The success of these events was ensured by the presentations of the PLATINUM consortium members in combination with keynote addresses of invited speakers external to the PLATINUM consortium. Webinars brought another dimension into the PLATINUM CoI: Interaction with the events' participants. They also had a positive effect similar to the PLATINUM book preparation in formation of yet another cross-disciplinary trans-institutional teams that worked on the events' arrangement.

We conclude this section summarising the lessons learned from the development of the PLATINUM project and consortium.

Lesson No. 1. It is important to pay attention to the interests of people involved in the preparation and implementation of the project. When someone suggests what might be done in the project, this may very often indicate explicitly what the person is interested to do or intends to do within the project. The PLATINUM experience shows that many team members prefer to do in the project what they intended to do before the project started (see the results of the survey conducted in 2020 in Section 5.2), at least in the beginning. It is good that the local project activities match as much as possible with the local needs and expectations of the participating universities because this will support the implementation of the project results into the teaching practice and enable the sustainability of the project results at partner institutions.

Lesson No. 2. It is good to have a back-up plan for the case when any of the key persons unexpectedly leaves the consortium for any reason (see the final part of Section 5.2). The same applies on a smaller scale to local communities of inquiry.

Lesson No. 3. It is wise to prepare the proposal on time and double/triple check the budget before submitting (compare with the last paragraph in Section 5.2). Nowadays, Erasmus+ proposals are submitted through an online platform—a website maintained by European Commission. It is recommended to submit the proposal and check the details afterwards. If there is anything to modify, correct or improve, do it and resubmit before the deadline because the last successful submission is the one that will be evaluated.

Lesson No. 4. It is important to keep the management effort reasonably balanced to steer the project efficiently. If the project management is too active and authoritative, much less space is left for the initiative of other consortium members. On the other hand, inactive management leads to reduced activity at the project level and delays in the project implementation might occur (see the final part of Section 5.4). It is reasonable to steer the project with the management effort placed somewhere in the middle between doing almost nothing and nearly everything. The initiative of the team members should be always encouraged and supported with the management monitoring the workflow in the background. The authors adopted the following strategy for taking important managerial decisions: first the opinions of the team members are sought. They are discussed in the meetings or through the email correspondence and then the decisions are made by the project leadership.

Lesson No. 5. There is a persistent risk of delays. Usually, this issue is considered in the Risk Management Plan submitted with the proposal. Even though people tend to neglect this issue ("we plan well and there will be no risks of delay"), it is necessary to take delays into account. There are always people who respond with a certain delay, and there always are people who deliver with a delay. If something is needed from the partners, it is better to ask them well in advance and remind them regularly (compare with the final part of Section 5.4).

Lesson No. 6. If a message is sent to the community and a response is expected from the community members, it is necessary to set a fixed deadline (see the final part of Section 5.4). Statements like "please respond at your earliest convenience" should always be combined with "but no later than ..."

Lesson No. 7. It is good to arrange the system of "emergency communication" (SMS, a messenger app). It can be used in situations when a response is needed urgently, and people do not have immediate access to e-mails or cannot promptly process large documents (compare to the experience with running webinars in Section 5.4).

Lesson No. 8. It is challenging to schedule regular online meetings for large groups of people (see the final part of Section 5.4). The larger is the group, the more difficult it is to find the time slot when everybody is available. On top of all that, it is very likely that regular meetings need to be re-scheduled every semester/term. Polling services like DOODLE are helpful in arranging regular meetings. However, the general advice/solution could be: run the project with a smaller consortium, if possible.

Lesson No. 9. Sometimes, financial rules and regulations of the funding programmes have certain peculiarities. However, we need to deal with it. It is a big advantage to have someone in the team who is skilled in accounting and financial issues and can support other partners when necessary. This helps to maintain the financial discipline (compare with the final part of Section 5.4).

Lesson No. 10. All people have their working habits. This also applies to the work with digital technology. It is good to know in advance how are the project participants used to work with digital tools. Based on that knowledge it is easier to predict or design the means for collecting and storing project documents and deliverables (see the final part of Section 5.4).

Lesson No. 11. It is a big advantage to have someone in the team who is sufficiently knowledgeable and particularly enthusiastic about the topic of the project and also well skilled in social media, communication, and public relations (here we refer to the last paragraph in Section 5.4).

Lesson No. 12. The idea of building the global community is a big thing. The implementation of this idea might be challenging (we refer to the open questions introduced in Section 5.5). Even if there is a plan of how to achieve this goal, circumstances can change, and the plan becomes no longer realistic. Fortunately, the internet opens a new universe of possibilities for reaching out to people and building networks or communities. Organising virtual events might be one of the possibilities, but there are many more: discussion forums, hackathons, etc. It is necessary to use the imagination and creativity, two very important human attributes, then only the sky is the limit!

5.6. Reflection About Collaboration Between Mathematicians and Mathematics Educators

We acknowledge that the "lessons learned" in Section 5.5 are rather general and may be applied to many groups of people and many projects. So, what is special about the collaboration between mathematicians and mathematics educators in the PLATINUM project and what have we learned from it?

The first lesson we learned is that the collaboration between mathematicians and mathematics educators is fruitful, though it takes a lot of time and effort. As described in Sections 5.2 and 5.3, it took us three years to arrive from the very first idea of a kind of collaboration to the start of the project. To date, we have almost three years of collaboration developing together common understanding of IBME principles, designing own teaching and learning resources in line with the main principles of

IBME, reading and writing about local CoIs, disseminating project's ideas, promoting intellectual outputs, and organising online events (see Sections 5.4 and 5.5). However, we acknowledge that the outcomes described in this book are worth all the effort and fully agree with Professor Barbara Jaworski, who stressed after the third PLATINUM webinar that "we need more collaboration between mathematicians and mathematics educators."

Another observation is related to the question "How to bring such a collaboration into life?" PLATINUM experience suggests that the key word for the start and realisation of a collaboration could be the development. Even though this term might be perceived differently by the team members, it encompasses sufficiently well the interests of both mathematics educators and mathematicians. In our experience, developmental educational project blended harmonically the research experience and interests of mathematics educators with the teaching experience of mathematicians and their interest in the improvement of own teaching and students' learning. There might be other possible points of common interest, but this one—development—worked for PLATINUM.

We learned a lot in the project, and we are grateful for this opportunity. It has been a great experience and a pleasure to be part of the PLATINUM Community of Inquiry. We hope very much that the book produced by the team will provide the reader with useful information and many valuable ideas.

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