Understanding PARRISE: Innovation and Change processes in a collaborative European Project

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INTRODUCTION

The PARRISE project (Promoting Attainment of Responsible Research and Innovation in Science Education: http://www.parrise.eu/) is a European Union (EU) initiative aiming to develop approaches to science teacher education based on a Socio-Scientific Inquiry Based Learning (SSIBL) framework (See Figure 1) that amalgamates and extends Socio-Scientific Issues (SSI), Inquiry Based Science Education (IBSE) and Citizenship Education pillars to promote responsible research and innovation in education settings. For many years, and across a number of EU projects, inquiry has been advocated and supported at curriculum level but with varied success in influencing classroom practice. Similarly, socio-scientific contexts have been long advocated as ways of engaging students in reasoning about the personal and public issues, concerning for instance sustainability and health, that they will encounter as scientifically literate citizens. In recent years there has been a focus in Europe on citizenship and socially responsible research (https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation). Thus the PARRISE project represents the intersection of a number of key innovation themes in science education, for Europe and globally. This report relates to an interview study of the experience and perceptions of key players in PARRISE, focusing on the underlying framework, on project processes, and on activities and outcomes.

The development of the SSIBL framework has been largely the responsibility of Dr. Ralph Levinson, from University College, London Institute of Education, who has a strong background in research around 'post-normal' perspectives on science education, including links between socio-scientific issues and citizenship education. The first developed draft presented a framework that included explication of the rationale for SSIBL, the nature of exemplar activities, criteria for successful implementation for teachers and students, and of possible pathways to developing SSIBL Teacher Professional Development (TPD). The document provided a focus for ongoing discussion and refinement over the three years of project meetings, and an updated version was developed following the meeting of the consortium in Toulouse in May 2017 (See Figure 1). This version was able to draw on the experience of partners over the project. A key feature of PARRISE, therefore, was the existence of

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an innovative and challenging theoretical underpinning, that was not settled from the outset but was subject to refinement through the collaborative efforts of all partners.
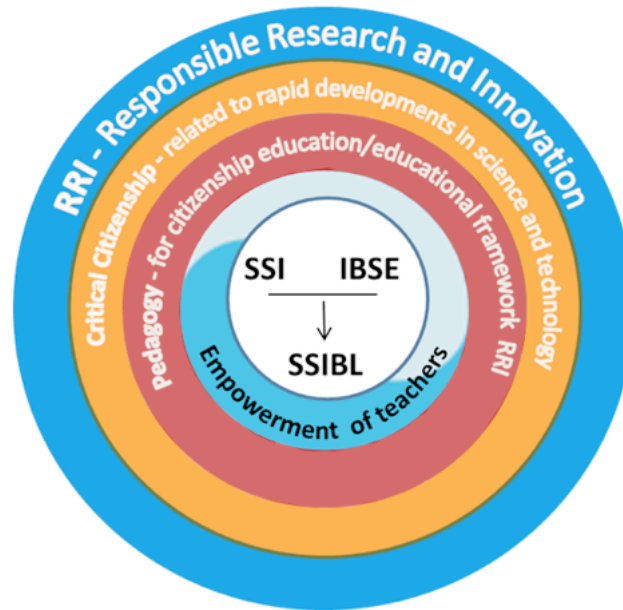

Figure 1: The Socio-Scientific Inquiry-Based Learning (SSBL) framework

The PARRISE project poses significant challenges to traditions in science education, combining a number of strands of theoretical and epistemological advocacy — responsible research, inquiry, socio-scientific inquiry informed by post normal science, and citizenship education — each of which calls for significant change in teacher beliefs and practices. The 18 partners across 11 European countries represent a diverse and developing response to the project purposes. Analysis of plenary reports during the program of joint meetings of partners in the PARRISE project, supported by informal observation of the discussion over three years of these meetings, have shown clear evidence of significant change in Teacher Professional Development (TPD) practices over two years, and in the growth of shared understanding of the core principles underpinning PARRISE. However, it is also clear that partners appropriate the SSIBL framework in ways that reflect their countries' curriculum practices and traditions, their TPD structures, and their epistemological beliefs concerning research practices, and the nature and status of science and scientific knowledge. This circumstance reflects the diversity of European traditions.

The PARRISE project is one of a number of European collaborative projects in Science Education that focus on teacher education and curriculum reform, based on inquiry perspectives. It is representative of EU collaborative projects more widely. Thus, a study of the processes through which partners from varying educational traditions and contexts across Europe negotiate meanings and share processes of educational innovation is potentially of interest more generally in informing processes of systemic reform in member countries. The study therefore pays particular attention to partners' responses to the communication mechanisms and program structures, to the way meanings are conscripted within the different contexts, and the ways in which shared meanings can be and are established.

The current study aimed to examine the processes by which the SSIBL pedagogy framework was conscripted by the different partner teams for their purposes, and the nature of the communal negotiation and individual pathways to understanding during

the project development. These cases are seen as illustrative of change processes attendant on European innovation projects and will provide fresh insights both into the broader European union project, and the way that innovation intersects with different education and epistemological histories and beliefs. The research questions are:

1. What is the nature of variety of interpretations of SSIBL and practices in TPD that have arisen during the PARRISE project?

2. In what ways has the SSIBL framework been interpreted and appropriated by the different national projects to serve valuable purposes?

3. What have been the differences in context, the local factors, and the shared processes in the PARRISE community, that have influenced the pathways of change?

4. To what extent has variation in interpretation and practice been a generative, or a constraining feature of the PARRISE project?

We believe that understanding the nature of differences in perspectives, beliefs, and practices opens the possibility of better understanding the challenges and possibilities of cross-European collaboration generally. It can also shed light on how best to perceive the nature and role of the SSIBL framework, and on possibilities for sustainability options under different circumstances. We anticipate this report will be useful in informing the final PARRISE report. A preliminary version of the report was presented at the May 2017 PARRISE meeting in Toulouse, and notes were taken of the discussion.

RESEARCH DESIGN

The research utilises a phenomenological methodology, exploring participants' perceptions of the nature of the change process and of the meaning attached to the SSIBL pedagogy within individual contexts. The data for the study were generated through interviews with partners from a sample of countries involved in PARRISE. Invitations to take part in the project were sent to leaders of all the country teams who then themselves volunteered or identified another member to agree to be interviewed. Interviews were conducted with representatives of 10 participant groups, from 10 different countries. The interviews were semi-structured, with follow up questions probing particular lines of inquiry that were opened up. Each interview took 30-60 minutes. The interview questions are listed in Appendix 1. The interviewees also included members of the management team and the lead author of the SSIBL framework. Questions of the management team related to key successes, challenges, and perspectives on diversity of response across the consortium, and on change. Questions of the SSIBL framework author focused on the background and context of the framework, its role in PARRISE, and the ongoing processes of refinement.

The interviews were conducted using the Zoom conferencing online platform which has a recording facility. The interviews were conducted in English. Interview recordings were then transcribed. Each transcript was sent to the interviewee for member checking and commentary. Ethics permission was obtained through Deakin University, and included a commitment to anonymity in the reporting. Quotes from the interviews that are used in reporting have been tidied up to remove pauses and

asides, and to represent clear English usage. All quotes are from interviews with the PARRISE partners.

The transcripts were analysed by the two Deakin researchers, together with a research assistant, to identify preliminary themes that related to the research questions. These themes represented all the interview data. These themes were then refined in an all-day workshop prior to the Toulouse meeting involving the researchers and members of the PARRISE External Advisory Board, and the analysis further refined during that meeting. This produced some 'meta-themes' that drew on knowledge of the context of European projects, and on the research literature in science education, to articulate key features of the experience of the participant groups that relate to the context of change in curriculum and pedagogy, and communication within cross national processes. These meta-themes are reported on in the discussion section.

FINDINGS

Perspectives of the PARRISE management team

The management team from Utrecht were able to comment on the genesis of the project, and provided some valuable insights into the intentions and underpinning features of PARRISE, and their perspectives on the process over time. The project had been reviewed at the end of the second year and been given a very strong endorsement by the review panel appointed by the European Commission concerning its achievements. The interview touched on a number of themes (presented below) which became important in informing the subsequent analysis.

The focus on pedagogy: A central feature of PARRISE has been the focus on pedagogy as the core of the innovation, rather than on resource development around content, as defining 'good practice'. This distinguishes PARRISE from many other projects.

The iteration between theory and practice: A major strengths of PARRISE was identified as the open nature of SSIBL, where the experience of partners fed back into refinement of the framework, allowing flexibility of interpretation and development according to local context. The lack of specificity of processes from the start, while challenging and even initially troubling for some partners, has enriched the project and supported growth in understanding of how best to develop SSIBL TPD.

> *So, other projects can learn from us that (you shouldn't) be too afraid of designing a project which changes and in which you have to think about 'what steps should we take now'. Of course, there should be a core structure that stays fixed. But there is no need to specify everything from the start.*

The importance of contextual experience across the consortium: Gradually partners have moved beyond considering the three SSIBL pillars (Socioscientific Issues SSI, Inquiry Based Science Education IBSE, and Citizenship Education) separately and seen the unity in the framework in focusing attention on societal contexts of the subject, with Responsible Research and Innovation (RRI) as an overarching construct. The third consortium meeting, in Vienna (2016), marked a step up in partners' shared understandings: *"I saw the change in Vienna that people had a grip on it and were able to give their concrete views about what it was and how they tried to implement that"*. Partners were able to bring to the discussion their concrete experiences of the nature and process of TPD. They realised more and more that they were on the same

track. There remain differences between what different partners emphasise in the framework and in their practice, but views about difference have matured.

Curriculum and sustainability: Some partners have been successful in promoting the approach with other universities, and sometimes have influenced national curricula. Partners more and more are looking for this curriculum integration as important for sustainability of the PARRISE approach.

The SSIBL framework

The perspectives of the main architect of the SSIBL framework provided insights into the genesis of SSIBL, the challenges, and into the strength of variety in forging new understandings of how such an approach can work. A positive view was expressed about the role of the project processes in providing an atmosphere where dialogue could lead to substantive change.

The core nature of the SSIBL framework: The genesis of the SSIBL framework stems from a desire to "*take what has been a conventional role of scientific inquiry and to see how you can make something which has a much broader significance*" – to provide room for consideration of social questions, and move beyond empiricist notions of inquiry. The challenge in developing the framework was to bring the three pillars, and RRI, together in a way that was meaningful.

Responsible research and innovation (RRI), leading to action: There was a desire to move beyond 'socio-scientific issues' to take up the broader European conception of social responsibility encapsulated in RRI. This is particularly expressed through the emphasis on action, going beyond understanding and reasoning. In one of the partner countries for instance there are real possibilities because in the curriculum "*there is obviously a real commitment to interdisciplinary work and getting kids involved in environmental projects*", whereas in other countries the curriculum is much more rigid.

Change over the project: Partners who were initially conservative in their views have subsequently been quite open and developed to do interesting things. The leadership "*have provided an atmosphere where people can genuinely talk about problems without feeling unduly defensive about things.*" The diversity of contexts has helped move ideas about the SSIBL framework forward …

> *There've been quite interesting synthesis or synergies between different countries, different ideas. People are prepared to talk about the problems, now I think that has been extraordinarily impressive ... it's really got people with very different ideas talking to each other in a way that probably wouldn't be possible in another forum.*

The themes emerging from participant interviews

The interviews illuminate change processes within PARRISE, and potentially provide fresh insights both into the broader European union project, and the way that innovation intersects with different education and epistemological histories and beliefs. The themes are:

- The structure of TPD initiatives;
- The nature of exemplary activities;
- Key changes to practice;

- Responses to the SSIBL framework; and

- Experiences of communication and collaboration.

The structure of TPD initiatives

A major theme in the interviews concerning the structure of the PARRISE initiatives is that of fitting SSIBL approaches within existing structures, particularly those concerning time. Partners focused exclusively on pre-service or in-service TPD, although some were involved in both. The issues for each were distinct.

For partners who did not customarily run in-service TPD, exploration of SSIBL within the pre-service courses was the path taken. The main challenge for these was fitting it into the existing curriculum.

> *We have the chance to introduce SSIBL activities within different subjects in the graduate or post-graduate course. In order to be able to do so, you have also to identify what kind of content within the graduate course or the post-graduate program can be aligned with a SSIBL model.*

For one partner this was done through a SSIBL day with the option of an action research project on SSIBL. For another partner, there was a problem with convincing colleagues to incorporate SSIBL activities, and they had more success in convincing other universities to innovate, through their links into a national network of teacher educators. Thus, apart from structural issues, teacher educator beliefs were a challenge.

For incorporating SSIBL into in-service TPD, there were a range of challenges described, and approaches to deal with these. A number of partners found recruitment of teachers difficult. In some cases, teachers were resistant to spend time on approaches that were not directly applicable to the curriculum, given its overcrowded nature and their own lack of time. One partner however was optimistic that changes in the science curriculum were heading in a direction that would open up opportunities for the SSIBL approach. For another partner, accreditation of the TPD was an issue. In at least three cases, a solution to recruiting and promoting SSIBL was to work through science centres, or teacher education centres with a special relation with teachers. Such strategic partnerships were a feature of many of the partners' strategies to promote the approach.

For others, the issue is epistemological, involving a belief that inquiry approaches do not generally, or at least efficiently, lead to robust scientific knowledge, and that the SSIBL approach would de-emphasise this focus on scientific knowledge.

> *We have at least had good discussions with the teachers that are involved in in-service courses and it is still a challenge to convince them to spend time with more open ended SSIBL activities. Because many think that you need to give the students all the science knowledge before you can go into dealing with it. But we have started to make some impact and made some changes to the courses.*

A related issue was teachers' commitment to laboratory work and the feeling that taking time from experimentation was a move in the wrong direction.

One interviewee articulated clearly the stages of resistance of teachers that they had to overcome. These were:

1. A resistance to including non-objective knowledge into the science curriculum: "*Once we started to talk about atomic energy, nuclear energy,*

some of the TPD participants said, "Oh, are you talking politics? It is simply not appropriate at this university. ...We are scientists that try to be impartial". So we said no, we are citizens, actually, and some of us even live close to the nuclear power plant that is about to be using a system ... that has not yet been verified in other establishments".

2. In a crowded curriculum, there was no time to be taken if the standard of knowledge is not to be diluted. "*So then we had to look at the different schools and the different school culture. Whether they have projects. Whether they have science center visits, and informal learning opportunities at the same time. And yes, fortunately, some of the teachers could be channeled into this culture of after school learning, and could realise projects and not hurt the interests of physics education.*"

3. The "personality" issue: Some teachers were not drawn to discussing issues that had no clear resolution, but were committed to describing what they considered as truths. "*We used a lot of lunchtime in the TPD courses and after TPD beer drinking sessions, convincing teachers to integrate in their personality doubt and ambiguous statements and discussions*".

A number of partners had worked closely with teachers through a type of design research cycle, learning to refine SSIBL activities to local contexts and teachers' growing experience.

We are pretty convinced of the importance of if you really want to impact teaching practices, you have to really connect to the real classroom and you have to give teachers the opportunity to try things out in their classroom and then reflect back and share the experience with other colleagues. So, we managed to offer four to five different sessions along two months, and with time between different sessions so teachers can take a SSIBL activity, implement it into their classroom, videotape themselves and then come back and share the experience and discuss it with the rest of the colleagues. I think this is a really powerful approach. This way of working with teachers, we cannot transfer this model into the preservice teacher model, because we don't have the opportunity to connect with the classroom in this way.

Another interviewee talked about the need to adjust the TPD to teacher pre-conceptions.

We wanted to see what they know about RRI and the different components of the SSIBL framework, and then design our activities based on their needs ... Then other practices that we are carrying over from past activities is that we engage teachers with and co-design activities. So it's not just about informing but it's also about engaging them in how to put what they have been learning in practice.

The nature of exemplary activities

A number of common themes arose relating to the nature of exemplary SSIBL activities, and TPD approaches that could support teachers to understand and implement SSIBL. A key idea was that of the need for a focus on action:

Having an end product and then taking action on something, is what differentiates a SSIBL lesson from an inquiry lesson or a science lesson.

There was an acknowledgement that the core of SSIBL was taking SSI approaches, and IBL approaches, and amalgamating these in a way that produced something greater than the sum of the parts. One partner, after describing projects where teachers

worked on possible solutions to locally relevant issues, such as reported relations between recycled water treatment and heart disease, or of the effect of pollution on fishing, talked about the relations within the SSIBL model:

> *I think what was really useful was the circle with the SSI with IBL it is kind of the SSIBL approach ... the IBL was very familiar for me, the SSI was familiar on the other side, but the combination of them was new to me and it was important.*

A further point made was the need, in working with teachers on SSIBL, to address both their beliefs about core issues of teaching and learning, and the alignment of the activities with the local curriculum.

> *If one of the main beliefs is that students are not motivated for science, we try and discuss with them why, what could be the reasons, and then maybe discuss with them in which way the SSIBL model could really support them to address these problems ... We try to make explicit connections with their beliefs, we try to make specific connections with the science education curriculum.*

An ongoing debate within the project was whether TPD should begin with an exposition of the SSIBL framework or with activities that exemplified the approach, and later examine the principles underpinning these. Most partners combined these approaches with some back and forth between the two. However, it was clear that partners who could talk of a developmental sequence in their TPD design were clear about the need to feed in examples of classroom practice, and engage with teacher beliefs and concerns.

> *I think the strength has been sharing our own experiences of the different teaching examples and the responses of our teachers and teacher students ... having to really think harder about our own experiences and sharing our own experiences. I have learnt and realised that it is important to find ways to challenge the teacher's beliefs and working with them so that they are also have the possibility to see the effects of different teaching traditions. So, bringing in, for example, excerpts from classrooms that have been working on it and having teachers analyse it and look at how you can understand what is going on in the student's discussion.*

Another partner was explicit about the development of their TPD, from focussing on illustrative activities to teacher designing their own activities.

> *Instead of just presenting them the key features of the SSIBL model in a theoretical way and lecturing them about how wonderful our science education model is, we introduce them in a SSIBL scenario and ask them to explore it, discuss it, inquire about it and look for a solution. After that, we ask them to reflect on the educational potential of going through all these processes and try and identify the kind of contents and competencies that they are using when trying to solve the SSIBL activities.*

The next phase involved having teachers design their own activities according to context.

> *One of the teaching skills that we have struggled with and I think it has made us evolve our teacher professional development model is a skill related to designing SSIBL classroom activities, because the first time we implemented our teacher professional development, we don't pay attention to designing activities, we just gave concrete examples and asked teachers to work on them. Of course, we offer then the opportunity to design their own, but I think that in a group of 20 in service teachers, just one designed his own SSIBL activity for his classroom, so we thought that maybe promoting designing skills could be a really interesting thing, because you don't always have 'ready to be used classroom activity materials'.*

The results, measured against a set of 'quality criteria' they had developed, were disappointing. However, in the next, third iteration teachers worked collaboratively with the criteria leading to impressive outcomes.

> *...we gave the criteria in advance, and after their first design, we asked them to revise their own design according to the criteria again and try to improve it. We used self-evaluation and peer evaluation for improving the designs of the SSIBL activities that the teachers made themselves. This last time, they produced an amazing set of really good SSIBL activities according to the criteria we drew from the SSIBL framework.*

In fact, over the course of the project, there has been growing recognition of the need to produce clear criteria for SSIBL activities to guide teachers, and guide the design and conduct of TPD. This attention to design principles took various forms in different partners' practice. For the two French partners, for instance, the 'démarche d'enquête' was important as an investigative framework, separate from SSIBL, that was used to guide design of SSIBL activities. For another partner, there was an explicit movement in the TPD from discussion of the underpinning ideas, to engaging teachers as learners to work through SSIBL activities, then gradually to have them think about their own context, and work in small groups to redesign, or add to these activities or design new activities.

> *And I think that they learn a lot during this process as well because it's a different thing hearing or acting as students and someone else designing for them, (compared to) if you try to design something for your own students that you are expected to enact.*

Key changes to practice

Many of the changes partners talked about related to improvements in the way they ran their TPD initiatives, and better understood the essence of SSIBL. Partners started at different points so it is difficult to describe a simple change trajectory. In some countries, TPD practices have included IBL and SSI for some time.

The most common change described was one from a focus on scientific inquiry structured around scientific ideas and laboratory based evidence, to one where a socio-scientific issue or question drove investigation, often over a longer sequence.

> *So for instance, we had a project on DNA and it was all about letting teachers and children know what DNA is and how it works, and then for the PARRISE project we took DNA as an example project. For them, we said, okay, DNA, you have to know what it is first, sure, but then also we thought about if you can get the DNA and you can use it, for instance, to find murderers and they come to you and they ask you, "Do you want to give your DNA to us so we can look for maybe in your family for a possible murderer, do you want to give your DNA?"*

> *And we thought of different controversies also. If you can check in your DNA whether you are a sports type, that you can better focus on endurance sports or maybe more fitness, would you want to know that? ... We created scenarios around that topic.*

There was a recognition with some interviewees of the paradigm change implied by the SSIBL framework, which had significant implications for pedagogy, moving away from lectures and laboratories to pedagogies and settings designed to promote critically informed citizens.

> *This very different approach with very different learning outcomes requires a very different educational model. We have to somehow transfer this model to the way we work with teachers also, because the way we work with teachers from our point of view*

has to be consistent with the kind of science education model we want them to up take and take into their classrooms.

A number of the interviewees talked about change in understandings across the consortium more generally, over time. They described:

- A growing understanding of how the pillars interrelate in practice; and

- Growing confidence with the nature of SSIBL activities.

We evolved quite a bit. And then the first meetings people were really really concerned whether or not they would be able to understand what they were talking about and what actually each of the four dimensions meant to one another. But now I feel that the questions are more fine-tuned, the issues that we raised.

We have all been better at including more of the aspects of it but are doing it with different tools or different examples or different ways of running the workshops.

These reflect growing understanding of the variety of practices and activities that exemplify the SSIBL framework, that allow discussion to be more grounded in TPD and school activity.

Finally, there were changes in the interactions that participants had, as a result of PARRISE. In some cases, alliances were made with members of the consortium. In a number of cases partners had formed alliances with teacher education centres or science centres, or members of other faculties, to develop approaches.

A thing that we learned from PARRISE is that it is urgent for us here in (country) to establish teacher training networks, at least teacher networks.

There was a clear impression from the interviews that being part of PARRISE had widened the perspectives of individuals, through interacting with a diverse set of people and ideas, and contexts.

I could see that there were other partners in the consortium who interpreted some features in a very different way from mine, and the exchange of perspectives and ideas and conversations have really had an influence on my view also, and I could see that my view had evolved throughout the time of the project. I think it is always enriching, because you have the opportunity to look at things from different perspectives and to connect these different ways of looking at things with concrete examples from different people.

Interpretations of and responses to the SSIBL framework

Underlying partners' views of the nature of the SSIBL framework was the presumption that it was, during the project, evolving. There was a tension between the need for clear prescriptions of what SSIBL should look like within a TPD course and within schools, and an acknowledgement that the role of PARRISE was to explore and refine the framework. Some interviewees were explicit about the strength of contextual variation in interpretations of the model.

So, if we have a model that can be really useful in different contexts and can be enacted in very different ways, that tells me it's a powerful model. In this way, I think that because of the way the project has been designed, it gives room for a lot of freedom and flexibility and it came out as a strength. On the other side, maybe this flexibility sometimes has drawbacks. For instance, if we think of evaluation, we didn't agree on a common framework for evaluating from the beginning.

A key challenge for interpreting the framework was to better understand how the SSI and IBL could be integrated in practice, and secondly how RRI was positioned in the framework. Over the project there were changes in perceptions of the role of RRI, which varied from regarding it as an overarching theme sitting in the background, to a growing realisation that it potentially had significance as a further pillar.

The following quotes present four different perspectives.

We also tended to emphasise the use of experiments when implementing IBSE, but this idea has evolved along the SSIBL project, because we have had the opportunity to become familiar with socio-scientific issues and citizenship education. So now our idea of inquiry is closely connected to other features such as socio-scientific issues and citizenship education ... maybe as a result of the exchange of experiences with other partners within the project, long conversations on multiple occasions, then I have started to look at RRI as a key component of our science education model. It's not just an outside objective of our society, but it could even become a key feature, a kind of pillar within our SSIBL framework.

If I had to identify what kind of key features in our model could be directly related to responsible research and innovation, I would say that taking into account different perspectives could be one. Really appreciating democratic deliberation could be another one. The idea of a sharing ideas, debating, discussing and looking for consensus on an appropriate decision of a group – by the way, contrasting views, different views could be another one. Taking action could be another one

We've been focusing on societal issues for a long time now, combined with inquiry-based learning because we feel that those topics actually make things more relevant to the students. And the other part that's really differentiating us in the SSIBL framework from other people's and other RRI project's approach, this emphasis on more active citizenship as the outcome of this engagement with the material. So we want students to take action which can be demonstrated in many different ways.

We don't explicitly address (RRI). ... I think we're still trying to figure it out how that's part of the project ... Maybe a good way into this is thinking about consumer risk because it's all about how products have been created and it's the decisions we make in relation to the stuff we consume that might have been produced in a responsible and ethical way basically. So the science behind the stuff we're using, the products that we're using, have been created based on this idea of RRI.

There was a general view that partners had achieved a reasonably consistent view of the framework but that there was contextual variation in how it should or could be applied. There was general agreement that over the life of the project, partners were able to come to a more consistent view of how to apply the framework in practice.

And I think, I find it hard to explain why, but I really have the impression that through in the meeting in Vienna, just by having the time to talk to each other a lot, hearing the needs, I think that we're on the same track.

It is not so much that it has changed our understanding of what is included in the framework I would say. We have all been better at including more of the aspects of it but with are doing it with different tools or different examples or different ways of running the workshops.

However, there was acknowledgement that if one scratched the surface, interpretations of aspects of SSIBL remained different for different partners.

Perhaps we have a model structure but if we try to understand what is critical thinking, for example, I think we have some difference in what for us is critical thinking. It's

important but critical thinking is not only about the production of scientific knowledge it's about social knowledge, social education. I think everybody has changed but I'm not sure that SSIBL is the same tool, used in the same way in the different contexts.

On the other hand, there was acknowledgement that flexibility in interpretation of the framework was a strength, and that because of this variation its role in the project had been invigorating.

Yes [it has been interpreted differently], and it's very invigorating. It is a good model, and you can use it in all sorts of different ways. Some of them were more project based. Some of those are interdisciplinary. Others were community involvement oriented. I think it's perfect because in every country, the SSIBL framework is possible and it's important. It's not empty. Some things that are flexible are empty. It's not. It's rich enough to be flexible and important.

Participants' experience of communication/collaboration

The communication within the project was quite layered, including annual consortium meetings which included whole consortium discussions and smaller work package discussions (separate primary, lower secondary and upper secondary groups), more regular skype meetings of work package groups, online discussion and postings on the PARRISE website including a newsletter, and individual contacts. In some cases, partners had formed alliances with other institutions, sharing ideas and activities more closely. All interviewees were positive about the communication they had experienced during the project. They all gave a positive picture of the consortium members developing an increasingly consistent perspective on the key nature of the framework and the TPD.

One theme that emerged was the value of collaborating with people of like mind – sometimes on the basis of similar culture and language but also on the basis of shared histories of interest and shared views.

We can interact very positively with some people like (names of people from different countries) because … I think probably we have the same culture -- not only culture but background in science education and the idea we need to change our system. And we have discovered more people that we didn't know before. We have discovered these people and I think that gives us more confidence in what we can develop that people can share at the same time some paradigms or ideas about the evolution of education and of teaching.

It is very easy within a diverse range of partners to encounter some members with which you can actually cooperate more tightly with. But it is also interesting to notice that there is the diversity of opinions. But also, how this relates to their specific national context.

The face to face interactions were held to be important, beyond reading what was written in 'deliverables' and reports:

I think to me it was very, very helpful. Face-to-face and bringing some examples was for me very important. I produced all the deliverables and I read the deliverables from other participants, but hearing them, it was much more useful because there are a lot of differences.

We try to share materials, we had some Skype meetings in smaller groups, so groups of two or three … People are willing to spend the time translating some of the materials and sharing them. So that was an advantage of how the project is organised.

An important value of the interactions has been to clarify for partners the nature of the framework and their own ideas about how to enact this. An important aspect of the interactions is the sharing of examples, which lends clarity of thought to all participants in the communication.

It has been very important and very good interactions and particular the smaller Skype meetings that we have had where we have shared information. Because this is when you need to express both what your thoughts are and what and how you are doing this, and that you really carefully listen to other partners' solutions and descriptions. But that is when you are making progress yourself in how you think about what is going on. So, the interactions have been very good -- we have learnt a lot from them. But I can't say in a way how they have affected the change. It is I think that when you're having those meetings you become more clear yourself about what you are doing and what effect it has and why the responses -- You realise - Why do I want to change this or that - when you have to explain that to someone else.

I could see that there were other partners in the consortium who interpreted some features in a very different way from mine, and the exchange of perspectives and ideas and conversations have really had an influence on my view also, and I could see that my view had evolved throughout the time of the project. I think it is always enriching, because you have the opportunity to look at things from different perspectives and to connect these different ways of looking at things with concrete examples from different people.

Allied to this, partners described the value of realising their own problems and solutions were shared by others even if the education context was very different.

It is very interesting to witness that some of the problems that we encounter, and some of the obstacles, are actually common amongst partners regardless of the specificities of our specific school context. So, it's very useful to understand that people in other countries are actually dealing with the same problems our teachers are dealing with.

So, to be able to integrate this community and share best practices and discuss the failures, because that is something that is very very important also. And usually you only share successes.

Sometimes when we exchange what we call best practices, I mean teacher professional development activities, some of them have been really inspiring, and then we got some ideas about what we could do to make the most of our context.

It's been very useful to share ideas and to share materials ... to hear about scenarios that other partners have been using. Then strategies like the SSIBL machine strategy that is included in the revised framework because we've been working with the teachers on how can you phrase good SSIBL questions? We found that really useful.

There was some practical advantage gained by partners being able to present ideas from other countries, gained from the meetings, as proof of their status.

What I noticed for the participants is that they are really really keen and happy to be able to do something that is being done in other countries. So, for them to be able to incorporate the (ideas of) various European partners and understand that they are testing things that are state of the art ...

PROJECT STRUCTURE

The interviewees were generally very positive about the project structure and management, and about the interactions that had occurred. To the question 'what

might have been done differently' however, there was some useful critique. Some comments related to the nature of the deliverables and the lack of insight that came from the particular required form. There were a few comments on the term 'best practice'.

> *A term like best practice, I have the impression that it was used differently across different partners, so if you can look at a best practice as an example project but when we call something about best practice, it was more like tools that you can use in the classroom to work on the project and not really the project itself.*

One partner argued that the notion of rounds of TPD activities that were iteratively improved as part of a design experiment, leading to 'best practice', was unhelpful and not supportive of the type of collaborative work with teachers that actually went on:

> *I think the way the project plan was talking about best practice in first, second and third rounds and talking about it as if some things that we do turn out to be good examples and now we just need to refine them, was inhibiting us a bit in the beginning of the project. But to us it is more of having the opportunity to make different trials and learn from those trials and also include teachers in them -- also using teachers as informers during the different rounds. So, it is also collaboration with the teachers. ... The problem is the terminology in the deliverables and the terminology regarding how to report it. And also, this about findings - I don't know if it is their best practice or something else.*

Allied to the strong endorsement of the communication pathways in PARRISE, there was a common feeling that more time was needed to talk, and find time to better understand what each other was doing.

> *In terms of at the consortium level, I think that I would have liked more time to engage with the partners and really understand what they're doing. Like we exchange, we understand this need and we exchanged examples during the WP meetings etc. but sometimes this is difficult because examples are in a different language. So unless you have it in English and unless you have a really long time to explain also the differences in the educational system or why you're doing this thing, so your own history as a group; there are many gaps in what we understand about what each one of us is doing.*

There were tensions related to having a pre-defined as against flexible model, or at least a model that was developed and completed in a shorter timeline. A minority of partners made this comment.

> *If you look at the timeframe then it would have been best, I think, if the theoretical framework was ready before we started TPD courses.*

> *We use (the SSIBL framework) a lot to brand the idea and explain it to them more visually but the initial document that was, for some time for us at least, there was this question of who was it for? So was it for teachers? Was it for teacher educators? ... And it was an evolving document because of that, because we needed to go through the activities and provide feedback, and emphasise the important aspects and give examples and make them more concrete for students and other teacher educators.*

While there was flexibility in the design of TPDs that were part of PARRISE, there were some criticisms of the range of TPD that were approved being too narrow, and too much emphasis on the particular model being promoted. Given the range of traditions of TPD across Europe, decisions about what is 'in' or 'out' of the scope of the model are very important and potentially divisive.

SUSTAINABILITY

Judgments about the sustainability of SSIBL TPD practices in the partner institutions are hard to make, but evidence of embeddedness of these practices at different levels provide some cause of optimism. Many of the initiatives described in this report involve TPD structures and teacher education curricula that will have an ongoing life. Further, the enthusiasm shown by interviewees about the success of PARRISE and their changed perspectives, and also the productive links they have made with other consortium members, provides further cause. The ultimate hope invested in PARRISE is of course not limited to change in the participating institutions, but to the project as seeding a shift to SSIBL pedagogies/practices across Europe more generally. In fact, some evidence was found in the interviews of wider influence and uptake of these ideas beyond the particular institution.

First, there was evidence of incorporation of SSIBL into a cross national TPD initiative.

> *In a teacher conference, in the beginning of the PARRISE project, we managed to get the (National Education Agency) interested and also got money from them to develop material for an on-line TPD stretching over a full school year. It will be sustained because we do have more teachers who can take in-service courses and work collaboratively. We have incorporated our learning into that. So, that is how it will be sustained for in-service TPD.*

Other partners were confident the relationship with a network of teacher training centres will bear fruit.

> *For the second round of the TPD we were actually able to collaborate with a teacher training center. There is a network of teacher training centers and I think that the course will be very successful and this is something that the center will take as best practice also.*

> *I received an email from a teacher center asking us to offer a new course next year, so probably we will do that, although the PARRISE project will be over by that time. They were interested in the kind of teacher training we offer.*

There is some hope in at least one country that national examinations will begin to incorporate items consistent with the SSIBL approach.

> *There is a national examination with the kind of questions that value relevance, each will be in some way suitable to the SSIBL approach so maybe it will be sustainable but we need to investigate it.*

Another partner described interest and support from the Ministry of Education.

> *We have a new inspector at the ministry who is really open to new ideas and she has been attending some of the project meetings, like the public sessions that we have. She was there to support teachers and she has also said yes to the teachers that they can try these new ideas out because she feels that they're important ideas to work with. So I'm not sure how sustainable this process would be long-term because I think that you need resources ... But I think that we are taking steps towards that goal.*

That partner also described PARRISE as part of a long-term project that will continue to run.

> *If you look at it long-term in terms of the science study project that we've been engaged with, there is a continuity there and this is sustaining- by going from one project to another. So there is gradual build up I guess, in that sense. Like we won't just leave*

whatever we did with the PARRISE project and move on to a new idea, we will try to build on that.

Finally, another partner argued that PARRISE has captured a mood for political and citizen action in the general population, that indicates sustainability.

It will have an impact on the long term, quite important matter of fact, because citizens have been politically extremely passive in the last few years, because they felt nothing can happen .... And PARRISE showed us an area that yes, things can change.

DISCUSSION

PARRISE is one of a number of European projects focusing on innovative processes in education, involving collaboration across multiple education systems and national cultures. As such this study has the potential to offer insight into the wider European project, and to processes of cross-national innovation more generally.

The project has been evaluated and received a high score from the European Commission, providing some justification for paying attention to the structures, experiences of partners, and outcomes, as indicative of a successful initiative. In fact, in the interviews partners in general talked very positively about their experience and their learning, and the quality of what they felt they had achieved through the PARRISE processes. In the findings section, we reported the various dimensions of this. Now, in the discussion, we take a broader view and try to identify the major features of PARRISE as a well-regarded collaborative European project, trying to draw lessons from it with regard to innovation and change in networked systems. In particular the study would like to say something about the process and value of collaboration across diverse education systems, in promoting a substantial innovation.

A number of things should be noted about PARRISE. First, it follows a number of projects focused on inquiry science, that a number of members of this consortium have previously participated in. Second, with the bringing together of several strands of science education pedagogy and beliefs, and linked these with the wider call for RRI within Europe, the project is complex, forward looking, and challenging. The ideas being promoted, those of education of a critical citizenry through science education and linking responsible research with classroom processes, are both new, and challenge longstanding traditions within the subject. Third, the background and contexts of the partners vary widely. Some systems have established inquiry practices while others do not. Some partners have long experience with research in SSI. Some are from strong traditions of academic disciplinary knowledge, and there is a variety of experience of sustainability project work.

Nevertheless, there is substantial evidence that partners have developed over time a substantial commonality of interpretation of the SSIBL framework and a variety of approaches to TPD that overall enrich the SSIBL conception. There is evidence that the project processes have opened up a variety of lines of communication and collaboration that have enriched partners' understandings and practices. Given this, it is useful to examine the evidence from these interviews to ask questions of what have been the enabling features of PARRISE, what have been the challenges, and what does the project tell us about the process of educational innovation in Europe.

Negotiating complexity

Partners' experience of PARRISE has been productive but varied. In many ways, the story of the project has been one of response to complexity – in two senses.

First, there was wide variation among partners in their background regarding the SSIBL pillars of IBSE and SSI, and different commitments and beliefs about science education. There were also different traditions of TPD including primary-secondary differences, and different curriculum and other structural constraints that imposed limitations on the possibilities of innovating around SSIBL. Access to teachers, and freedom to vary pre-service courses, were among these.

Second, the complexity and epistemological challenge presented by the SSIBL framework was a major factor in framing partners' experience of PARRISE. A key aim of the SSIBL framework was to move science education away from an empiricist framing, and a predominant focus on positivist conceptions of knowledge and learning, towards a more socially critical conception of scientific practice with an orientation towards education for citizenship and responsible research and innovation. This conception provides a considerable challenge to existing traditions, and proposes a complex interaction between at least three different strands of reformist movements in science education.

Given these complexities, and the relatively open form of the framework at the beginning, one might think that the project would be in danger of dissolving into disparate camps. Yet the experience of consortium meetings, and the evidence from these interviews, indicate that a relatively robust commitment to the SSIBL vision has been forged, and a reasonably consistent view of SSIBL achieved over time, particularly, in the view of a number of interviewees, from the fourth consortium meeting in Vienna. It is important to note that not one interviewee voiced concerns that the project had been unproductive. All seemed committed to its basic principles and spoke positively of their experience in the project. It is interesting to consider, given the contextual constraints, how this has occurred. What are the features of PARRISE that have led to these outcomes?

Diversity in response to the SSIBL framework

Response to the SSIBL framework over time developed in different ways for different partners. For many, who had experience of and commitment to inquiry science (IBSE), the issue became how to widen notions of IBSE to include inquiry into socio scientific issues. For others with an SSI background, the challenge was to link socially acute questions with IBSE activities. Interviewees described a process of gradually coming to understand how to link these two major traditions into a coherent whole. A further challenge was to come to understand how these related to citizenship, and to RRI for which there were changing views over the course of the project. In the conversations that took place in consortium meetings and in work package skype meetings, partners had access to, and needed to come to terms with, other educators with particular expertise and beliefs in the different SSIBL pillars, and it seems that this diversity performed a generative function.

A large part of reason for the flexibility partners experienced in responding to SSIBL was the way in which it was created and viewed as a draft document, able to be negotiated and interpreted sufficiently flexibly to accommodate partners' differing beliefs and contexts. In a project such as this, built around a theoretically complex and challenging innovation, there is an inevitable tension between offering a tightly

specified framework that offers prescription of process and illustrative, clarifying exemplars, as against offering a framework conceived of as 'in process' with members conceiving themselves to be part of a design experiment.
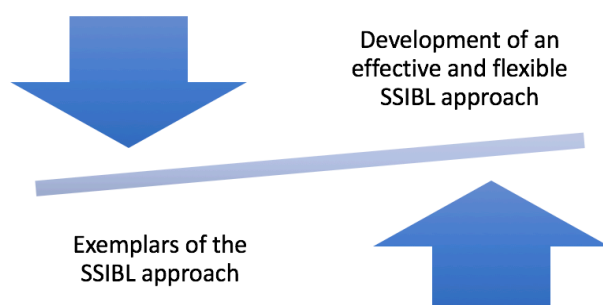

Figure 2: Balancing the needs for flexibility and specificity

On the one hand, it was important that partners were able to develop responses to SSIBL that reflected their particular contexts. On the other hand, they struggled at times to work through what was the essence of a SSIBL activity and how teachers and students could be effectively engaged through such activity. Having exemplars would have been valuable, but at the start they had not yet been developed. It was only after a number of cycles that partners developed and shared explicit criteria and approaches, and exemplar activities. Evidence from these interviews indicates that the open approach to the framework allowed room for coherence to develop through these diverse TPD developments.

From the interviews, it seemed that the SSIBL framework was interpreted similarly at one level, but there was diversity in how it was implemented in practice; what was emphasised, and what TPD processes were enacted. A number of interviewees claimed this variation in practice as a strength. Within the project, discussion of SSIBL was central, and generative. There was evidence of broad agreement about the essential core of the innovation, and of growing commonality of vision.

Diversity within TPD

There was considerable variation of structure within the PARRISE TPD models. Within pre-service courses this related to different curriculum constraints, and to whether colleagues were willing to entertain time allocation to SSIBL. With in-service, it related to access to teachers and constraints offered by teacher beliefs and curriculum alignment. The issues and possibilities for pre- and in-service SSIBL development were very different. For pre-service the issues mainly related to how to structure and balance theoretical and practical experiences of SSIBL activities, within a constrained time. For in-service teachers, there were sometimes strategic partnerships formed with teacher education centres, in one case with a national on-line TPD. In a few cases partners were able to develop over time a cycle of collaborative development of approaches with teachers, beginning with developed exemplars of SSIBL activities, to teachers designing their own contextual activities, and finally to the development of criteria for exemplars. There were thus two levels at which the challenge of SSIBL was addressed: at the level of beliefs about the purposes of science education and the in-principle structure of a SSIBL approach; and

at the level of context-specific enactment in real classrooms (see Figure 3). The classroom enactment cycles became very important for exemplifying the core nature of SSIBL. For the 'belief' level the challenges were: "*It's politics, not science*", "*There's no room in the curriculum*", "*I'm not the sort of person who runs such discussions*". For the 'enactment' level the challenges were: "*How do we coordinate the pillars, with the need to teach content*"; "*What issues/controversies will be accessible and productive?*", "*What are the criteria for designing a good SSIBL sequence?*"
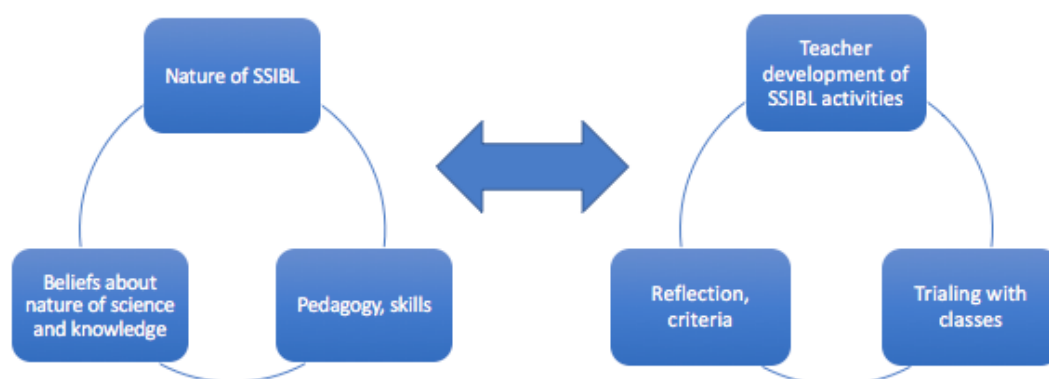

Figure 3: Dual focus on beliefs and perceptions, and teacher practice, in SSIBL TPD

Enlisting diversity through layered communication

Interviewees talked about the generative nature of communication within PARRISE, and its operation at different levels: consortium meetings, work package meetings via skype, smaller group meetings online, and individual communication with like-minded partners. Some spoke of the success of the project management of creating an environment where people could speak openly and discuss difference. There is evidence that the complexity and diversity discussed above were generative forces when the communicative structure was both open and diverse. Partners indicated they were both challenged and enriched by discussions in the wider meetings with others of different viewpoints and ideas about pedagogy and curriculum purposes, yet could readily find like-minded colleagues with whom they could discuss and jointly plan activities. In the end, a good deal of commonality of beliefs and vision was evidence in partners' responses to the framework, and beliefs about the purposes of science education.

CONCLUSION

PARRISE has been both a complex and innovative project, both theoretically and structurally. The SSIBL framework at the centre of the innovation challenges traditional perspectives on science education and draws on a range of critical theoretical traditions to propose a rethink of its purposes. The research questions driving this study represent an attempt to chart the processes by which interactions between the complexity of SSIBL, and the complexity of contexts across the partner institutions, have been generative or constraining. The four research questions are best responded to in pairs.

1. What is the nature of variety of interpretations of SSIBL and practices in TPD that have arisen during the PARRISE project?

2. In what ways has the SSIBL framework been interpreted and appropriated by the different national projects to serve valuable purposes?

The study has demonstrated the range of epistemological beliefs and histories of practice that underpinned a variety of responses to the framework, and the variation in context of pre- and in-service TPD that led to a variety of approaches within and across work packages. Each partner has in common the strategic development of alliances and opportunities over three annual cycles, to put in place effective and individual responses to the challenge of PARRISE. These include alliances with science education TPD centres, alignment with national TPD iniatives or school curriculum initiatives, extentions of existing partnerships focused on sustainability, and cyclical refinement of in-service TPD practices focused on innovation. Through sharing and discussion of this variety of activity, partners over time developed a more robust and coherent perspective on the SSIBL framework and its possibilities for guiding practice.

3. What have been the differences in context, the local factors, and the shared processes in the PARRISE community, that have influenced the pathways of change?

4. To what extent has variation in interpretation and practice been a generative, or a constraining feature of the PARRISE project?

An important variation in partners' experience concerns whether their focus was on pre-service TPD or whether they had the capacity to work with in-service TPD over time. A major advance in interpretation of the framework over the course of PARRISE involved the development of criteria and processes by which teachers could become relatively autonomous in developing their own SSIBL sequences based around local context. The openness of the framework to variation was an important feature that allowed these innovations to develop, and be shared.

The SSIBL framework has sat within the project as the subject of a design experiment where the diverse contexts of the partners have fed into progressive refinement of the framework and the development of exemplar TPD activities. While this open structure has at times created discomfort, ultimately it has proved an effective strategy for accommodating the diversity of partners' beliefs, experience and contexts to forge a framework sufficiently rich and flexible to be applicable across these diverse systems.

A key to this has been the creation of a community with layered communication processes, where partners feel able to express their views and negotiate difference, and feel able to interpret the framework in ways that match their context while acknowledging the need for coherent representation of the central pillars. A very positive aspect of the PARRISE project has been this dual attention to the need for coherence, and acknowledgment of diversity. Sharing and negotiation of ideas across multiple platforms has been key to this.

ACKNOWLEDGEMENT

Appendix 1: Interview questions

1. Can you talk about the TPD initiatives you have undertaken as part of the PARRISE project? How was this different from your normal practice?

2. Can you talk about the history of your project and how it relates to the SSIBL framework – how did you start out? What have been the challenges? How have your practices changed over the three years since you started? How successful have the changes been?

3. Can you look at this diagram of the SSIBL framework, and talk about what you understand as the key aspects. From your perspective, what have been the useful aspects of the SSIBL framework that have driven your work? Has your view of the SSIBL framework changed over time?

4. How have your interactions with other members of the consortium in the meetings affected the way you have implemented change?

5. To what extent has your particular context affected the way you have gone about the project, differently to other members?

6. Do you feel there have been differences in the way different members have interpreted the nature of the framework?

7. Do you feel a common understanding has been developed about the nature of the PARRISE project, across the three years?

8. What have been the strengths of the way the PARRISE project has operated, for you?

9. What might have been done differently, that would have been helpful for you?

10. What has been the impact of the PARRISE project on you, your colleagues and your students?

11. To what extent do you think the initiatives you have implemented will be sustained into the future?