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Published online: 19 Sep 2022.

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Seeing and seeking relevance in the challenges of a STEM school–university partnership

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ABSTRACT

School–university partnerships can be fertile environments for collaboration by educators and researchers. So far, studies of these partnerships have mostly focused on identifying partnership challenges and presenting them as difficulties to be prevented or solved. In this case study, we examine challenges in relation to the partnership's future directions, using a boundary-crossing perspective. We pose that some challenges, experienced by partners as discontinuities in perspectives and/or practices, are connected to envisioned opportunities for boundary crossing, and thus hold potential for partnership advancement. We provide proof of concept by analysing the challenges and opportunities of a STEM school–university partnership between 48 high schools and two universities (one research university and one applied sciences university) that offers an enrichment program for secondary school students and teachers. Data involved partnership documents, 12 semi-structured interviews, and 42 survey responses from partners of schools and universities. By presenting this case study, we show that partnership challenges are connected to expansive opportunities posed by partners, and this connection is relevant to the advancement of the program and the collaboration between partners, as well as the emergence of new purposes.

School–university partnerships have shown to be fertile environments for collaboration between researchers, teachers, and other education professionals (e.g. Breault & Breault, 2010; Farah, 2019; Stevenson Jr & Shetley, 2015). In the last decades, school–university partnerships have become increasingly complex, varied in type, and covering a wide range of activities, often beyond a single function (Teitel, 2008). Partnerships exist, for example, with the functions of teacher professional development, preparation of students for university, development of school-based educational research, or research-based education. Research has shown that educational partnerships' work can result in advancing purposes in the wider field (e.g. closing an achievement gap, see Coburn & Penuel, 2016). This highlights the value of investing in their support and improvement.

There is increasing research on identifying partnership challenges (e.g. Babiak & Thibault, 2007; Martin et al., 2011; Smedley, 2010). Some of partnerships' challenges are the lack of common language and the clash of cultures between partners with different professional expertise and training (Coburn & Penuel, 2016; Ebbutt et al., 2000), or the existence of competing professional pressures that undermine the time spent in the partnership (Breault, 2013; Walsh & Backe, 2013). These

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challenges are presented as difficulties or obstacles to be prevented or solved, for which solutions are now starting to be offered in the form of particular partnership designs, supporting conditions, or collaboration strategies (e.g. McLaughlin & Black-Hawkins, 2007; Myende & Chikoko, 2014; Jackson & Burch, 2018). So far, however, few studies have focused on the intrinsic value of partnership challenges for partnership work (see Tsui & Law, 2007, for an exception). Moreover, the focus of studies up to date has been more on tackling challenges in order to secure the attainment of partnership goals or improve the outcomes of partnerships' interventions and seldom on the value of the partnerships' collaboration for the partners involved (Coburn & Penuel, 2016). A consideration of the value for partners goes beyond established goals and targeted outcomes and draws our attention to what space a collaboration between institutions, actors, and practices opens up, which by virtue of new relations can also include unforeseen opportunities (Akkerman & Bakker, 2011; Penuel et al., 2020).

Research suggests that crucial challenges faced by school–university partnerships result from the fact that 'partners are working across institutional, cultural, and professional divides' (Penuel et al., 2015, p. 194). Challenges have also been presented as 'gaps' (Farley-Ripple et al., 2018) or 'tensions' (Lillejord & Børte, 2016; Martin et al., 2011) between partners' perspectives and/or practices. This is why the concepts of boundaries and boundary-crossing, as formulated by Akkerman and Bakker (2011), may be a promising path to understand the relevance of partnership challenges (Penuel et al., 2015). Boundaries are defined 'as sociocultural differences that give rise to discontinuities in interaction and action' (Akkerman & Bakker, 2011, p. 139). For example, the differences in expertise of partners in different positions of the partnership may result in a tension felt by partners as they work together. An expert in STEM education and a researcher may differ in their ideas about conveying knowledge to students, and this may be identified as a challenge by these professionals. The boundary-crossing perspective can be thus used to analyse the challenges brought forward by partners, which arise from the discontinuities experienced by partners while working towards specific purposes. Penuel et al. (2015) proposed that paying attention to discontinuities experienced by partners is particularly important for partnership advancement. Navigation of challenges arising from discontinuities requires boundary crossing, that is, establishing or restoring continuity between partners' perspectives, practices, and even physical and sociocultural settings (Akkerman & Bakker, 2011). Attention to discontinuities and the envisioning of boundary crossing can help organize the collaboration, ensure mutualism, resilience, and continuity of the work within the partnership and has additional benefits, such as surfacing a group's expertise and its utility for partnership processes (Quick & Feldman, 2014).

The school–university partnership of this case study invited the authors to conduct an evaluation of the partnership and the program delivered by it. The general goals of the evaluation were accorded with the program leader (director), after which the research was conducted by the authors independently. This study, which examines the challenges and opportunities of the partnership, is a part of that research evaluation. The aim of this study is to revisit the notions of a partnership challenges, perceiving them not merely as difficulties to prevent or solve, but as linked to expansive opportunities and as emerging insights of partners into what is and can be of relevance for the partnership in the future. To achieve our aim, we investigated the challenges brought forward by partners in one school–university partnership located in the Utrecht region, the Netherlands and how they connected to partners' envisioned opportunities for the partnership. School–university partnerships are common in the Netherlands, fulfil varied functions and sometimes receive government support (Akkerman & Bruining, 2016). The partnership that constitutes our case study delivers programs for secondary school students and teachers of the region. It puts a strong emphasis on student development, a fact that differentiates it from other Dutch school–university partnerships that focus, for example, on teacher professional development (personal communication, program manager). Its origins trace back to 2004, a moment in which there was a call for programs that would help develop students' talents in STEM. These characteristics and its overall success make this school–university partnership a

rich case for our aim of studying the relevance of partnership challenges in light of the opportunities partners envision for the partnership.

Theoretical background

The term 'partnership' has been widely used and debated in the literature (Coburn et al., 2013). In this study, 'partnership' specifically refers to a long-term collaboration between schools and two universities, that fulfils common goals through educational functions such as students' education and teachers' professional development (cf. Farah, 2019). The term 'partner' refers to individual persons or to groups of persons, identified by their professional practice or main activity within the partnership (e.g. school teachers, university researchers, program staff), or the organizational units to which persons belong (e.g. school, university).

A boundary-crossing perspective on partnerships finds its roots in both cultural historical theories of learning (e.g. Engeström & Sannino, 2011) and the sociology of science (e.g. Star & Griesemer, 1989). Partnerships reveal different ways of working, different bodies of expertise, different perspectives, and different discourses, that on the one hand indicate the purpose of working together, but at the same time challenge partners in doing collaborative work (Akkerman & Bakker, 2011; Engeström et al., 1995). Using the earlier defined concept of boundaries, thus, challenges can be understood as arising from *discontinuities between perspectives and/ or practices* as they move within and between domains such as physical places, or jobs or functions and that are seen as demanding for partnership work (Akkerman & Bakker, 2011; Engeström et al., 1995).

The boundary-crossing perspective allows to focus not only on how partners experience and handle discontinuities between perspectives and/or practices, but also what and how continuities are then apparently and subsequently searched for. It has been suggested that partnerships are not static but evolve and are driven towards change and new directions and purposes (Callahan & Martin, 2007; Coburn & Penuel, 2016; Penuel et al., 2015; Tsui et al., 2008). In the face of discontinuities, partners continually envision opportunities (in the form of boundary crossing) to achieve specific purposes. Partners' purposes can be understood as instances where partners finally manage to engage in boundary crossing, that is to establish or restore *continuity in action or interaction* across practices (Akkerman & Bakker, 2011).

We pose that revisiting the notion of partnership challenges through the concept of boundaries can help uncover the hidden potential of these challenges for attaining specific purposes. In this study, we therefore focus on partnership challenges as difficulties arising from experienced discontinuities and on the relevance of attending to such discontinuities by finding how they connect to the envisioned opportunities for boundary crossing (see diagram of our conceptualization in Figure 1).
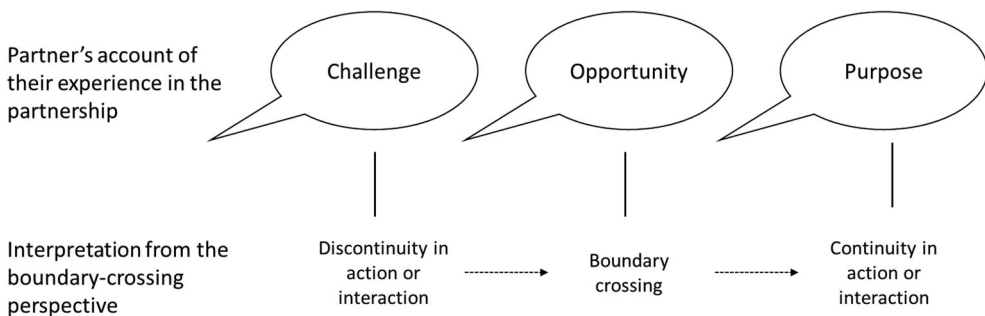
Figure 1. Conceptualization of challenges, opportunities and purposes of a school–university partnership, using the boundary-crossing perspective.

Research questions

The following research question and sub-questions were leading:

What relevance can be seen in the challenges of a school–university partnership?

(a) What challenges arising from discontinuities between perspectives and/or practices do partners experience in the school–university partnership?
(b) What opportunities for boundary crossing do partners envision for the school–university partnership?
(c) How do the challenges and opportunities of the school–university partnership relate to each other?

Methods

Partnership organization

Before looking for an answer to our research questions, we mapped and described the partnership by examining and analysing publicly available program documents[1] and the program website and conducting 1-hour consultations of the first author with three members of the program staff (the office manager, program manager, and program leader). The program leader is the highest responsible member of the program, the program manager is mainly responsible for program delivery and organization (e.g. curricula and planning of program activities with other members), and the office manager is responsible for online communications with members of the partnership and program participants, as well as keeping track of partnership meetings. Through the information obtained from these sources, we were able to understand the school–university partnership's history, functions, and organization. The first author has been involved with the partnership for the last two years, working as an intern first and as a junior researcher later.

Challenges and opportunities

After achieving a general picture of the partnership's functions and key partner groups and their activities, we inquired into partners' experienced challenges and their related envisioned opportunities for the partnership by using a survey ($n = 42$) and semi-structured interviews ($n = 12$) with partners from school and university. Both the questionnaire of the survey (Appendix 1) and the interviews (see Appendix 2 for the interview guide) included questions on participants' views on the roles, activities, and contributions of the different partners (including those of the interviewees) (cf. Akkerman & Bruining, 2016), as well as their thoughts on the purposes and value of the collaboration for all partners involved. Through the survey, we aimed at an overview of all the challenges and opportunities identified by all the different groups of people belonging to the partnership. The interviews were aimed at complementing the survey by allowing elaboration, clarification, and illustration of the challenges and opportunities appearing in the survey findings (Bryman, 2006).

Data Collection. The data collection through the survey and interviews was conducted during the same period of time (February–May 2020). We disseminated the survey online (Qualtrics, 2020) in Dutch by emailing all members of the six key groups of the partnership at the time of the study (except for those invited to an interview; see below). The invitation resulted in different numbers of respondents for each partnership group, with the group of school leaders having less coverage (Table 1). They were completed in an average of 15 min. Survey participants agreed to the authors using their data for research goals by checking a box in the online questionnaire. The interviews were conducted in English and took approximately one hour each. The first author interviewed people from six groups within the partnership (Table 1). We selected the interviewees in

Table 1. Number of people of each group of the school–university partnership who participated in the study.

Organizational unit/ Partner	Group	No. of interviewed or consulted people	No. of questionnaire respondents	Number of people per group
Program				
	i. program staff	5	2	10
	ii. program teachers	3	8	13
	iii. steering committee	1	–	9
School(s)				
	iv. school coordinators	1	23	∼48*
	v. school leaders	1	7	48
University				
	vi. transition coordinators	3	2	7

*The number of school coordinators per schools varies: most schools have one coordinator, while a few have two.

consultation with the program leader and manager (in the consultations). In this consultation, we explained that we were looking for interviewees who had been members of the partnership for several years and had had active roles within it. The program leader and manager gave us a list of interview candidates. We contacted all 25 of them by email to invite them to an interview. Of this total, 12 of them agreed to the interview, five declined for reasons such as lack of time or not working in the partnership anymore, one claimed that she preferred to work more time on the partnership before doing such an interview, and seven did not reply. The interviewees signed an informed consent form agreeing to the conditions of the interview.

Data Analysis. We first identified the challenges that partners said to experience from their own positions in the partnership. *Challenges* were operationalized as difficulties arising from discontinuities encountered by partners between their own and other people's perspectives and/or practices, and that were perceived to be challenging as they strived toward specific purposes envisioned by partners. Next, we identified which opportunities partners discussed in relation to the program and the collaboration. We operationalized *opportunities* as directions of boundary crossing, either already existing or not yet existing, that partners discussed as desirable in relation to specific purposes. In their accounts, partners framed opportunities directionally, in the manner of intentions, future plans, or desired steps that would lead to achieving certain purposes (see Figure 1). For the identification of both challenges and opportunities, we conducted a mixed content analysis of our interview and survey data (answers to the open questions of the questionnaire) by combining inductive and deductive coding phases in a sequential manner. In a final step, we examined the connection between challenges and opportunities to determine their relevance for the partnership's advancement. In the following we describe the analytical procedure in more detail.

The interviews were transcribed verbatim and both interviews and questionnaire answers were read several times to attain familiarity with the data. In the first phase of coding, we read each interview and questionnaire answers line-by-line, and inductively identified and coded fragments where partners pointed to partnership challenges. The coding was conducted by the first author and checked afterwards by the second author. This check led to refining criteria for what was meant as discontinuities in practices and/or perspectives that led to challenges, as experienced by the partners. In the second phase of coding, the first author assigned descriptive codes to the fragments referring to challenges, in relation to its content. These resulted in several fragments being grouped under the same label if it concerned a similar challenge (if the same boundary and groups of people were involved; see Table 2 for a list of codes along with example utterances from partners' accounts).

The authors collaboratively grouped the descriptive codes and their corresponding fragments into six main themes: conceptions of students and education, interests and goals for the program

Table 2. Themes used in the content analysis found in partners' accounts, along with examples of codes pointing to partnership challenges and opportunities.

Theme	Examples of fragments and codes – Challenges	Examples of fragments and codes - Opportunities
Conceptions of students and education	'Some partners think that HAVO students do not want to learn science, because they are not VWO students. They do want to learn, they just need different things' [views of HAVO vs VWO students]	'We are working so that in the future U-Talent will have more students from more diverse backgrounds' [broadening the program student population]
Interests and goals for the program and collaboration	'Why do you only do maths and natural sciences and not the entirety of disciplines? We have a lot of students who might be interested in it' [schools ask for social sciences and humanities]	'I really hope that we can really, in the long term expand the program (…) from STEM to the humanities and other fields.' [broadening to social sciences and humanities]
Program implementation in partner schools	'It's a challenge to adapt the program to the school's structure' [program integration into the school curriculum]	'In the future I would like to visit the partner schools to see the differences in the program and see how they can help each other' [school visits facilitate exchange]
Program development in university	'As a teacher, to know enough about a topic which you don't do any research in … Is what you know enough to be able to convey this topic to your students?' [university knowledge and its representation in program materials]	'With my colleagues I have made a collaboration and we will be teaching a module on astrobiology, vey new' [innovative educational materials]
Program structure and organization	'Synchronizing and planning the school and program agendas is challenging' [timing and deadlines]	-
Motivating others to participate	'You can see in the meetings that some school leaders come but they sit in the back and they do not say anything. It's a challenge to get them to participate' [low participation of school leaders in meetings]	-

and collaboration, program implementation in partner schools, program development in university, program structure and organization, and motivating others to participate.

To identify opportunities in partners' accounts, we followed a similar procedure to that described for the examination of challenges: Reading, identifying, and coding fragments and grouping under codes or labels. We assigned and distributed the 35 descriptive codes pointing to opportunities among the themes used for the challenges.

As a final step, we examined the relevance of the challenges in light of the related opportunities. We found the opportunities to be related to four themes of the challenges. No additional themes were needed to categorize the descriptive codes referring to opportunities. As a result, we divided the six themes of the challenges into groups: (1) purpose-oriented, and (2), basic challenges. Purpose-oriented themes of challenges related to partners' envisioned opportunities and purposes for the program and/or collaboration. Basic themes of challenges involved prerequisites for the collaboration and program to function efficiently. In contrast to purpose-oriented challenges, partners did not mention opportunities for partnership advancement in relation to the themes of these challenges.

As a mode of corroboration of the data found in the survey and interviews, we examined 18 documents containing notes from 2019–2020 meetings between partners. The notes were used after the rounds of coding as a means of triangulation by inquiring into the convergence of findings with interviews and surveys (Bryman, 2006). We read each document line-by-line and identified and coded fragments where partners pointed to partnership *challenges* or *opportunities*. Subsequently, we assigned these challenges or opportunities a descriptive code from the ones previously utilized in our analyses. No additional codes were needed. No additional challenges or opportunities were present in the notes that had not been found in the interviews and survey already. We saw this as a sign of saturation.

Results

The school–university partnership

The school–university partnership that constitutes the case of our study involves a research university, an applied sciences university, and 48 secondary schools of the Utrecht region in the Netherlands (https://u-talent.nl/eng/). According to the partnership's website and documents, the origins of the partnership can be traced back to 2004, when the Faculty of Science of the research university started offering a 2-year challenging STEM program for gifted secondary school students (100 per cohort) who came to the university two days per week (Michels & Eijkelhof, 2018). This program lasted until 2014. In 2014, the research university's Faculty of Science, the applied sciences university, and partner schools teamed up, this time to offer a wider range of activities (the 'program') to a much larger group of secondary school students and teachers. The program offers challenging STEM programs for secondary school students and secondary school teacher professional development activities and conferences. Different activities of the program take place at university and in the participating schools. Additionally, the program emphasizes the networking and exchange between partners through routine meetings. The partnership is also at a moment of expansion (personal communication, program manager): For example, in the student education area, activities are being offered now not only in STEM but also in the social sciences and humanities, and two new programs for students have been created in the past couple of years (one focuses on female students and the other on students whose parents did not attend higher education).

Program and collaboration: the two main functions of the school–university partnership

People from school and university framed their activities either in terms of the program (with the partnership as a means of executing the program), or the collaboration (partnership) itself. In this study, 44 out of 54 partners talked in terms of the program as the main focus of their activities. For example, Claire, a member of the program staff, framed her activity in terms of the *program* in this way: 'I am responsible for a major part of the program management. So that's deciding which activities take place, when and where. And that's mostly for students' activities and for teachers' activities.' In discussing the program, partners framed the collaboration, implicitly or explicitly, as the means by which the program was realized. For example, the importance of a network of schools was highlighted in order for the schools to exchange ideas on how to implement the program at the school level. Additionally, 24 out of the same 54 partners also discussed the collaboration as the main focus of their activities in itself. For example, Sophie, also a member of the program staff, spoke of having the role of ensuring the collaboration's continuity: '[The partnership] is a long-term commitment … And so, my main role is to make sure that we will continue to exist in a way that is optimal for different partners.'

The data in this study thus show that the collaboration between partners may not just be a means to design and run a program but may also have become the focus of partners' activities in itself in the recent years of the history of the school–university partnership. For example, the program leader stated:

> I want to stress that collaboration [between partners] was one of the goals that were there in 2013. But I have a feeling that it was there but hadn't really lifted then. So, I think it's something that is in the last 3, 4 years being addressed more and more.

This suggests that the relatively stronger focus on the program or on the collaboration may have varied for the different partners along the history of the school–university partnership. Initially, the collaboration may have been created as a means, following the research university's initiative to create a STEM program for talented secondary school students. The partners' accounts and program documents hint that after the partnership was established, it may have become less central in

the following years, while the program may have gained prevalence and become the core of partners' activities. Presently, the partnership's policy plan states the following as the partnership goals:

(1) Strengthening science education in secondary and higher education in the region, (…)
(2) Communicating and increasing the value of the knowledge developed in university
(3) Building a sustainable network between science education stakeholders (schools, universities, and societal partners). (Program leader, personal communication, October 14, 2019)

The findings regarding Purpose (3) of this policy plan show that collaborating is thought of as an important function of the partnership.

Program organization

Program organization can be summarized as follows. Two groups of people within the university, the *program staff* (1 in Figure 2) and program *teachers* (2) (university teachers or other university employees), are based at the university and work in, for example, coordinating the program's agenda or developing and delivering activities and materials. *Transition coordinators* (6) connect the program staff to different university researchers, who, for example, supervise secondary school students in research at university. *School coordinators* (4) are based in the schools and connect the university to the school by, for example, recruiting *students* and *teachers* and informing them of the university-based program activities. They are also in charge of delivering part of the program content in the schools (from now on, the 'school program'). *School leaders* (5) play a supporting role for the school coordinators as well as exchange views with leaders from other schools in relation to their program participation. The *steering committee* (3), a group of school leaders and university professors and leaders, oversees the program's functioning.

Our analysis first led to the identification of the challenges that concerned the program or concerned the collaboration, experienced by partners as what we call discontinuities in perspectives and/or practices. The next analytical steps allowed us to examine the relevance of these challenges in light of the partners' envisioned opportunities for specific purposes or efforts towards continuities in action or interaction. In this way, the boundary-crossing perspective enabled us to, rather than present a mere list of difficulties to be solved, identify the challenges connected to
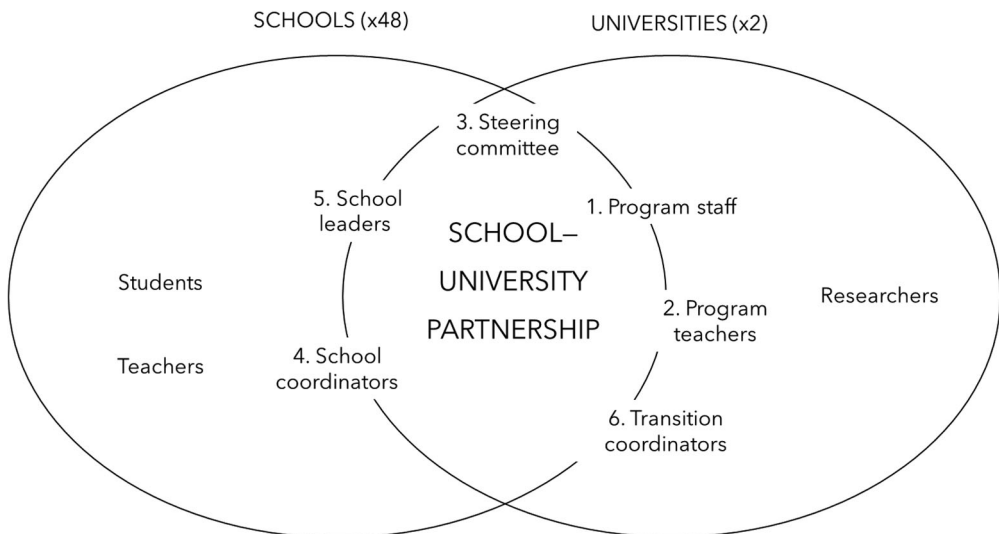
Figure 2. Partner groups and organizational units of the school–university partnership.

opportunities for partnership's purposes and advancement (Figure 1). In the following we present descriptions of challenges and opportunities, organized by their content (the themes found in our analysis).

Purpose-oriented challenges of the school–university partnership

Conceptions of students and education. Seven partners explained that while doing partnership work, they encountered differences (or *discontinuities*) between their own and other partners' conceptions of students and education. Differences in these conceptions constitute a challenge because they shape the partnership and program's vision and mission and the idea of who the program beneficiaries should be. For example, partners experienced discontinuities between their own and others' ideas on talent and the conception of 'talented student.' While some partners link talent to excellence and high performance, other partners associate talent with deep interest in a subject. Sophie, member of the program staff, explained that while she thought of 'talent' as an umbrella term for many students with different interests, schools, and other societal partners, however, appeared to interpret the program as still focused on a very select group of gifted students. Another example was given by Vera, also part of the program staff, who explained how her views on students from a particular track differed from the views of school leaders on these students. According to her, it was difficult to get the school leaders to incentivize these students to participate in the program, because they thought the students were not interested (which in her view was not true). These different conceptions become salient in discussions of who the main beneficiaries of the program should be, what kind of activities should the partnership offer, and what the program's place is in the wider societal and educational contexts.

We found that the navigation of different conceptions of students and education was not only interpreted as a difficulty in the partnership. Three partners also discussed opportunities that would entail *crossing the boundaries* between these conceptions and lead to partnership advancement. One example of this was the fact that some partners discussed the possibility of widening the student population that makes up the program beneficiaries. This would entail seeking the participation of students from more diverse backgrounds (e.g. students with parents of non-higher education backgrounds), either through the creation of new programs or the incorporation of these students to the 'mainstream' program. This suggests that, in navigating their own and others' conceptions of students and education, partners do not only find a challenge but also opportunities for partnership advancement. Furthermore, considering different conceptions of talent and excellence could also be valuable in advancing the contribution of out-of-school programs to a more equitable society.

Goals and interests for the program and collaboration. Another challenge of the partnership, discussed by three partners, was that of the differences (or *discontinuities*) between the goals and reasons partners have for participating in the program and collaboration. This challenge was mentioned by program staff as well as by other partners, such as transition coordinators and the steering committee member. When these differences are not made explicit, it could lead to a misalignment of partners' goals while working in the program, which subsequently could lead to working less efficiently on program goals. For example, speaking about the program, Sophie (program staff) explained:

> every single stakeholder within the cooperation has an own view on what we are and why we are here … The goals shouldn't conflict: as long as your private goals are aligned with the official goals, it's no problem. But if so, that's a challenge.

She explained that, for example, she had observed that some partners may have a goal of motivating students to pursue a STEM career through the program, while she herself wanted for students to find what interests them the most, whether it be STEM or other disciplines. This kind of difference

may result in tensions while both realizing the program and establishing and maintaining the collaboration.

Again, we found that while differences in interests and goals could be seen as challenging, partners also found opportunities for partnership advancement in these differences. One such opportunity, discussed by four partners, is the expansion of the program activities to the social sciences and humanities. According to three of these partners, the need for such an expansion lies in the fact that '[schools] ask for [these disciplines]. Why do you only do maths and natural sciences and not the entirety of disciplines? We have a lot of students who might be interested in it' (Claire, program staff). Two of the partners explained that this expansion would require effort from partners, as the program staff currently lacks the expertise in such disciplines, and these disciplines are generally valued less by other partners (thus implying that they would need to be convinced to take these opportunities). The expansion of the program to other disciplines would likely require that partners, depending on their activity within the partnership, *cross different boundaries.* One such boundary is the one that is experienced between some and other partners' goals and interests for the partnership (whether it should be STEM-oriented or expand to disciplines considered by some as less valuable). Another boundary would be the one experienced by program teachers, who see their expertise as different from the one needed for teaching these disciplines.

Exchanges between partner schools surrounding program implementation. Another challenge concerned the school program, that is, the part of the program that is implemented within schools, and of which secondary school students are the main beneficiaries. These are additional extracurricular activities meant to be conducted at the schools by the students who participate in the program. Our analysis showed that 18 partners found the implementation of the school program particularly challenging. Fenna, part of the program staff, said she even had the impression that some schools did not really implement the school program. Some partners suggested that schools should exchange lessons, solutions, and ideas between each other in order to attain program implementation. However, Claire, part of the program staff, mentioned that this exchange 'doesn't work out all the time that well,' and in the survey it was mentioned that the between-school collaboration had not yet 'lifted off' or 'been set into motion.' Maria, a school coordinator, explained that this exchange 'is not facilitated enough by the [university].' This points to the existence of *discontinuities* between the perspectives and practices of schools and between schools and university in terms of program implementation in partner schools.

Despite the difficulty of attaining program implementation in partner schools (due to lack of exchanges), 15 partners spoke of the opportunities brought about by this same challenge. For example, they spoke of the opportunity of developing a network between schools to share ideas on not only how to offer students a higher quality program, but also to exchange educational knowledge beyond the program purposes. Vera, part of the program staff, found it especially desirable for teachers to be 'part of a network in the sense that they really exchange content knowledge.' If this *boundary crossing* between schools' knowledge and practices were realized, it could lead to the purposes of a stronger collaboration between schools, exchange of good practices and a greater transformative power of the partnership in education.

It was suggested that the university and program staff would play a crucial role in the facilitation of such an exchange. For example, Claire talked about how doing regular school visits could help program staff learn about the differences between partner schools:

> What I personally would like to do is visit the schools more often … So it would be valuable to learn how they organise it and then see if there are differences and if they can learn from each other.

This example shows that establishing frequent school visits could help further permeabilize the boundaries between different school practices and partner schools in relation to how they implement the program.

Program development by university partners. Eleven partners brought forward challenges in relation to another aspect, that of the development of the program curriculum in university. Specifically, while developing the program, program teachers encountered challenging *discontinuities* between their own and other university partners' expertise and practices. For example, program teachers have the task of conveying university knowledge into educational material to be used in the program with secondary school students. This material contains content knowledge that is seldom taught in schools and that brings up-to-date university research to a level which students can understand and learn from. Here, program teachers experienced a challenge that is specific to this task: presenting knowledge to students in a way that goes in line with the disciplinary content as researchers understand it. Jana, a program teacher, explained the effort involved in navigating the discontinuity between her content knowledge expertise and that of researchers:

> We don't always know everything that the university researchers know … As a teacher, to know enough about a topic which you don't do any research in … Is what you know enough to be able to convey this topic to your students? Does it represent what the university teaches students? … You're not the researcher. You're trying to tell them what the researcher does.

While these differences in knowledge and expertise are found challenging, four partners also spoke of the opportunities brought about by the exchanges between program teachers and researchers (*boundary crossing*). For example, through such exchanges, teachers of the program would be able to create innovative educational materials that translate university knowledge into knowledge at the level of secondary school. The exchange could benefit researchers as well, as by exchanging with program teachers, they would become more aware of what secondary school students are interested in (secondary school students who, in time, would become university students and fellow researchers).

Basic challenges of the school–university partnership

We found two themes of basic challenges which we interpreted as prerequisites for more efficient collaboration and program work.

Program structure and organization. A basic challenge for 29 partners was the program's structure and organization. Partners across all groups experienced challenges or discontinuities in relation to the time and workload invested in the program vs that of other functions or job. Partners stressed this by highlighting the effort needed to keep up with the program's constant growth and increasing complexity: '[the program] can't be summarized in a few sentences. It's hard to get a picture of everything that is there and for whom it is meant' (Mark, school coordinator). In this sense, the management of one's own resources in relation to program activities, regardless of whether they belonged to school or university, constituted a challenge. As Martin, member of the steering committee, put it: 'what you see is it is rather stressful to keep everything going. Everyone is working at its [*sic*] max. So, one of the things that's so important is to really watch it closely and prevent burnouts.' Communication between school and university and the synchronization of the school and program's calendars (e.g. timing of activities and deadlines) were also mentioned as challenging by partners. Tackling these challenges would allow the partners to deliver the program even more efficiently. It must be noted that partners were asked specifically about workload, which may have to some extent induced the appearance of these themes. However, the detailed descriptions of the issues and the examples mentioned in (several) participants' accounts indicate that these issues are likely experienced by the participants. It must be noted that the excerpts of the accounts that were coded in these themes did not necessarily appear after the question was posed, but even before, and in response to other questions. Furthermore, workload was also mentioned in the consultations, which led us to include the question in the interview guide, as this seemed to be a relevant topic in the partnership.

Motivating others to participate in the program and collaboration. Twenty-nine partners within school and university have the role of motivating other people to participate in the program, such as program participants (secondary school teachers or students) or collaborators (school leaders or university teachers). For many partners, this constitutes a particularly challenging function, because the relevance they themselves assign to the program and collaboration, and their own level of participation, is not equalled in the views and participation of others (*discontinuity*). For example, according to Lucas, a school leader, achieving participation in partner meetings could prove challenging:

> I think it's two times a year at least when I see [the other school leaders], and it's a big difference between those leaders because some are just coming to have a look. They sit in the corner, they say nothing. And they say 'yes' if they need to vote. And others are really participating when we have a meeting. It's a big difference.

Lucas referred to the requisite of 'keep[ing] all the members of the network together' to make the collaboration work, and yet admitted to that being difficult 'because everyone has their own schedule and is always very busy. It's difficult to keep them attached to the network.' Achieving sufficient levels of participation is a requisite for the collaboration to work more efficiently, both within and beyond program functions. It must also be noted that different roles within the partnership require different types and levels of participation. School leaders, in particular, are invited to attend one or two annual meetings at the university, but are also required to support the school coordinator who implements the program in their schools. This implies a different type and level of participation than school coordinators, who are required to attend meetings, coordinate students' application and program attendance and deliver a part of the program content at the schools.

Discussion

Seeing partnership challenges through the boundary-crossing perspective

In this study, we used the concepts of boundaries and boundary-crossing (Akkerman & Bakker, 2011) to investigate the relevance of the challenges of a school–university partnership with the purpose of strengthening the education of talented students in STEM. Based on partners' discussions of the challenges they encounter while working together, we demonstrated that challenges, rather than being mere obstacles to be sorted, point to crucial discontinuities in perspectives and/or practices: They can be connected to future directions or expansive opportunities and, in turn, to the purposes envisioned by the partners for the future of the program and collaboration.

Based on whether we found opportunities linked to the challenges, we distinguished between two types of challenges. One type were basic challenges, which concerned basic requisites for the present efficiency of the program and/or the collaboration. For example, challenges of this type were communication issues in the program, or the challenge of keeping up with the organizational changes in the partnership. Another type were purpose-oriented challenges, which pointed to discontinuities in partners' purposes and motivations, perspectives about education and student excellence, and practices and expertise. Purpose-oriented challenges were considered especially relevant for partnership advancement because, in partners' accounts, they connected to opportunities for the program and collaboration (e.g. for achieving partners' purposes of expanding the program beyond STEM disciplines).

Partnership challenges linked to opportunities and partnership advancement

The challenges that we found for our school–university partnership can be found in other partnership literature. Challenges in organizational (communication, agenda) and participatory issues are well-documented (see Smedley, 2001, for a review) and threaten partnership stability and efficiency. In this respect, securing funding and institutional support seem to be key (Walsh & Backe, 2013).

Some of the purpose-oriented challenges found in this study have been documented as well, although their transformative potential is seldom recognized and deployed (as also observed by Coburn & Penuel, 2016). First, challenges surrounding partners' conceptions of students and education, or for example who the program beneficiaries should be, and differences in partners' goals and interests, have been found in other partnerships (e.g. Walsh & Backe, 2013). A closer look at how partners think about those differences and the opportunities they envision for program expansion indicates the great value in the navigation of these challenges. Such navigation led partners in our study, for example, to challenge the concept of talented student, and subsequently take up the opportunities of engaging new disciplines and a broader group of students in a high-quality STEM program. In doing so, partners could be said to be advancing education by 'respond[ing] to current issues, issues that are very much affected by past practices and history' (Miller, 2008, p. 92).

Second, challenges surrounding program implementation in schools and program development at university arise from discontinuities in practices and expertise often witnessed in inter-professional partnerships (Penuel et al., 2015; Vesterinen et al., 2017). Taking up the opportunities of strengthening the exchanges between partners can lead to the generation of continuities between practices and expertise, with concrete results such as innovative educational materials at the bridge between secondary school and university. This can also result in achieving other purposes such as partners' learning (e.g. Wang & Wong, 2017) and the advancement of education (Farah, 2019; Walsh & Backe, 2013). In sum, as shown in this study, challenges related to partners' envisioned opportunities and purposes for the partnership and education may be particularly relevant.

Further research should help bring light to exactly which mechanisms link challenges with opportunities and purposes. Learning mechanisms (Akkerman & Bakker, 2011) may be a useful concept to achieve this. Learning mechanisms explain the different ways in which people cross boundaries between perspectives and/or practices. In the context of our study, the crossing of boundaries involved in navigating partnership challenges would entail that partners consider what each group of people within the partnership could contribute to it ('identification') and set to establish routines or processes for a more fluid exchange between groups of people ('coordination') or generate new products or hybrid practices as a result of such exchange ('transformation'). In our study, we found glimpses of these learning mechanisms. Further research should design data collection instruments that help uncover these mechanisms, if present in the partnership.

Brokers and boundary objects have also been found to be important for the boundary crossing in partnerships (e.g. Farley-Ripple et al., 2018; Nicolini et al., 2012; Walker & Nocon, 2007; Wang & Wong, 2017) and may be useful to further understand how partnership challenges can be navigated. For example, a member of the program staff who spends time both at university and the partners schools could be a broker. Working documents or email communications between different partners, could be boundary objects. In our study, however, we found only a few examples of brokering in partners' accounts, perhaps due to our focus on challenges and opportunities. Further examination of brokers and boundary objects and learning mechanisms in relation to these challenges could be the next step to further assess the relevance of challenges and determine how they are useful in advancing partnership purposes.

Multiplicity of functions and purposes in the school–university partnership

A salient feature in partners' accounts was the focus on two distinct main functions, the program and the collaboration. We hint that such focus seems to have shifted throughout the history of the partnership. While the program seems to have been the initial purpose, the collaboration seems to have gained more prevalence in recent years. This conjecture was confirmed by the program leader and supported by the examination of partnership documents. Our findings show that, in addition to the multiple functions of the partnership, partners work in relation to more than a single purpose. As mentioned before, partners discussed challenges and opportunities in relation to making the

program useful for a more diverse population of students or talked about how collaboration between school and university can lead to innovation in the educational practice. In practical terms, this feature highlights the need, presented by Coburn and Penuel (2016), to consider the benefits of partnerships for partners themselves and other potential emergent opportunities and purposes of partners' activities.

Penuel et al. (2015) explain that 'as work unfolds, new challenges and opportunities emerge that require both new forms of expertise and new ways of making use of it' (p. 193). While there are potentially many benefits of partners envisioning new purposes (as with the partnership of this case study), new opportunities in relation to new purposes may come into conflict with one another and might call at some point for particular choices. In our study, five partners referred to the program and partnership getting 'bigger,' 'heavier,' and 'more complicated' as they developed. This strikes a cautionary note for educational practice as regards partnership growth in opportunities and purposes.

Conclusion

In the evaluation of this partnership, we have as researchers studied the partnership as a whole in a way that partners themselves may not be inclined to do. We revisited the notion of partnership challenges through a boundary-crossing perspective and considered challenges as linked to potentially relevant processes for a partnership's purposes or opportunities to achieve new purposes. The challenges (discontinuities in perspectives and/or practices) that were tied to opportunities (boundary crossing) seemed to have transformative potential, not only for the purposes of the partners and beneficiaries of the partnership's interventions, but also for purposes existing currently in the field of education, such as equity. Other challenges, related to organizational and participatory issues, appeared as more basic requisites for partnership work and are worth devoting resources to for the sake of the partnership's efficiency.

The use of a similar approach to that of this study can benefit partnerships that bring together researchers and educators by helping partners see challenges, not as obstacles to be sorted, but as holding great potential by being indicative of what is at the core of the partnership's work. With a good overview of (possibly emerging) purposes and opportunities, partners can make informed choices about the challenges that deserve most resources and attention.

Note

1. Program documents included the program policy plan, guides for program coordinators and schools and program brochures for students and teachers.

Acknowledgements

Disclosure statement

Funding

Ethical statement

The research in this study was approved by the Ethics Review Board of the Faculty of Social & Behavioural Sciences of Utrecht University (# 19-208).

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Appendices

Appendix 1

Questionnaire

1. Full name
2. What is your function within the U-Talent collaboration?

school coordinator – school leader – VOHO coordinator – teacher-developer – UU teacher-researcher

1. How long have you worked in this function?

    1 year – 2 years – 3 years – 4 years - > 5 years

1. In which school do you work?

    open – I work at UU – I work at HU – other

1. What do you think are the purposes of U-Talent?
2. What do you think differentiates U-Talent from other collaborations?
3. What do you see as your role(s) within this collaboration?
4. What challenges, if any, have you witnessed while working at this collaboration?
5. What challenges, if any, have you witnessed while fulfilling your function at U-Talent?
6. Are there specific aspects that you have enjoyed about working with U-Talent?
7. How satisfied are you with the functioning of U-Talent as a collaboration (from 1 to 5)?

Appendix 2

Interview guide

1. What according to you is or are the purpose(s) of U- Talent?
2. What according to you is the surplus value of having U-Talent in the educational field?
3. What do you see as your role(s) within this collaboration?
4. What – if any - have been challenges in U-Talent that you witnessed in this partnership?
5. What – if any – have been challenges have you faced while fulfilling your function at U-Talent?
6. Are there specific aspects that you have enjoyed in working in U-Talent??
7. How satisfied are you with the functioning of U-Talent as a collaboration?
8. What kind of interactions do you have with other members of the collaboration? (type) What do you enjoy the most about these interactions? What do you enjoy the least?

other UTalent staff
    School leaders
    School coordinators
    Teachers/Researchers
    VOHO coordinators
    HU project leaders

1. How do you perceive the workload you have in relation to this collaboration?
2. What do you think students benefit from participating in U-Talent?
3. What do you think is the role of schools/your school participating in U-Talent?
4. How do you think schools/your school benefit from participating in U-Talent?
5. What do you think is the role for university participating in U-Talent?
6. How do you think is the university benefits from participating in U-Talent?
7. What recommendations for improvement would you give to other members of the collaboration (with an equivalent function / with a different function)?