Encouraging Asian academic STEM teachers to research their own teaching practice

Anders Berglund
Uppsala Computing Education
Research Group, UpCERG
Dept of IT, Uppsala University
Uppsala, Sweden
Anders.Berglund@it.uu.se

Mats Daniels
Uppsala Computing Education
Research Group, UpCERG
Dept of IT, Uppsala University
Uppsala, Sweden
Mats.Daniels@it.uu.se

Jake Reardon
External Relations Team
Faculty of Science
University of Southern Denmark
Odense, Denmark
jare@sdu.dk

Abstract— **It might be a challenge for a STEM researcher to engage in research that is not directly relevant to his or her own field of specialization. The CUP EASTEM course, described in this paper, aims to support academic Asian STEM teachers in overcoming the challenge of researching their own teaching practices. In this paper we discuss, with CUP EASTEM, as a case study, how we have supported academic STEM teachers to take the steps needed to conduct research on their own teaching practices. The key is to broaden the perspective to also include theoretically sound, qualitative interpretative research. Furthermore, this is a journey that must be made without losing sight of the object of the students' learning, that is, the fundamental concepts within the STEM disciplines.**

Keywords—Student-centered learning, research approaches, qualitative research, STEM education

I. INTRODUCTION

It is a challenge for researchers, having their backgrounds in the STEM (Science, Technology, Engineering and Mathematics) fields, to investigate how their students learn within the discipline that they intend to teach. The challenge is largely due to moving into doing interdisciplinary research and in doing so typically moving from using quantitative research methods to qualitative research methods

In this paper, we discuss a course, CUP EASTEM, (Collecting, Understanding and Publishing for the EU funded capacity building project Euro-Asian Collaboration for Enhancing STEM Education), aiming at encouraging and inspiring Asian academic teachers within the STEM disciplines to investigate their own teaching practice, as well as the STEM teaching within their own institutions [1], [2].

The EASTEM project, a Horizon 2020 Erasmus+ Capacity Building project in the field of Higher Education (KA2), aims to bridge the gap between industry and universities, facilitating employability of graduates through student-centered competence development. Partner institutions in Indonesia, Thailand and Vietnam were encouraged to induce changes in their education to become more student-centered, and to create local infrastructures for making these changes sustainable. As the CUP EASTEM

course was given during the Corona pandemic, it was intentionally organized as four consecutive on-line seminars, intertwined with discussions over various electronic fora and exercises to be done between the seminars. We, the course organizers, facilitated the course in a student/participant-centred way to lead by examples, engaging in the very practice we were teaching, learning alongside participants and influencing group learning.

This paper is intended to serve as inspiration for how learning and teaching of theoretically sound qualitative research methods can be integrated into a developmental project by telling the story of CUP EASTEM as a case study. The remaining parts of the paper describe the ideas underlying CUP EASTEM, present the course in further detail, explore what influence the course has had on the EASTEM project, and discuss, built on the experiences of the authors, what learning that took place among the participants.

II. BACKGROUND

There is a more or less shared understanding in the research community on what the term "research" means, here expressed by a quote from Earl Robert Babbies (1998): "Research is a systematic inquiry to describe, explain, predict, and control the observed phenomenon." [3] However, there are important differences between how the phenomena of interest are identified, and on what grounds different theoretical and methodological underpinnings are selected. Understanding what evidence is, what it means "to measure" something, what the role of the researcher is, and what "data" is, are all issues that, to a certain extent, are linked to the research approach used in a specific project, see for example [4].

It can be a demanding endeavor for researchers having their academic background in the STEM fields to do high-quality disciplinary-based educational research [5]. Despite many values and practices being shared between different fields of research, there are also important differences. While STEM research can mainly be found in a positivistic tradition, often searching for numeric, exact, detailed answers that could be used for predictions, research based in the social sciences (often referred to as non-positivistic or interpretative) normally searches for a broad picture based on interpretations of how people understand different situations [6], [7] and [8]. The various notions of research normally require different underlying theories, a varying use of methodologies, and different assumptions of what the task and the role of a researcher is.

Maybe the field of discipline-based education research (DBER) [6] [9] is among the most difficult, as both the STEM field (in terms of the object of the students' learning) and the social sciences (in terms of methodological consideration) come into most projects.

The ways of valuing research quality is also contextually bound and vary over the fields, review contexts and policies [10]. Still, one can argue that "originality/novelty, plausibility/reliability, and the value of usefulness" are common understandings of what 'good' research is. [10, p. 120].

Seeing the capability of discussing teaching and learning as an integrated part of an academic competence is discussed by Boyer [11]. He offers four categories of scholarship: 1) discovery; 2) integration; 3) application, and 4) teaching and learning. The fourth (the scholarship of teaching and learning) "encompasses a broad set of practices that engage teachers in looking closely and critically at student learning in order to improve their courses and programs, and to share insights with other educators who can evaluate and build on their efforts" [12, p. xix]

According to the experiences of the authors, quite a number of researchers change, or complement, their fundamental ways of understanding research during their academic careers. However, only a few of these are explicitly documented, as for example [8] and [13]. Courses and seminars with similar aims are plentiful in the world, at different levels, spanning from Master level courses to staff development courses intended for experienced researchers, see for example [14] and [15].

III. PURPOSE

There are several reasons for our initiative to offer the CUP EASTEM course as a part of the EASTEM project. First and foremost, we wished to support Asian academic STEM teachers at the partner institutions to overcome the differences between the various perspectives on research, and particularly to increase the possibilities to get papers accepted at discipline-based educational research conferences and journals. We also intended to broaden the teachers' perspective of what research in their field is, to also encompass Boyer's fourth category, scholarship of teaching and learning. Further, arguing with [12], we believe that the results of EASTEM [1] ought to be widely disseminated. After two years of discussions, many partners still struggled with seeing how qualitative data in STEM could be academically meaningful. This course provided hands-on experience for partners to experience the scientific impact and relevance of qualitative data through their own activities and reflections.

An additional important outcome of the CUP EASTEM effort was to create a "momentum" in the EASTEM project despite the pandemic. The "momentum" was created by introducing a joint activity for the project participants, Asian, as well as European.

IV. THE CUP EASTEM COURSE

The course was offered in May and June 2020 and was described in the following way in the initial presentation for the participants:

After CUP EASTEM the participants should have the intellectual tools and methodologies to make and publish small studies from their local EASTEM projects. These studies should be aimed for conferences in STEM education and for the mid-term report [a mandatory quality assurance requirement from European Union-funded programs].

The course was given in four seminars, each of them collecting around 25 participants. All Asian and some European partners attended at least one of the seminars, and many attended all. Furthermore, several partners (Chiang Mai University, Del Institute of Technology, Bandung Institute of Technology) shared their learning, perspectives, or roadblocks that not only encouraged participation but prompted additional dialogue that would otherwise not have been possible.

The course was centered around four seminars. The focus of the four seminars were as follows:

1. Introduction. Quantitative and qualitative research. Rigor in qualitative research. Research questions.

2. Phenomenography. Practical work on data offered by the seminar leaders.

3. "Getting your hands dirty on your own data." How to read, understand and analyze data. Practical work on local data.

4. Joint discussions on on-going work. Future plans.

The first seminar served as an introduction highlighting distinctions between different research approaches (or research paradigms). Issues like quality, trustworthiness etc. were discussed, with the aim of opening for seeing qualitative research as trustworthy and useful for certain questions, such as small-scale studies on outcomes of, and attitudes to, learning.

The participants worked in small groups on qualitative data during the second seminar. The data came from an earlier study by the first author, and was adapted and anonymized. The aim of the seminar was to empower participants to create a phenomenographic outcome space, or alternatively another kind of relevant categorization. One of the authors has successfully applied this seminar structure before [16]. After this seminar, participants were able to identify and employ questions to extract qualitative data from their teachers and students using a semi-structured interview template

Figure 1. The first author discussing research approaches.

The third seminar pushed the idea of student/participant-centered learning one step further. The participants were asked to collect data, for example in the form of interviews (often by chat or video due to the pandemic) from their own institutions. These were jointly analyzed and discussed. The differences between qualitative research approaches became visible, and actions to take to assure quality of the data were discussed. For example, a participant from Thailand captured pro/con data from teachers who reflected on their transition to remote/online teaching and learning, which the entire class could then analyze and classify, extracting themes or observations from the data as a practice for when they would collect and analyze data of their own.

The fourth seminar continued the work from the third, in that the participants presented on-going or planned qualitative research, particularly how to analyze data that had been collected by the participants during the course. Further, the discussions concerned venues for publishing and what to consider when submitting papers to discipline-based educational research conferences or journals.

V. OUTCOME

Evaluating a seminar series like this is a challenge, as the effects of the participants' learning, if any, do not become visible directly. Instead, the participants are introduced to a new way of thinking that later may appear in their work. This activity explicitly encouraged a new approach to research, teaching, and led to the writing of papers in areas that otherwise would not been approached (or have been approached with doubt).

Still, in viewing the CUP EASTEM project as a case study, there are several indicators that we can use to confirm our thoughts and actions were supported through this course. While these indicators are both direct and indirect, we argue that when they are taken together, provide a relevant picture of the CUP EASTEM project.

First of all, the attendance of approximately 25 participants per seminar is relatively high, as the project consists of 10 Asian partner universities, as well as the 3 European partners. The atmosphere throughout all seminars was open and supportive, with a balance of formal presentations and relevant questions and informal discussions. More than 80% of the participants kept their cameras on, allowing for an interactive communication, making it possible to offer this course as an example of student-centered learning (SCL).

A survey consisting of four open-ended questions after the last seminar received 7 answers, well distributed over the different partners. Without exception, all answers to the different questions were positive.

We illustrate this by some of the answers to the first question:

"What would you say you learned by participating in CUP EASTEM? Please elaborate."

I have learned how to do Qualitative research systematically. I also have learned how to read, and analyse data during my research.

The seminars gave me very much bright insight into how to do education research especially in a qualitative way. Of course, I still need more practice and advice from the experts, but I know how to start such a research.

The remaining three questions were more focused on the continuous work of the EASTEM project, and how CUP EASTEM fit into the whole of the activities.

It is impossible to judge if CUP EASTEM really has increased the publication rate on the EASTEM project from the Asian partners for several reasons: Covid-19 has changed the daily work at many institutions. Conferences have been cancelled or postponed. Further, as we pointed out above, the lead

time from gaining insights in a new way of doing research (in this case by attending CUP EASTEM) until a paper is publishable is considerable in academia. And finally, this course is a part of an on-going project, where the research methods discussed are intended to be used mainly in the writing up of the final EASTEM report.

VI. CONCLUSIONS

As a result of CUP EASTEM being offered we find that the bar to discuss qualitative research and the openness to see "research", "results" and similar terms were broadened. Further, participants were empowered to work in a student-centered way. From the perspective of the EASTEM project, perhaps the most important aspect is that we kept the built mutual trust within the project alive with strong bonds between participants during the difficult time of Covid-19.

There are also some minor changes that stems from the course that we wish to highlight.

- We are aware of over 20 papers being in preparation (at least an abstract was written or data collected), submitted, or published early 2021. Approximately half of these apply different kinds of qualitative methods directly influenced by the CUP EASTEM course and group discussions.
- The Indonesian and the Thai partners have, as a part of the EASTEM project, arranged four joint national courses on teaching for SCL, the largest of which included about 2000 participants. At the moment of writing, data intended for both quantitative and qualitative evaluations, have been collected, but not yet analyzed.
- The authors of this paper, who also are the leaders of CUP EASTEM, have observed a clear change of attitude, in terms of, for example concerning the kind of questions asked and for wishes getting feed-back on research ideas among the participants towards qualitative research. This is particularly evident in bimonthly project meetings, where participants actively submit questions for feedback.
- CUP EASTEM has directly contributed to the EASTEM project's momentum, increasing dialogues and advancing ideas despite Covid-19 lockdowns and barriers to in-person meetings.

As a summary, the indications presented in this case study supports our thinking in that we made a difference, kept the momentum going in the project, and strengthened our relationships and collaborations in the project in a meaningful, productive, scientifically sound and intentional manner.

ACKNOWLEDGEMENT

REFERENCES

[1] A. Berglund, V. Dagiene, M. Daniels, V. Dolgopolovas, S. Rouvrais, and M. Tardell, 'Euro-Asia Collaboration for Enhancing STEM Education', in *In proceedings of the 5th APSCE International Conference on Computational Thinking and STEM Education 2021*, Singapore, 2021, pp. 136–140.

[2] 'Euro-Asia Collaboration for Enhancing STEM Education'. Accessed: Apr. 28, 2021. [Online]. Available: https://eastemproject.eu/

[3] E. Babbie, *The practice of Social Research (6th Ed.)*. Belmont, CA, USA: Wadsworth, 1992.

[4] A. Pears, N. Thota, P. Kinnunen, and A. Berglund, 'Harnessing theory in the service of engineering education research', Piscataway, NJ, USA, 2012, pp. 391–395.

[5] S. R. Singer, N. R. Nielsen, and H. A. Schweingruber, Eds., *Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering*. Washington, D.C., USA: National Academic Press, 2012.

[6] C. S. Reichardt and S. F. Rallis, Eds., 'The Qualitative-Quantitative Debate: New Perspectives', *New Dir. Program Eval.*, vol. 61, pp. 1–98, 1994.

[7] A. Berglund, M. Daniels, and A. Pears, 'Qualitative Research Projects in Computing Education Research: An Overview', *Aust. Comput. Sci. Commun.*, vol. 28, no. 5, pp. 25–34, 2006.

[8] I. A. Rind, 'Becoming a Qualitative ESL Researcher: A personal monologue', *J. Lang. Educ.*, vol. 7, no. 1, pp. 219–228, 2021.

[9] C. Henderson *et al.*, 'Towards the STEM DBER Alliance: why we need a discipline-based STEM education research community', *Int. J. STEM Educ.*, vol. 4, no. 14, 2017.

[10] L. Langfeldt, M. Nedeva, S. Sörlin, and T. Ducan, 'Co-existing Notions of Research Quality: A Framework to Study Context-specific Understandings of Good Research', *Minerva*, pp. 1–23, 2019.

[11] E. L. Boyer, *Scholarship Reconsidered. Priorities of the professoriate.* San Francisco, CA, USA: Jossey-Bass, A. Wiley Imprint, 1990.

[12] P. Hutchings, M. T. Huber, and A. Ciccone, *Scholarship of Teaching and Learning Reconsidered. Institutional Integration and Impact.* San Francisco, CA, USA: Jossey-Bass, A. Wiley Imprint, 2011.

[13] M. Daniels, *Developing and Assessing Professional Competencies: a Pipe Dream? Experiences from an Open-Ended Group Project Learning Environment*. Uppsala, Sweden: Acta Universitatis Upsaliensis, 2011.

[14] A. Berglund, A. Pears, A. Nylén, and F. Ahmad, 'Teaching and Learning Computer Science at Al Baha University, Saudi Arabia: Insights from a staff development course', Los Alamitos, CA, USA, 2015, pp. 1–6.

[15] A. Berglund and N. Thota, 'Computing education research course: Student-centric pedagogy with active student engagement.', presented at the NU 2012, Gränslöst lärande, Göteborg, Sweden, 2012.

[16] A. Berglund, I. Box, A. Eckerdal, and R. Lister, 'Disseminating phenomenography: Workshops for the computing education research community', presented at the EARLI SIG 9 Workshop on Phenomenography and Variation Theory: Implications of Phenomenography and Variation Theory in Practice, Sweden, Kristianstad, Sweden, 2008.