

Duquesne University

## Duquesne Scholarship Collection

---

Graduate Student Research Symposium

---

2021-04-09

### TEACHER COLLABORATIONS TO CREATE CURRICULAR COHERENCE: SHIFTS DURING COVID-19

Mona Baniahmadi  
*Duquesne University*

Amy M. Olson  
*Duquesne University*

Follow this and additional works at: <https://dsc.duq.edu/gsr>



Part of the [Curriculum and Instruction Commons](#)

---

TEACHER COLLABORATIONS TO CREATE CURRICULAR COHERENCE: SHIFTS DURING COVID-19. (2021).  
Retrieved from <https://dsc.duq.edu/gsr/2021/proceedings/7>

This Paper is brought to you for free and open access by Duquesne Scholarship Collection. It has been accepted for inclusion in Graduate Student Research Symposium by an authorized administrator of Duquesne Scholarship Collection.

**TEACHER COLLABORATIONS TO CREATE CURRICULAR COHERENCE: SHIFTS  
DURING COVID-19**

**Mona Baniahmadi**

**Advisor: Amy M. Olson, Ph.D.**

**Department of Educational Foundation & Leadership**

**Duquesne University**

**Abstract**

Education policy and standards strive for more coherent curricula because “a coherent, well-articulated curriculum is an essential tool for guiding teacher collaboration, goal-setting, analysis of student thinking, and implementation” and students learn better when “connections are made from one year to the next, from one idea to another, from one representation to another” (NCTM, 2016, p. 1). This suggests teachers must work to make connections across topics, practices, representations, and strategies.

Vertical coherence occurs when teachers who teach the same course collaborate across grade level. In contrast, a curriculum that is horizontally coherent occurs when teachers at the same grade level collaborate to align their learning activities, instruction, and assessments (The Glossary of Education Reform, 2014). Both assume teachers should collaborate with their colleagues to develop a high-quality, coherent curriculum (Chalk, 2020). Yet teachers today are inundated with diverse curricular resources that may not be well connected vertically or horizontally.

In this study we surveyed 524 public elementary mathematics teachers about their curriculum use and the resources they used to ensure a more coherent curriculum. Results indicate that prior to Covid-19 teachers relied on curriculum resources, standards, and other online materials to make connections vertically and horizontally. Fewer teachers mentioned they collaborated with other teachers, and collaboration mostly occurred across grades levels. But during Covid-19 and the switch to remote instruction, teachers reported could not use the same strategies to build coherent connections. They instead relied more heavily on each other and collaboration with their colleagues to design a coherent

curriculum. In such an unprecedented and socially isolated time it was a surprise to find an increase in teacher collaboration. It is also evident from the data that many teachers were thinking of how they can best support each other during remote teaching through their learned experiences.

*Keywords:* Curriculum Design, Coherent Curriculum, Teacher Collaboration, Covid- 19 Pandemic.

## **Introduction**

Education policy documents and curriculum standards in various countries strive for more coherent curricula. For example, in the United States, organizations such as the National Council of Teachers of Mathematics (NCTM, 2006) have argued for a more coherent curriculum. Among the reasons cited for this position, coherency in curriculum aids students in making connections in tangible ways to their immediate lives (Ennis, 2008). Students perceive coherent curricula not only as enjoyable but also as valuable, filling a clear need they recognize and accept.

Since existing definitions of what it means for curriculum to be coherent are limited (Newmann et al., 2001) and outdated (i.e., based on fidelity to a textbook), it is necessary to develop and operationalize one, particularly as teachers today are inundated with diverse curricular resources that may not be well connected to each other or to key ideas students need to master. Teacher collaboration is an important piece of developing both a shared definition and coherence. For example, “Studies show that promoting curriculum change via teachers can be best achieved through utilizing teacher development and through stimulating collaborative curriculum design” (Garet, Porter, Desimone, Birman, & Yoon, 2001; Penuel, Fishman, Yamaguchi, & Gallagher, 2007). The benefits of teachers collaboratively generating new knowledge about curriculum and teaching in schools or teams are increasingly recognized (Cober, Tan, Slotta, So, & Könings, 2015; Cochran-Smith & Lytle, 1993, 2009; Hubers, Poortman, Schildkamp, Pieters, & Handelzalts, 2016; Pareja Roblin, Ormel, McKenney, Voogt, & Pieters, 2014).

## **Purpose**

The purpose of this study is to investigate (a) resources teachers used to support curriculum coherence and (b) degree to which teachers collaborated to establish coherence during remote teaching and Covid-19.

### **Research Questions**

The research questions which guided to the design and implementation of this study are the following:

- What resources/strategies do teachers use to create a more coherent curriculum?
- Do teachers collaborate to establish vertical and/or horizontal curriculum alignment?
- When teachers collaborate, do they focus more on vertical or horizontal alignment?

### **Related Literature Review**

#### **Coherent Curriculum**

Education research has documented teachers' use and modification of published sets of curriculum materials (e.g., Choppin, 2011; Remillard, 2005; Sherin & Drake, 2009). However, if many of today's teachers are more frequently moving toward online resources, they are responsible for building a coherent structure of lessons from a diverse range of resources. And yet, teacher education programs do not yet know how to support this aspect of teaching.

Curriculum development and design is critical for stimulating effective education. A well developed and designed curriculum “is more than a collection of activities: it must be coherent, focused on important contents, and well-articulated across the grades” (NCTM, 2000, p. 14). The use of curriculum materials depends on several factors and resources, such as teachers’ skill and knowledge (Cohen, Raudenbush, & Ball, 2002). Definitions of coherence must therefore account for both the design and use of curriculum.

One perspective on curricular coherence comes from domain and discipline specific expertise about how knowledge is constructed in a particular content area, such as mathematics. For example, the NCTM (2016) highlights that “a coherent, well- articulated curriculum is an essential tool for guiding teacher collaboration, goal-setting, analysis of student thinking, and implementation” (p. 1). The statement went on note that, “coherence means that connections are made from one year to the next, from one idea to another, from one representation to another. There is coherence pedagogically, logically, conceptually, in terms of learning science and with the real world” (p. 1). This suggests that coherence means connections not only across topics, but also across practices, representations, and strategies. For example, teachers may need to improve their moves and decisions around selecting and adapting tasks in the given curriculum materials, to increase coherency as students participate in the learning activities.

### **Vertical Coherence**

There are two major ways the coherence of a curriculum can be evaluated: (a) Vertical coherence; (b) Horizontal coherence. A curriculum that is vertically coherent or vertically aligned helps students to connect what they learn in one grade level to the next grade level. In a vertically aligned curriculum teaching is logically sequenced so that students’ skills and knowledge will make progress to prepare them for higher level challenges and works (The Glossary of Education Reform, 2014). A well-designed, vertically aligned curriculum flows. At first, students receive the skills foundation they need, and teachers reinforce the skills across classes and grades. Vertically aligned curriculum brings cohesion in the class. It helps schools meet their goals and make better decisions (Chalk, 2020). One way for vertical alignment to be developed is through opportunities for teachers who teach the same content to collaborate across grade level.

### **Horizontal Coherence**

A curriculum that is horizontally coherent or horizontally aligned occurs when teachers work within and across subject areas within grade level. For example, teachers at the same grade level might meet to align their learning activities and assessment practices with their curricular goals. Horizontal teams focus on coordinating instruction and assessment to evaluate students' progress and achievement according to grade level standards (The Glossary of Education Reform, 2014). One of the benefits of horizontal alignment is that every student who enrolls in the same grade level or takes the course within the schools, learns equal knowledge and receives the same instruction. Also, horizontal alignment improves instruction and communication between teachers as they exchange their experiences and ideas (Chalk, 2020).

As described in the following sections, research shows that vertical and horizontal alignments support student success by (a) reducing unnecessary repetition; (b) making knowledge more meaningful; (c) setting clear expectations; and (d) sparking professional growth (Chalk, 2020).

**Reducing unnecessary repetition.** Some lessons share similar foundational knowledge. Vertically aligned curriculum needs teachers to think and enact beyond the grade level or classroom walls. They should collaborate with their colleagues to develop a high-quality curriculum that builds from foundational knowledge at each level. If teachers make decisions independently, they may not know what is taught in other classrooms. Consequently, the materials may repeat over and over at the same level, rather than “spiraling” to productively build deeper learning when content is revisited.

**Making knowledge more meaningful.** Sometimes students have opportunities to see connections across subject areas or to see how content from one area (e.g., mathematics) is part of learning in another area (e.g., history). This connectivity gives students opportunities to examine content with more depth and develop deeper knowledge of the topic. Seeing content in other subject areas also allows students to use reasoning and representation norms from different domains, thereby applying their information in different ways, from many perspectives.

**Setting clear expectations.** Vertical and horizontal alignments are the practices in planning and coordination. When developing the alignments, curriculum maps are used to assure students make progress throughout the year, from basic to more complex skills as needed. These maps not only help teachers to plan before students arrive to the class, but they can also be shared to serve as a communication and an opportunity for parents and students to know what to expect.

**Sparking professional growth.** Students' improvement and progression depends, in part, on a teacher's professional development. Efforts to vertically and horizontally align a curriculum and to support that alignment in practice provide opportunities for teachers to gather together to share their ideas and experiences and try new methods. Teacher collaborations around a mapped and aligned curriculum provides a way to see what others are doing and what is working best in their classrooms (Chalk, 2020).

From the perspective of vertical and horizontal coherence, a coherent curriculum is one in which students' learning builds on their previous knowledge and lessons are not repetitive or redundant across grade level and subject areas. Teachers know about the materials and standards that are taught in the previous grades and subsequent grade levels. In incoherent curriculum, in contrast, teachers might decide independently about what students learn, without collaborating with other teachers, basing what they teach on consistent learning expectations or considering what students learned in previous grades and will need to learn in subsequent grades. As a result, students may not receive appropriate lessons throughout their academic grade levels, and they will not meet the academic expectations (The Glossary of Education Reform, 2014).

### **Teachers' Collaboration**

With the transition away from traditional, single source, published curricula and toward the availability of a wide variety of publisher- and teacher-created curricular resources online, teachers' active involvement in collaboratively designing curriculum materials is becoming more prominent in educational practice (Simmie, 2007; Vescio, Ross, & Adams, 2008). A major reason is that traditional teacher development practices were found to be inadequate, not only for professional development (PD)

but also for curriculum development and implementation, because of the passive nature of curriculum-relevant PD (Borko, 2004; Lumpe, 2007). For example, many teacher PD around curriculum often focuses on knowledge of the curriculum and fidelity of the curriculum rather than on making sense of a variety of curriculum.

One practice shown to improve curricular coherence is teachers working collaboratively with one other (Voogt et al., 2011) and with the curriculum design team at the school level “to plan instruction, implement the task, predict student work, respond to student learning needs, and provide consistency in curricular goals and instruction for students” (Larson, 2016). According to Lewis, Perry, & Hurd (2009), collaborative design not only improves within and across teachers, but also works to improve implementation of the curriculum as well as supports teachers to develop ownership of the curriculum.

The active involvement of teachers in collaborative curriculum design can improve the coherence of the enacted curriculum, enhance teachers’ ownership of the curriculum, and promote teachers’ curricular collaboration (Penuel, McWilliams, et al., 2009). The active involvement of teachers in collaborative curriculum design can improve the harmonization of the enacted curriculum, such active involvement can only be effective when teachers themselves feel the need to change their practice, are convinced that their effort will bring about that change and install that change (Becuwe et al., 2015; Morris & Hiebert, 2011).

From this review of the literature, three important lessons on curricular coherence are learned: The first lesson is that curricular coherence should not be treated strictly as a matter of disciplinary structure; instead, it must take into account students’ prior knowledge and experiences within and across content areas (Sikorski & Hammer, 2017). The second lesson is that supporting a coherent curriculum must include supporting teachers to make connections between ideas and their instructional practices to improve students' understanding (Bransford, Brown, & Cockling, 2000). Third, supporting teachers’



collaborative curriculum design is an important element that contributes to the coherence of curriculum (Voogt et al., 2011).

## **Methods**

In this research study we collected national survey data during remote teaching due to the Covid-19 pandemic. Teachers were asked about their curriculum before the pandemic, during remote teaching in Spring 2020, and their plans for Fall 2020. We utilized the services of MDR, a marketing company with considerable experience surveying teachers nationally, to assist us with survey design and administration. MDR administered the survey in September 2020.

### **Participants**

A total of 524 third, fourth, and fifth grade elementary mathematics teachers responded to the nationwide online survey. The data reported here include teachers who indicated they taught mathematics content at third grade ( $n = 190$ , 36%), fourth grade ( $n = 215$ , 41%), and fifth grade ( $n = 198$ , 38%). Most taught in public schools ( $n = 474$ , 90%) located in suburban ( $n = 285$ , 54%), urban ( $n = 149$ , 28%), and rural districts ( $n = 88$ , 17%). They overwhelmingly taught remotely during the Spring 2020 Covid-19 shutdown ( $n = 516$ ) and planned to continue teaching remotely in Fall 2020 ( $n = 460$ ).

### **Data Sources**

The first intention of the survey was to capture a snapshot of the diverse curricular resources being used to support the needs of teachers. However, the timing of the survey was impacted by the Covid-19 pandemic (99% of the participants moved to remote instruction in March 2020), which allowed us to also gain some insight into the challenges teachers faced in transitioning to remote learning. In the survey teachers were asked resources and strategies they used to make connections between their lessons vertically and horizontally prior and during the Covid-19.

The data presented here are drawn from teachers' responses to the following questions:

1) Prior to covid, how did you make sure your lessons were connected day to day?

- 2) Prior to covid, how did you make sure your lessons were connected to other content areas?
- 3) Prior to covid, how did you make sure your lessons were connected across grade levels?
- 4) After moving to remote teaching in Spring 2020, were you able to use the same strategies to make connections?
- 5) What new strategies did you use to make connections?

### **Findings**

In this section we report our findings on the context of teachers' curriculum use and the resources and strategies they used to make connections vertically (to other grade levels) and horizontally (within content and across subject areas) before and during the pandemic.

Results indicate that prior to Covid-19 teachers relied on curriculum resources, standards, and other online materials to make connections vertically and horizontally. Fewer teachers mentioned they collaborated with other teachers, and collaboration mostly occurred across grades levels.

#### **Horizontal Coherence Within Subject Prior to Covid**

The data revealed that prior to Covid-19, 399 (76.1%) teachers used the curriculum, 376 (71.8%) teachers set up lessons in similar ways day to day, 362 (69.1%) teachers made connections to the standards, 354 (67.6%) teachers used formative assessment, 340 (64.9%) teachers used pacing guides, and 326 (62.2%) teachers worked with other teachers to connect their lessons day to day.

#### **Horizontal Coherence Across Subject Area Prior to Covid**

Also, data have shown, prior to Covid-19, 303 (57.8%) teachers used the curriculum, 275 (52.2%) teachers made connections to how mathematics is used, 271 (51.7%) teachers made connections to the standards, 245 (46.8%) teachers set up lessons in similar ways, 239 (45.6%) teachers made connections to mathematical reasoning, 202 (38.5%) teachers used the pacing guides, and 195 (37.2%) teachers worked with other teachers to connect their lessons to other content areas.

#### **Vertical Coherence Across Grades Prior to Covid**

In addition, teachers reported, prior to the pandemic, 338 (64.5%) of them used the curriculum, 309 (59%) worked with other teachers, 277 (52.9%) made connections to the standards, 247 (47.1%) used

pacing guides, 216 (41.2%) used data from benchmark tests, 204 (38.9%) used formative assessment, and 196 (37.4%) set up lessons in similar ways, to make sure their lessons were connected across grade levels.

**Summary**

In general, more teachers identified horizontal coherence strategies to connect their lessons day to day than across content areas or vertically across grade levels. Across both types of horizontal alignment and vertical alignment, many teachers relied primarily on connections built into their curriculum and on the standards to establish coherence. Results indicate that prior to Covid-19, 326 (62.2%) teachers worked with other teachers to connect their lessons day to day, 195 (37.2%) teachers worked with other teachers to connect their lessons to other content areas, and 309 (59%) teachers worked with other teachers to make sure their lessons were connected across grade levels. Teacher collaboration was the sixth most popular response in horizontal coherence within mathematics content and the seventh most popular response in horizontal coherence across subjects; however, teacher collaboration was the second most popular way teachers built vertical coherence.

**Impact of the Pandemic on Teacher Strategies**

The data shows that during Covid-19 and switch to remote instruction, the majority of teachers ( $n=332$ , 63.4%) felt they were not able to use the same strategies to make connections as they do during normal instruction. As the data shows in Table 1, the majority of teachers ( $n=332$ , 63.4%) indicated their prior strategies were not effective. Only 2.9% of teachers ( $n = 15$ ) teachers reported that they did not have to make any changes to ways they built connections.

<b>Not at all</b>	<b>n= 68</b>	<b>13%</b>
<b>A bit</b>	<b>n =332</b>	<b>63.4%</b>
<b>A lot</b>	<b>n= 98</b>	<b>18.7%</b>
<b>Completely</b>	<b>n= 15</b>	<b>2.9%</b>

*Table. 1*

Despite this, and unsurprisingly given the constraints on pandemic teaching, teachers engaged in fewer strategies to build coherence overall and the frequencies of all the strategies were reduced during Covid-19. The data show that, during Covid-19 teachers continued to rely primarily 218 (41.6%) on connections built into their curriculum. Interestingly, the second most commonly used strategy during the pandemic was teacher collaboration 210 (40.1%). In such an unprecedented time it was a surprise to find an increase in teacher collaboration as teachers were socially isolated. In addition, 181 (34.5%) used standards, 148 (28.2%) set up lessons in similar ways, 138 (26.3%) used pacing guides, and 123 (23.5%) used formative assessment to make coherent connections.

### **Discussions**

The results of this study provide a glimpse of the ways teachers attempt to build coherence in their classrooms prior to the pandemic as well as some of the challenges to doing so faced by teachers during Covid-19 pandemic remote instruction. The literature emphasizes the importance of teachers' collaboration on designing a coherent curriculum. The active involvement of teachers in collaborative curriculum design can improve the harmonization of the enacted curriculum, enhance teachers' ownership of the curriculum, and promote teachers' curricular collaboration (Penuel, McWilliams, et al., 2009). The findings show that prior to the pandemic, teacher collaboration was less common than reliance on the curricular resources to provide coherence. As teachers continue to move away from a singular curriculum and instead navigate increasingly higher frequencies of curricular resources, creating coherence between diverse materials may become a challenge. Results also indicate that prior to Covid-19, teachers endorsed most other strategies more than collaboration with other teachers when establishing horizontal coherence; collaboration was more highly ranked when establishing coherence vertically across grades levels. The rank order of teacher collaboration for the purpose of designing a coherent curriculum increased during the pandemic. During Covid-19, teachers demonstrated collaborative skills even while socially isolated. They mostly preferred to learn from their colleagues and how they can best support each other to design a coherent curriculum. In such an unprecedented time it was a surprise to find teacher collaboration was one of the most popular strategies. Future research needs to examine how teachers collaborated during

Covid-19 and what we can learn from their collaboration that might continue to be helpful after the pandemic.

Although this was a nationwide study, the results may not be generalizable for several reasons. First, the experiences of teachers in a pandemic may not generalize well to more normal classroom experiences. In addition, the retrospective responses about teacher practice prior to the pandemic may be influenced by their current remote teaching experiences. Finally, a survey provides some areas to explore, but future efforts need to draw stronger connections to teachers' actual collaborative practice and the support needed to make that practice more effective.

In conclusion, coherent curriculum helps students to build on their previous knowledge and support teachers to make connections between ideas and their instructional practices and learning activities which leads to students' success.

## References

- Becuwe, H., Pareja Roblin, N., Van Braak, J., Tondeur, J., Castelein, E., & Thys, J. (2015). Conditities voor de succesvolle implementatie van leergemeenschappen: De casus van Teacher educator Design Teams voor ICT-integratie [Conditions for successful implementation of professional learning communities: The case of teacher educator design teams for technology integration]. *Tijdschrift voor Lerarenopleiders*, 36(4), 5–16.
- Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher*, 33(8), 3–15.
- Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.) (2000). *How people learn: Brain, mind, experience, and school*. Washington D.C.: National Academy Press.
- Chalk. (2020,02,14). *Your first steps to vertical alignment*. <https://www.chalk.com/resources/vertical-alignment/>
- Choppin, J. (2011). Learned adaptations: Teachers' understanding and use of curriculum resources. *Journal of Mathematics Teacher Education*, 14, 331-353.
- Cober, R., Tan, E., Slotta, J., So, H.-J., & Könings, K. D. (2015). Teachers as participatory designers: Two case studies with technology-enhanced learning environments. *Instructional Science*, 43, 203–228.
- Cochran-Smith, M., & Lytle, S. L. (1993). *Inside/outside: Teacher research and knowledge*. New York, NY: Teachers College Press.
- Cochran-Smith, M., & Lytle, S. L. (2009). *Inquiry as stance: Practitioner research for the next generation*. New York, NY: Teachers College Press.
- Cohen, D., Raudenbush, S., & Ball, D. (2002). Resources, instruction, and research. In F. Mosteller & R. Boruch (Eds.), *Evidence matters: Randomized trials in education research* (pp. 80-119). Washington DC: Brookings Institution Press.
- Drake, C., Land, T. J., & Gichobi, M. (2009). Curriculum capacity: Understanding district investments in the teacher-curriculum interaction. Paper presented at the Annual Meeting of the American Educational Research Association. San Diego, CA. April 2009.

- Drake, C. & Sherin, M. (2009). Developing curriculum vision and trust: changes in teachers' curriculum strategies. In J. T. Remillard, B. A. Herbel-Eisenmann, & G. M. Lloyd (Eds.), *Mathematics teachers at work: Connecting curriculum materials and classroom instruction* (pp. 321-337). New York, Routledge.
- Ennis, C. D. (2008). Examining curricular coherence in an exemplary elementary school program. *Research Quarterly for Exercise and Sport*, 79:1, 71-84.
- Garet, M., Porter, A., Desimone, L., Birman, B., & Yoon, K. (2001). What makes professional development effective? Analysis of a national sample of teachers. *American Educational Research Journal*, 38(4), 915– 945.
- Hubers, M. D., Poortman, C. L., Schildkamp, K., Pieters, J. M., & Handelzalts, A. (2016). Opening the black box: Knowledge creation in data teams. *Journal of Professional Capital and Community*, 1, 41–68.
- Larson, M. (2016). Curricular Coherence in the Age of Open Educational Resources. *National Council of Teachers of Mathematics*.
- Lewis, C. C., Perry, R. R., & Hurd, J. (2009). Improving mathematics instruction through lesson study: A theoretical model and North American case. *Journal of Mathematics Teacher Education*, 12, 285–304.
- Lumpe, A. T. (2007). Research-based professional development: Teachers engaged in professional learning communities. *Journal of Science Teacher Education*, 18, 125–128.
- Morris, A. K., & Hiebert, J. (2011). Creating shared instructional products: An alternative approach to improving teaching. *Educational Researcher*, 40, 5–14.
- National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: Author.
- National Council of Teachers of Mathematics. (2006). *Curriculum focal points for prekindergarten through grade 8 mathematics: A quest for coherence*. Reston, VA: Author.
- National Council of Teachers of Mathematics. (2016). NCTM position: Curricular coherence and open educational resources. Retrieved from <https://www.nctm.org/Standards-and-Positions/Position-Statements/Curricular-Coherence-and-Open-Educational-Resources/>

- Newmann, F. M., Smith, B., Allensworth, E., & Bryk, A. S. (2001). Instructional program coherence: What it is and why it should guide school improvement policy. *Educational Evaluation and Policy Analysis*, 23, 297-321.
- Pareja Roblin, N. N., Ormel, B. J. B., McKenney, S. E., Voogt, J. M., & Pieters, J. M. (2014). Linking research and practice through teacher communities: A place where formal and practical knowledge meet? *European Journal of Teacher Education*, 37, 183–203.
- Penuel, W. R., Fishman, B. J., Yamaguchi, R., & Gallagher, L. P. (2007). What makes professional development effective? Strategies that foster curriculum implementation. *American Educational Research Journal*, 44, 921–958.
- Penuel, W. R., McWilliams, H., McAuliffe, C., Benbow, A. E., Mably, C., & Hayden, M. M. (2009). Teaching for understanding in earth science: Comparing impacts on planning and instruction in three professional development designs for middle school science teachers. *Journal of Science Teacher Education*, 20, 415–436.
- Remillard, J. T. (2005). Examining key concepts in research on teachers' use of mathematics curricula. *Review of Educational Research*, 75(2), 211-246.
- Simmie, G. M. (2007). Teacher Design Teams (TDTs) – Building capacity for innovation, learning and curriculum implementation in the continuing professional development of in-career teachers. *Irish Educational Studies*, 26, 163–176.
- Sikorski, T. R., & Hammer, D. (2017). Looking for coherence in science curriculum. *Science Education*, 101, 929–943.
- Stein, M. K., Remillard, J., & Smith, M. S. (2007). How curriculum influences student learning. In F. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 319–370). Charlotte, NC: Information Age Publishing.
- The glossary of education reform. (2014). *Coherent curriculum*. <https://www.edglossary.org/coherent-curriculum/>
- Vescio, V., Ross, D., & Adams, A. (2008). A review of research on the impact of professional learning communities on teaching practice and student learning. *Teaching and Teacher Education*, 24, 80–91.



Voogt, J. M., Westbroek, H., Handelzalts, A., Walraven, A., McKenney, S., Pieters, J., & De Vries, B. (2011).

Teacher learning in collaborative curriculum design. *Teaching and Teacher Education*, 27, 1235–1244.

Voogt, J. M., Pieters, J. M., & Handelzalts, A. (2016). Teacher collaboration in curriculum design teams: Effects, mechanisms and conditions. *Educational Research and Evaluation*, 22(3-4), 121-140.