



**A MEETING OF MINDS AROUND PEDAGOGICAL
CONTENT KNOWLEDGE:
DESIGNING AN INTERNATIONAL PCK SUMMIT
FOR PROFESSIONAL, COMMUNITY, AND FIELD
DEVELOPMENT**

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A Meeting of Minds around Pedagogical Content Knowledge: Designing an International PCK Summit for Professional, Community, and Field Development

This Summit has been an excellent example of collaborative inquiry – where we explored ideas, put our tentative thinking out there, revised our thinking, drew on resources.... We looked at papers, talked about models, put representations up, modified them...It was the best of the best for collaborative inquiry. –PCK Summit participant

I feel much more part of a community working in the same field. This means I have people with whom I can work and discuss, which is always good for progress. Also I can see my own work in context and review accordingly. Finally, in the light of the summit, I can see issues that would make good future projects and have a stronger idea of how to investigate these from secure theoretical perspectives. –PCK Summit participant

I. Introduction: The Case of the PCK Summit

A “conference” is a familiar mode of work for academics. Conferences provide opportunities to bring professionals working in a field together to share and build knowledge. As common as conferences are, however, they are quite challenging to design in ways that truly succeed in galvanizing the attention of an academic community on a shared problem, in generating powerful new understandings, and in energizing and shaping an agenda for future research and development work that will move a field forward. Conferences may aspire to these ends, but as typically designed, rarely achieve them. This paper presents a case study of a conference that provided an exceptionally powerful experience for the participants—both individually and as a professional community—and is pushing forward important work in the field.

Dubbed the “PCK Summit,” this conference brought together an international group of 22 researchers working in the area of *pedagogical content knowledge* (PCK) in science. The group met for five+ days—from dinner on Saturday through lunch on Thursday—in Colorado Springs, CO, in October 2012.¹ The meeting achieved these outcomes:

- Formation of professional community. Participants arrived well prepared in advance and eager for several days of work together. The energy level and intellectual effort that launched the summit did not lag, but rather was sustained through the last session. Researchers who

¹ The conference was funded by the National Science Foundation (grant # DRL-1108899), the Spencer Foundation, and funds from a NSF grant housed at the University of Missouri. Janet Carlson of BSCS (Biological Sciences Curriculum Study) and Julie Gess-Newsome of Willamette University were Principal Investigators.

had put years of work into PCK research were willing to put aside their hard-won “niche” perspectives and openly explore the prospect of a unified model of PCK for science education research. Participants experienced the Summit as a true manifestation of “professional learning community.”

- Conceptual advancement. A unified model was proposed and discussed at the end of the meeting (see Appendix B). Participants worked together and pushed through to the end of the summit to explicate that model and its many new implications. Every participant engaged questions about the benefits and challenges a unified model may present to them as individual researchers and to their field.
- Field development. On the last day, all researchers identified multiple next steps for their work. Several of these—a NARST panel, a new international research study, a journal article and edited book— involve new collaborative efforts springing from the joint work of the Summit.

This paper elucidates the key elements of the PCK Summit’s design and the reasons for its success. Our hope is that others in NSF and beyond may derive practical lessons about how to conceptualize, prepare for, facilitate, and follow up on academic conferences so that they succeed in building individual, community, and field capacity.

The paper draws from multiple data sources: interviews before and after the summit with the organizers, direct observation of the summit itself, informal conversations with participants throughout the summit, participation in daily debriefs with the organizers and planning committee during the summit, and a post-summit online survey of participants.

II. Key Design Components of the PCK Summit

From its initial conception on, the PCK Summit benefited from purposeful and well informed decision-making about every element:

- The rationale for and focus of the Summit
- The identification of participants
- Their preparation for the summit
- The selection of the setting
- The design and structure of the work of summit
- The responsive facilitation

Here we examine how these key design components contributed to the success of the meeting as an experience for the participants and as a catalyst for an evolutionary leap for PCK in the field.

The rationale for and focus of the Summit: to strengthen the concept, the community, and ultimately the field

The idea for a conference was born from recognition of a weakness that limited the utility of PCK in the field both theoretically and practically. Key researchers working with the concept of pedagogical content knowledge saw that while PCK had been a useful construct, particularly for improving science teacher preparation, research about and application of PCK has been suffering from a lack of shared definition and conceptualization of the construct in the field. The conference was formed around the clear purpose of naming this weakness and working to strengthen the concept and the research community and thus increase their relevance and value to the field.

As a result of their own work in PCK as well as their comprehensive knowledge of others' research, the Summit organizers realized that in spite of the fact that research has been ongoing in PCK since the late 1990s, researchers were not speaking same language. In particular, they noticed that there were significant and troubling divergences in key elements that drive research and make it meaningful, including definitions/conceptual frameworks, instruments, methods, and findings. These divergences were present in several key aspects of PCK research. These included the grain size of PCK's explanatory power (e.g., is pedagogical content knowledge meaningfully linked to a specific area within a discipline (energy), to a discipline (physics), to science overall?); the relationship of PCK to content knowledge; the role of personal orientations or beliefs in PCK; means of assessing PCK, and many others. These divergences, they felt, were diminishing the power and value of the PCK construct to contribute effectively to improvement of science teaching and learning.

Identified areas of divergence in the field were translated into the organizing structure for the meeting and drove the presentation topics for the invited participants. The expressed purpose of the summit was to bring together leaders in the field to share aspects of their research and to discuss issues related to research on PCK that would address and "solve" the problem of divergence. The organizers stated the objective, as shown in the comment below, as either attempting to create a unified vision or model of PCK *or* to identify how explicitly recognized divergences could lead to productive lines of research:

There is something that is not playing right in the field. This seems like the right time to bring the field together and ask, can we come up with either a unifying definition for pedagogical content knowledge, and maybe even a theoretical grounding for it, that will drive measurement and assessment techniques? Or, if we are going to be divergent, can we be purposefully divergent so we have lines of research that we can determine which are going to be more fruitful or less fruitful in getting us the kind of answers that we seek.²

² Throughout this report, comments are lightly edited for clarity.

Participants learned of this focus and purpose early on in an email from the organizers:

As we all know, Pedagogical Content Knowledge (PCK) has generated a lot of interest in the research community. Unfortunately, few commonalities exist in the way we have conceptualized or operationalized the construct in science education. The PCK Summit is designed to allow an international group of experienced PCK researchers the time and space to delve into our collective efforts, uncover our assumptions, understand the divergences in our approaches, and perhaps agree upon the most fruitful tools that have been found to date in the exploration of teachers' professional knowledge, including PCK... We hope that all of us participating in the Summit, as a research community, will agree upon a few deliberate and purposeful paths on which to focus our individual and collective research in the future. The ultimate goal of the Summit is to catapult the research on teachers' professional knowledge on a productive trajectory.

The validity of the organizers' concern resonated with the invited participants. In fact, a theme we heard during the discussion at the Summit was that a "status problem" exists with PCK research, and as a result, researchers have been having more trouble publishing their studies and getting their papers accepted at meetings of their professional associations. Participants believe PCK's loss of potency in the field stems from the absence of a coherent construct and theoretical foundation for PCK. They thus came to the Summit with a felt need to bring clarity to the work so that those outside the PCK community in STEM education research can see the value in this line of inquiry.

The rationale and focus of the Summit thus spoke to two related needs felt by the international community of PCK researchers: one was the need to sustain and further their individual research programs, and the other was to form a research community unified enough to keep PCK alive as a construct that the field perceives as academically sound, rigorous, generative and useful. The organizers and participants alike could see that without a better supply of research-based knowledge about PCK, the field's demand will shrink, and that cycle limits the utility of PCK as a contributor to improvement of science teaching, the ultimate goal.

Purposeful and informed selection of participants

The conference organizers were familiar with nearly all of the research and researchers in PCK in science education. They invited participants who not only had a track record of research in PCK, but who had been developing different (sometimes divergent) conceptual frameworks, instruments, measurements, and uses. In other words, it was the participants' work that was leading the field and also surfacing the need for a discussion about a unified model.

Participants were drawn from three professional contexts: established academics who have been conducting basic PCK research for many years; promising newcomers to PCK research in academia; and professionals working in education research and improvement non-profit organizations (e.g. WestEd, BSCS, Horizon Research) using PCK as a construct for their teacher development implementation research. In addition, 2 math education researchers were invited to

provide perspective outside of science; one of these, from an established math education research group that no longer conducts research into PCK, was invited to provide a contrasting view of the basic utility of the concept. (Appendix A lists the participants.)

On the survey, 100% of participants said the selection of participants either contributed, or contributed greatly, to meeting the goals of the summit. Several participants commented on the quality of the people who attended the summit and the unexpectedly rich, intense, and “ego-free” interactions among them. Examples:

I was expecting to meet a collection of extremely bright, hard-working, open-minded PCK researchers at this summit. This turned out to be the case, but even more than I had originally expected.

A pleasant surprise, and one that I believe accounted for the achievements expected from the summit: There were minimal to no "ego issues"—almost everyone was willing to question their assumptions, suggest alternative ways of conceptualizing PCK, and let go of some of their own prior beliefs.

[I was surprised by] how well everyone got on. It is sometimes hard staying with a small group, eating every meal and working intensely every day, but the group gelled very well and I feel I made good friends with people I had only previously heard of. I was also surprised by the quality of the discussions. These were all excellent and very productive, which is highly unusual in my experience.

And in an email following the summit, one participant wrote, “The people... were top notch; great thinkers and willing to compromise on their own views, even when they had held those views for a long time.”

Preparing for the Summit through disciplined sharing of work and engagement in thinking

Both the organizers and the participants devoted considerable time and much disciplined writing, reading, and synthesis work to preparing for the Summit the several weeks prior. Participants were asked to write detailed answers to a set of questions about their research program in PCK, including: their definition of PCK, model used, assessment tools, synopsis of work, and references. In addition, they wrote structured “Expanded Papers” (EP) describing similar aspects of their research projects but in more depth: overview, theoretical background, rationale, methods, results, references, and hyperlinks to related articles. (The organizers conceptualized these EPs as the “basis of an analysis and synthesis of the field” that would serve the Summit as well as contribute to a book and journal articles after the Summit.) The written answers and Expanded Papers were all posted to the PCK website. Participants were then asked to read all of the EPs and answer the following questions about the set as a whole:

1. Are there attributes of PCK and teachers' professional knowledge that are similar across multiple papers? Are there attributes that are unique to a smaller subset of papers? Identify the papers and attributes.
2. What similarities and differences exist in the measurement tools and analysis methods used to uncover PCK?
3. Are there results across papers that reinforce some of the PCK findings? Are there results that are contradictory? Can you propose explanations for the complementary or contradictory nature of the results?
4. After reading the papers, what questions do you have for specific research teams?
5. After reading the papers, what questions do you have for the group to consider?

This focused and structured preparatory work provided participants with a solid summary of their colleagues' scholarly work and of ways each researcher's work connected (or not) with one another. This created the opportunity to dive right into the core of the issues right from the beginning. The preparation tasks also anticipated the intellectual "juice" that would animate discussion at the meeting. It is clear that this approach was better than the alternative of not asking participants to become familiar with one another's work or of asking participants to, on their own, learn about one another's work. Involving each person in an intentional and inclusive sharing of their own work and engagement with one another's work—around core questions that would guide the Summit—was remarkably effective in setting a rigorous tone and "level playing field" for the Summit, enabling each person to enter it with a strong voice for their own work, a regard for and engagement with each other's work, a degree of shared language, and a preview of core problems to discuss.

On the follow-up survey, 100% of the participants reported that the preparatory work either contributed, or greatly contributed, to the Summit. Many commented that the papers helped them understand others' perspectives. One participant commented that s/he would have liked more time to analyze and discuss the written material.

Designing Summit discussions for critical, collaborative inquiry

The Summit was structured primarily as a series of small- and whole-group discussions, which is not an unusual format in general. What made the design of the PCK Summit so effective was the way in which the organizers made this format serve so purposefully to advance the intellectual agenda.

Launch: visiting the origin of PCK. In a presidential address to a meeting of the American Educational Research Association in the mid-1980's, Lee Shulman coined the term "pedagogical content knowledge" as a way to distinguish the special kind of content knowledge that teachers need to know to teach a subject. The concept resonated strongly with the teacher education and development community, generated quantities of research and activity, and remains the most

visible sign of Shulman's legacy. The organizers of the PCK summit invited Shulman to open the meeting with a talk about PCK. This launch thus embraced and put the participants in personal touch with the intellectual history of the concept. Delivered via Skype (Shulman was traveling and unable to attend in person), Shulman's talk was part personal reminiscence about the origin of the concept and part strong encouragement to the new generation of educators to continue inquiring into it in ways that he didn't do. Shulman's talk was referred to throughout the summit, serving as a kind of community touchstone.

Focus questions. Each half day was framed around a question that lay at the heart of the problem (discrepant concepts, tools, findings, and so on) and that pushed the group inexorably toward a resolution—either to posit a unified model or to identify and agree upon discrepancies that would generate new research of value to the field.

Individual team sharing of research for the whole group. After the initial framing of the day, sessions began in whole-group format with two or three 10-minute presentations by research teams of participants sharing their own work. The conference organizers had asked each team in advance of the meeting to prepare these such that they would address the question of the day and the identified discrepancy/problem. The organizers had selected and sequenced these short presentations purposefully on the basis of how interesting or provocative a given research team's work was in this particular area of discrepancy. One session, for example, included three teams' sharing of their tools for assessing teachers' PCK. Aligning them this way made the differences and discrepancies visible and available for exploration.

Small group inquiries into questions, tensions and potentialities. Following the presentations, participants were divided into 3 small groups to tackle the questions and challenges driving that session. These small group discussions were of substantial length—one or two hours. The intention of each small group's focus question was to highlight the diverging views and to compel the participants to see whether they could (or could not) work toward a more unified model of PCK. In each small group session, participants moved from the structured questions toward refinement of their own new ideas and toward identification of where the discussion should go next. Each day participants worked in different assigned groups on different subtopics related to PCK research; thus they were exposed to different people, perspectives and experiences.

Purposeful syntheses. At the end of each day, each small group presented to the whole group in some detail, often with one group member using a diagram on the wall to show their thinking, and with the 25 or so participants clustered in a semi-circle, leaning in, asking questions, commenting, and identifying congruencies and in-congruencies in the discussions of other groups. The purpose was not only to share thinking, but to probe for the possibility of a shared model—to see how near the group was getting to the aim of the Summit. Small clusters of participants often continued as the dinner hour neared.

Emergent interest groups. Out of these carefully sequenced and intensive discussions, strands of particular interest emerged organically. The facilitators recognized and named them and, in the last two days, participants chose to work in one of four interest groups for the purpose of taking the work forward beyond the Summit. The four foci were:

1. Refining the PCK model
2. Developing PCK in teachers (over the trajectory from pre-service to experts)
3. The research map for PCK
4. Connecting PCK to policy

Resolution. On the final day, the participants arrived at the point where they could visualize a potential unified model for their work going forward that drew on all of the conversations and iterations from the previous four days. In essence, this model evolved the original concept of PCK drawing on different kinds of knowledge bases “out there” (sometimes referred to as canonical PCK) into what the group termed “topic specific professional knowledge.” The proposed definition of PCK became: “PCK is the knowledge of, reasoning behind, and enactment of the teaching of particular topics in a particular way with particular students for particular reasons for enhanced student outcomes.” (See Appendix B for a graphical depiction of the final model, as well as a small sample of thinking-in-progress emerging from small groups.)

Moving forward. The last day also brought more progress on the four interest group topics. Participants agreed upon next steps for products resulting from the summit: a special journal issue, a book, and an interactive website to house instruments and other key documents, videos, and presentations.

Responsive, goal-oriented facilitation

The importance of skilled facilitation cannot be overstated. One participant commented that, “The leadership team facilitated the development of our thinking without pushing any particular ideas.” That and the fact that, as this commenter also said, “The participants were dedicated to the effort!” meant that the discussion neither wandered aimlessly nor was it overly controlled. Rather, the skilled facilitation brought to the fore participants’ best and most authentic individual and joint thinking. The actual design of the facilitation was, in fact, more complex than met the participants’ eye. The organizers originally elected not to facilitate themselves, but rather selected neutral facilitators knowledgeable about science education but not necessarily about PCK and not invested in the outcome of the summit. In reality, though, the organizers ended up serving as the most powerful facilitators because they—and not the independent facilitators—truly held (or “sourced”) the vision and purpose of the summit. As such, they brought the strongest intention to facilitation. The organizers participated fully in the meeting and in so doing stayed in contact with the flow and energy of discussion; and together with the larger planning team (and the evaluators) met each day to debrief and to identify the facilitation moves needed the following day to keep the momentum moving toward the meeting goal. The organizers and

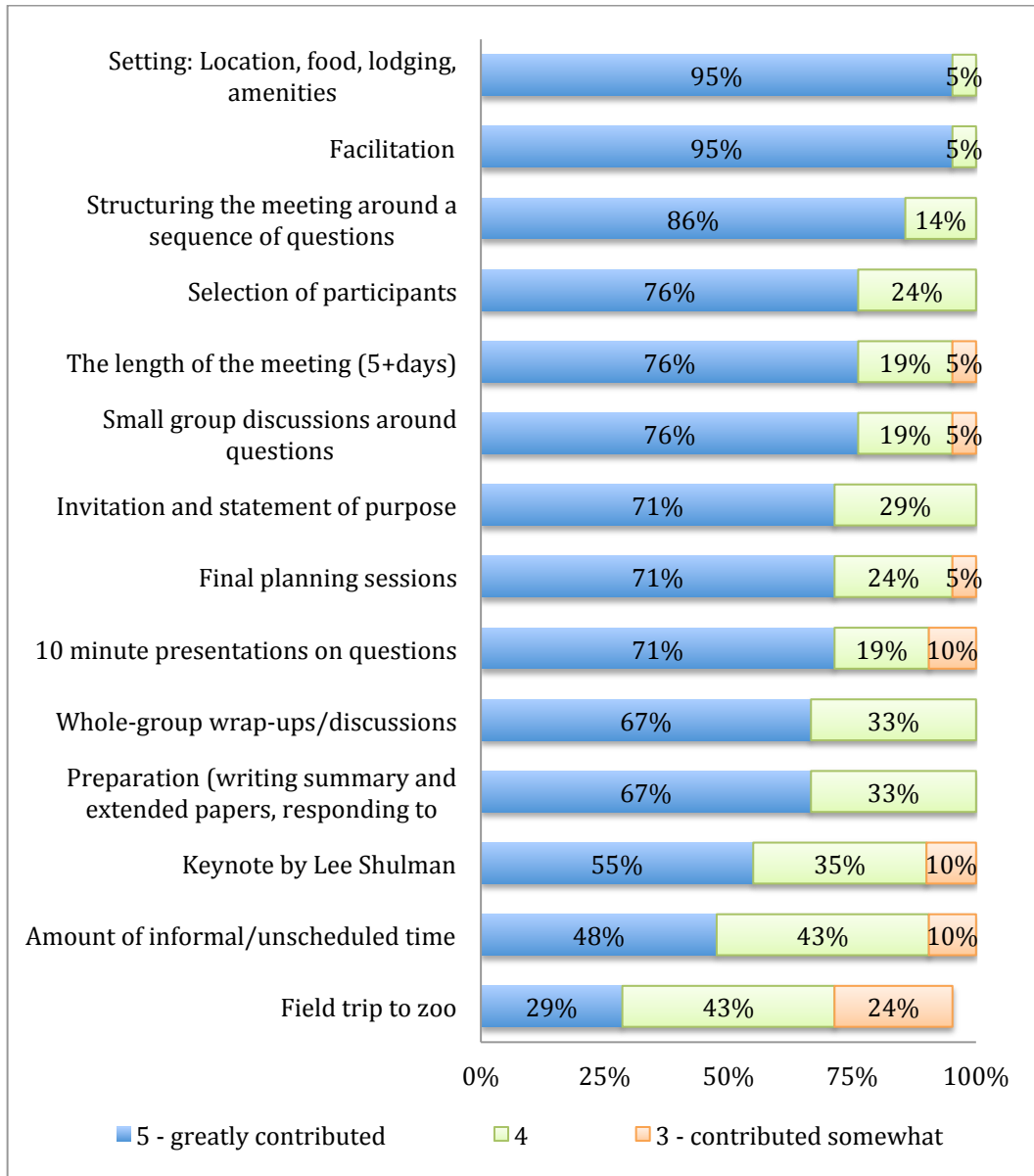
planning group were very responsive to the evolving needs and thinking of the summit participants. Several times in the last two days, the planned agenda was altered to take advantage of the positive momentum that was building from the small breakout groups.

Participants' evaluation of design components

As shown in the graph on the following page, participant survey results show very positive ratings for the many components of the summit.

Figure 1. Participants' assessment of the contributions of particular design components to the Summit's success

Participants rated each component's contribution to the success of the Summit on a 5-point scale. Ratings of 5 are shown in blue, ratings of 4 in green, and ratings of 3 in orange.



In addition, participants made many positive comments about the design overall. A sampling:

The length of the summit (5+ days) was a crucial element for making progress. I think it took the first couple of days to get all of the ideas and perspectives about PCK on the table. People first needed to present their perspectives before deeply considering others'.

In the final days of the summit, I felt there was true dialogic, meaningful conversation about how we could achieve some consensus on our understanding of PCK.

The structure of the meeting was excellent. The first three days were tightly structured, and the rest of the meeting agenda was responsive to the ideas generated and opportunities for emerging consensus. The people were top notch; great thinkers and willing to compromise on their own views, even when they had held those views for a long time. The mix of large- and small-group work meant that no one had to fight to be heard. And I think once the more reluctant individuals heard themselves speaking in a small group, they were more willing to contribute in the large group. The strategy of having neutral facilitators worked well. By neutral, I mean that neither Joe nor John had a well-known stance on PCK, and because of that, no one had to worry that they were pushing their own agenda.

On the last day of the summit, as they were offering their final reflections and observations, one participant remarked:

This [summit] has been an excellent example of collaborative inquiry – where we explored ideas, put our tentative thinking out there, revised our thinking, drew on resources.... We looked at papers, talked about models, put representations up, modified them...It was the best of the best for collaborative inquiry...

Reflection on the design: The importance of intention

The design of the meeting provided participants with many and varied opportunities to share ongoing research findings, as well as the raise and look into puzzles, questions, and concerns. The purposeful mix between research presentations and group discussions brought the group together and moved the work forward while also enabling individual researchers (or groups) to find their place within the whole. The design, the 5-day timeframe, and the collegial tone combined to promote a very open, problem-solving, inquiring-together stance, as opposed to what is typical of academic conferences: presenting (and critiquing) finished work. This was not a meeting where final knowledge was imparted, but rather, one where ideas were built on prior knowledge and emergent knowledge to build new insights collectively. Participants stated what they did not know, or were not certain of, more than they stated what they did know. There was no tone of competition, but there was encouragement of disagreements and rigorous thinking. The disagreements served the important purpose of clarifying where the field is solid and where it is not, in a helpful way.

The summit organizers designed the meeting with this explicit intention:

The guiding questions [for the 10 minute presentations] did open up chances for them to say this is how we have thought about it and this is how we have studied it and this is

what we used to do. There were all of these opportunities for people to say their own piece so they didn't feel squelched. At the same time, there was all of this opportunity to say, well, what can we do in common? I think people, because they felt free to say their own thing, were quite generous in getting with the program and seeing where they could connect with other people, and they were excited by what other people were saying.

The small group discussions following the presentations were the meat of this summit: this was where researchers tackled the thorny issues, where people had the opportunity to dig into the concepts, tensions, and debates. It was in these small group discussions where participants began to open their minds to new and different ways of understanding PCK; nearly every day, groups brought new proposed definitions and graphical portrayals of PCK to the whole group to reveal their thinking and their questions. Agreements and disagreements were aired not in a competitive tone but in conscious ways to advance the discourse. Disagreements served the purpose of clarification rather than status-building. The small groups in particular enabled this kind of interaction. It is intellectually relatively simple to present a paper about one's own research; it is much more intellectually demanding and risky to sit for many hours and days in small groups of researchers from diverse perspectives and address questions and problems of both theoretical and practical importance. It was the small group inquiries, also, that generated the focal areas that continue to be pursued in interest groups.

IV. Contributions of the Summit to Researchers and the Field

The purpose of the PCK summit was to increase the value of PCK research and PCK-related practice by attempting to create a more unified vision of research in PCK in science education, and at the same time to support individual researchers' need to carve out a particular path within that vision. In this section, we highlight the benefits of the Summit both to individual PCK researchers as well as to the field of PCK research as a whole. Our identification of these benefits was derived from our observation and participation in the summit, from comments from summit organizers and participants, and from evidence of ongoing professional activity of participants beyond the summit.

Benefits to individual participants include:

- The visibility and satisfaction gained from the opportunity to personally contribute to an explicit effort to advance the PCK construct and move the field forward
- Strengthening of participants' personal knowledge base, which will ultimately enable them to make a greater impact in their sub-field of teacher preparation and teacher in-service development

- Receiving feedback/input on their own research and current thinking, which strengthens their own research agenda by making it more rigorous and more targeted on questions other researchers believe are important (especially valuable for new scholars)
- Building and validating professional identity through belonging to a strong and open professional community
- Contributing to and gaining new knowledge of multiple international education and research contexts

On the survey, 100% of survey respondents indicated that the summit had the potential to advance their work to a great or very great extent. Their written comments indicate the strong impact the summit had on their thinking about and research on PCK, and reflect ways in which the Summit points to a new future for them in this field. A sampling:

I feel much more part of a community working in the same field. This means I have people with whom I can work and discuss, which is always good for progress. Also I can see my own work in context and review accordingly. Finally, in the light of the summit, I can see issues that would make good future projects and have a stronger idea of how to investigate these from secure theoretical perspectives.

The summit really empowered me and gave me more confidence in my own research.

The Summit reshaped my thinking about PCK in substantive ways that will affect my work going forward.

During the summit, I was able to refine my future research plan reflecting on my own ideas and listening to others' ideas.

The majority of respondents also noted that it was likely or very likely that they would participate in future collaborations with other summit participants. In fact, since the summit, several participants are preparing papers for upcoming conference sessions (NARST) or have proposed conference sessions (ESERA), one has submitted a proposal for a small conference of international collaborators around PCK, one is heading a team to design and conduct an international research project, and an outline for a book has been prepared and will be vetted at NARST this year. A presentation has already been given at Association for Science Teacher Education (ASTE) conference on the summit and the model that was created.

Overall, individual participants found the experience to be extremely beneficial – even transformative. All of these researchers are regular conference-goers and many of them participate as board members of their professional organizations. Comments on the survey, as well as in informal conversations throughout the week, indicate that many participants were not

expecting the summit to have as strong an impact as it did. In particular, a few people commented on the extent to which people were able and willing to question their own assumptions and be open to others' perspectives, even after (for some of them) years and years of work in this area.

The summit also resulted in benefits to the field as a whole, including:

- Generating a more explicit body of collective wisdom about and critique of the PCK model has potential to increase the rigor and value of PCK research
- Creating better and more coherent definitions, measures, and frameworks for PCK has potential to enhance the status and usability of PCK research
- Clarifying PCK and making its definition more unified makes the construct more usable and applicable, which can help teacher educators who work in both new and experienced teacher development
- Strengthening the PCK community and field contributes back to individual researchers and their formation of a generative and valuable research trajectory.

On the survey, 100% of participants agree that the summit has potential to advance the collective development of PCK-related work to a great or very great extent. In addition, 100% believe that the summit and its follow-up activities have a lot or a great deal of potential to raise the visibility and stature of PCK in STEM education. Sample comments on the benefits to the field:

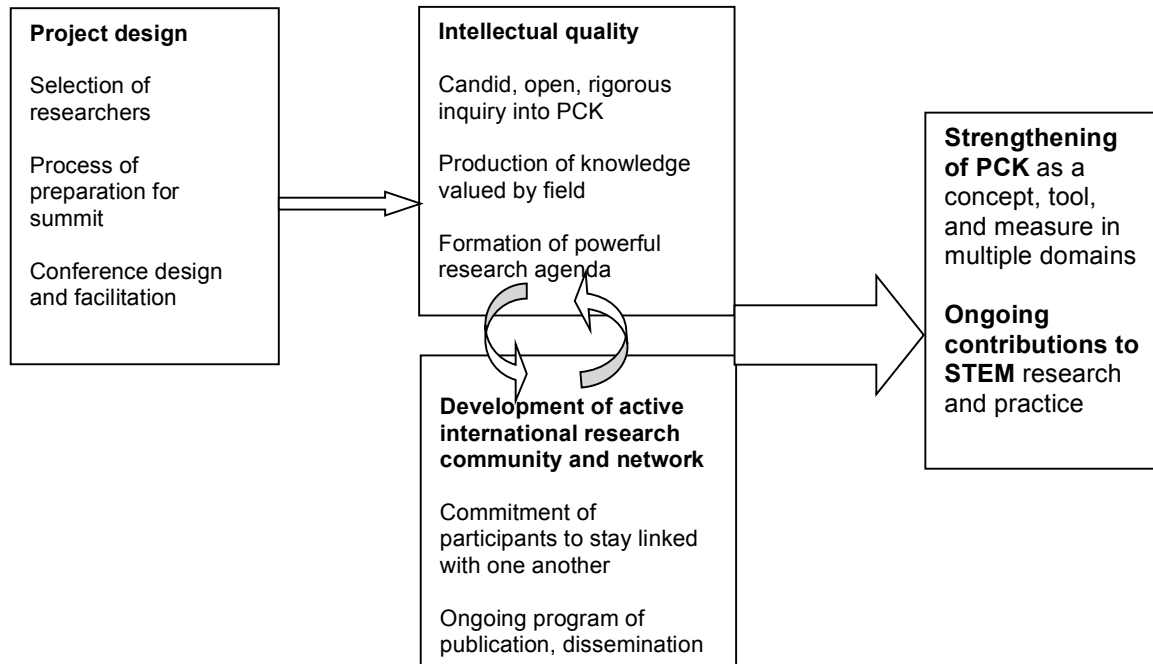
The field was, in my view, at a difficult point pre-summit, as it lacked a clear theoretical framing. The summit, while not solving this entirely, achieved a means of opening up discussion, prompting a move towards consensus. This has the potential to be powerful for developing the work.

I think we all have a better sense of how to discuss our work in relation to an overall research agenda. Some of our work will address the nature of teachers' PCK, the types of knowledge that are drawn upon to develop PCK, the filters between knowledge and practice, and the relationships between PCK and student outcomes. If we all think about these areas of research and explicitly report how our work is contributing to greater understanding in the areas, it will be a very helpful thing in terms of improving teacher preparation and professional development initiatives.

I think that if we really get a common theory and we work on that it is possible starting to establish the foundation of a renewal model of PCK.

The diagram below depicts the ways in which the design and conduct of the meeting functioned to generate reciprocal benefits to the field and to individuals.

Figure 2. The PCK Summit design and outcomes



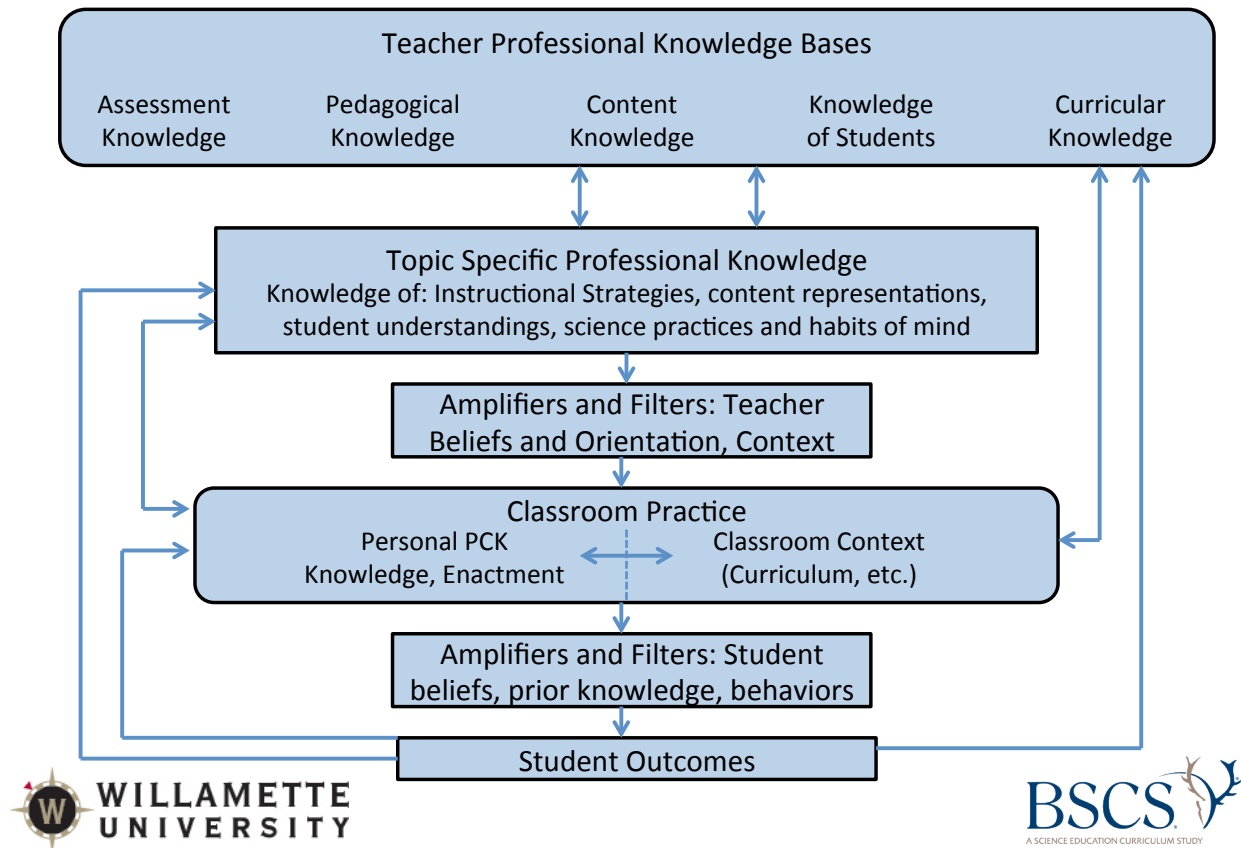
The summit provided opportunities that enabled participants to work together on a set of issues in a way that is uncommon in academic work. The tone and purpose were anchored in the rigor of a true inquiry. While the ultimate outcomes of the summit remain to be seen, the immediate indicators suggest that the Summit was quite successful at supporting the development of a reciprocal relationship between strengthening individual scholars’ engagement with and knowledge of the critical issues and questions they face as PCK researchers and the development of a strong research community that can move the work forward to make a greater contribution to science education.

Appendix A: PCK Summit Participants

NAME	ROLE	WORKPLACE
Janet Carlson	PI	BSCS, Colorado, USA
Julie Gess-Newsome	PI	Willamette University, Oregon, USA
April Gardner	PI	BSCS, Colorado, USA
Amanda Berry	Participant	Leiden University, Australia
Rebecca Cooper	Participant	Monash University, Australia
John Loughran	Participant	Monash University, Australia
Andreas Borowski	Participant	RWTH Aachen University, Germany
Hans Fischer	Participant	University Duisburg-Essen, Germany
Sophie Kirschner	Participant	University Duisburg-Essen, Germany
Andoni Garritz	Participant	Universidad Nacional Autónoma de México, Mexico
Kira Padilla	Participant	Universidad Nacional Autónoma de México, Mexico
Jan van Driel	Participant	Leiden University, Netherlands
Ineke Henze	Participant	Leiden University, Netherlands
Elizabeth Mavhunga	Participant	Marang Centre, Wits University, South Africa
Marissa Rollnick	Participant	Marang Centre, Wits University, South Africa
Vanessa Kind	Participant	Durham University, UK
Rebecca Schneider	Participant	University of Toledo, Ohio, USA
Aaron Sickel	Participant	Ohio University, Ohio, USA
Sean Smith	Participant	Horizon Research, Inc., USA
Eric Banilower	Participant	Horizon Research, Inc., USA
Soonhye Park	Participant	University of Iowa, Iowa, USA
Jeekyung Suh	Participant	University of Iowa, Iowa, USA
Patricia Friedrichsen	Participant	University of Missouri, Missouri, USA
John Lannin	Participant	University of Missouri, Missouri, USA
Kirsten Daehler	Participant	WestEd, USA
Lee Shulman	Special guest	Stanford University, USA (via Skype)
Heather Hill	Special guest	Harvard University, Massachusetts, USA
Jenifer Helms	Evaluator	Inverness Research, USA
Laura Stokes	Evaluator	Inverness Research, USA
John Settlege	Facilitator	University of Connecticut, Connecticut, USA
Joe Taylor	Facilitator	BSCS, Colorado, USA

APPENDIX B: GRAPHICAL DEPICTIONS OF PCK

1. PCK “Consensus Model” created at the conclusion of the Summit



2. Samples of working models generated in small group discussions during the Summit

