FOSTERING GLOBAL COMPETENCIES AND DEEPER LEARNING WITH DIGITAL TECHNOLOGIES RESEARCH SERIES

AN EXPLORATORY STUDY OF DIFFERENTIAL EFFECTS OF COACHING ON SYSTEM-WIDE STEM IMPLEMENTATION
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AN EXPLORATORY STUDY OF DIFFERENTIAL EFFECTS OF COACHING ON SYSTEM-WIDE STEM IMPLEMENTATION
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EXECUTIVE SUMMARY

The viability and usefulness of the coaching model is addressed in this report. Initial findings from year one, and part of the year two longitudinal mixed methods research support expansion of the coaching model as a means of growing the Science, Technology, Engineering and Mathematics (STEM) strategy. This outcome is due to the realization that STEM coaching provides increased teacher self-efficacy and delivers a variety of positive effects for students and teachers engaging in STEM activities.

Figure 1: Initial Findings

What the Research Says

Literature focussed upon STEM highlights that STEM is important because it helps generate the workforce of tomorrow through the development of specific competencies in STEM related subject matter (Hobson et al., 2015). These STEM competencies are currently touted by researchers as being essential for securing prosperity, competitiveness, and economic growth of nations (Ryan & St-Laurent, 2016).
Previous research has shown that STEM Coaches provide several benefits for teachers trying to implement STEM (Ripberger & Blalock, 2015). These advantages relate to increased job satisfaction and self-efficacy; encouragement of inquiry-based teaching practices; improved teacher effectiveness, enhanced student learning outcomes, and superior results in schools that implement STEM Coaching for teachers (Hobson et al., 2015). Furthermore, when STEM Coaching is combined with STEM implementation the chance of the application being successful improves from below 50% to 85% (DeChenne et al., 2014) since having a STEM Coach working with teachers increases their familiarity with engineering, inquiry content, and inquiry-based learning strategies (Ryan & St-Laurent, 2016).

Figure 2: Successfully Implementing STEM

Nevertheless, if a teacher and STEM Coach are somewhat mismatched in their areas of expertise, conflict and miscommunication can result (Ryan & Bagley, 2016). Research provides a caveat in that this unevenness can be resolved via relationship building using verbal and nonverbal competencies both in person and online. Moreover, having the STEM Coach and the teacher uncover and share common goals for student success and STEM implementation.
enhances the developing relationship (Ripberger & Blalock, 2015). STEM Coaches provide teachers with perspective and tools they can use to look at and alter their own teaching practice. Central to this occurrence is having the role of the STEM Coach clearly defined in the schools they coach in, and trust being developed between themselves and teachers (Hobson et al., 2015). Additionally, STEM Coaches help teachers make the transition from STEM theory to STEM classroom practice over time (Ripberger & Blalock, 2015).

**Figure 3: What the Research Says**

**Evidence and Results of the Toronto District School Board Study**

Overwhelmingly, across multiple domains, teachers and students responded positively within the coaching model (Hobson et al., 2015). Teachers supported the view that education in STEM provides a means for students to solve real-world (authentic) problems and thrive in their pursuits following secondary school graduation. Owing at least in part to the coaching model, teachers felt confident in their ability to teach STEM and in their understanding of inquiry based instruction (Ryan & St-Laurent, 2016).

The majority of teachers believed students learned in their class when STEM was taught. These findings were also anecdotally matched with teacher interviews as they further expressed
perceptions of increased student engagement. Furthermore, students were shown to have additional increases in academic competencies as a result of STEM education. These improvements were reflected in students showing interest in future careers that involve design, technology usage, and science. All findings were further amplified when teachers had regular connections with STEM Coaches.

**Figure 4: Evidence and Results**

Recommendations to improve the STEM Coaching model included: more access to STEM Coaches, STEM Coaching assistances developing STEM related lesson plans, building specialized STEM content, and schools having their own STEM Coach or STEM Lead Teacher. Additional training or promotion of the TDSB STEM K-12 Academic Workplace (AW) site was also recommended, as well as involving STEM Coaches in the actual implementation of the STEM strategy.
Figure 5: Recommendations to Improve the STEM Coaching Model

Ways to Improve STEM Implementation

#1 More access to STEM coaches (consistent on-site presence)

#2 More STEM training for coaches

#3 Ways to help with mismatched teachers and coaches

#4 Demonstrate STEM resources on TDSB AW site

Figure 6: Highlights of STEM Coaching Model Results

STEM Coaching Model

Areas of Improvement

- More access to STEM coaches, (consistent on-site presence)
- More STEM training for coaches
- Mismatched teachers and coaches
- STEM resources on TDSB AW site

TDSB STEM Coaching Results

Teacher & Student Findings

- Confidence Teaching STEM: 60% to 84%
- STEM Improves Teaching: 10% to 87%
- Continue with STEM: 10% to 82%
- Helps With Problem-Solving: 4% to 40%
- Interest in STEM Careers: 22% to 78%
- Improves 21st century skills: 4% to 40%
INTRODUCTION

Our exploratory research details the first few years of implementation of the Toronto District School Board’s (TDSB) K-12 STEM Strategy. Our study involved 80 teachers, 50 administrators, 10 STEM Learning Coaches¹ and 439 students in 60 TDSB STEM pilot schools.

Specifically, this study focused on the STEM Coaching Model and set out to evaluate the effectiveness of the coaching model used within the TDSB’s K-12 STEM strategy. Research efforts investigated the relationships amid coaching, teacher practice, teacher engagement, student learning, and engagement. Herein, the report displays truncated results from year one STEM implementation and from partial year two quantitative and qualitative data. Our hypothesis suggested STEM Learning Coaches play significant roles in STEM teaching and learning.

Using comprehensive data collected via a longitudinal mixed methods research design this “use-inspired research” identified the characteristics of effective STEM Coaches and a STEM Coaching Model, informing system-wide STEM program implementation across a large urban school board as noted in Figure 7.

¹ In this report, STEM Learning Coach and STEM Coach are used interchangeably.
We further laid the foundation for STEM by improving teacher knowledge, engagement and classroom practices with STEM. Teachers were provided with ongoing professional development on STEM including: STEM learning coaches, workshops, and professional development sessions, on topics ranging from implementation, curriculum, lesson planning and teaching strategies.

Our ultimate goal is to provide STEM education for all. Our objective is to provide students with opportunities to apply their knowledge and skills within the context of real world problems, and finally improving student knowledge and achievement.

**Figure 7: Heuristic Framework for the STEM Strategy**

**Source:** (Sinay, Jaipal-Jamani, Nahornick, & Douglin, 2016, p.81)
WHAT THE RESEARCH SAYS

The Importance of STEM in the 21st Century

In their report entitled, *STEM: Building a 21st century workforce to develop tomorrow’s new medicines*, the Battelle Technology Partnership Practice (2014) concluded,

China and Singapore have developed and implemented strategies specifically aimed at gaining a competitive edge in STEM fields, making major investments in improving the state of STEM education to increase the number of scientists, engineers, and other STEM graduates overall. As a result of their investments, they have the highest rates of science and math literacy among Organization for Economic Cooperation and Development (OECD) countries. (p. 3)

Additionally, beyond STEM competencies sets being produced by school systems, the economic systems of societies have demanded students moving into adulthood have STEM related competencies for STEM careers.

The nation’s STEM-related workforce, from scientists and engineers to information technology professionals and mathematicians, drive economic growth in a number of ways and are critical to securing continued growth in an increasingly competitive global economy. (Battelle Memorial Institute, 2014, p. 8)
The Coaching Model's Effect on Teaching and Learning

There are multiple sources that feature the ways that the coaching model effects teaching and learning (Hobson et al., 2015). Coaching of STEM teachers is such an opportunity for several key reasons. First, cognitive coaching increases teachers’ job satisfaction over time and has been shown to increase teacher efficacy (DeChenne et al., 2014). Second, coaching “does indeed seem to be an effective method for removing the traditional barriers to inquiry and encouraging teachers to adopt inquiry-based teaching methods” (Kraus, 2008, p. 169). Third, researchers have linked coaching to change in teaching practice and improved student learning (Lockwood, McCombs, & Marsh, 2010). Fourth, there is an increase in teacher retention, competence and effectiveness when they are coached, mentored and involved in an induction program (Jones, Dana, LaFramenta, Adams, & Arnold, 2016). Fifth, “coaching has the potential to become an important vehicle for the success of STEM reform initiatives” (Ortmann, 2015, p. 150). Sixth, “beginning teachers who are mentored are more effective teachers in their early years, since they learn by guided practice instead of trial-and-error alone” (Jones et al., 2016, p. 273).
AN EXPLORATORY STUDY OF DIFFERENTIAL EFFECTS OF COACHING ON SYSTEM-WIDE STEM IMPLEMENTATION

Figure 9: The Coaching Model’s Effect on Teaching and Learning

Figure 10: University of Florida - STEM TIPS – Teacher Induction and Professional Support

Supporting Coaches, Empowering Teachers

(Jones et al., 2016) Used with permission.
The STEM Coaching Model and STEM Implementation

DeChenne et al. (2014) realized, “if the professional development is followed by instructional coaching in the newly acquired teaching strategy at the teacher’s school, successful implementation reaches 85%” (p. 3). The 85% is a significant jump up from the 50% that is common in research findings concerning professional development, coaching, and mentoring. Coaches are more commonplace in literacy and mathematics, yet instructional science coaching remains uncommon (Jones et al., 2016; Walpole, McKenna, Uribe-Zarain, & Lamitina, 2010). Nevertheless, the addition of instructional coaches to a summer STEM professional development experience provided increased exposure to engineering and inquiry content, and the implementation of inquiry teaching strategies (DeChenne et al., 2014). Many have come to understand that STEM literacy includes knowledge, attitudes, skills, understandings, awareness, and engagement in STEM-related issues (Bybee, 2013; Jones et al., 2016). STEM literacy also includes abilities, procedures, concepts, metacognitive capacities, and being socially and personally relevant to students (Hobson et al., 2015; Zollman, 2012).

Figure 11: The STEM Coaching Model and STEM Implementation

Professional Development WITH Embedded Coaching

Leads to 85% implementation

Use Coaching

*Compared to 50% implementation without coaching (DeChenne et al., 2014)
Of a cautionary note, is the finding that when coaches and teachers have dissimilar disciplinary expertise from each other, conflict and miscommunication is probable (Gross, 2012). The conflict is mitigated somewhat if personal goals are emphasized and not just theory or practice itself. Coaching using verbal and nonverbal skills (Ippolito, 2010; Neuberger, 2012) offers a means to build and sustain relationships. However, virtual coaching online has also receiving positive support from users (Jones et al., 2016). In any medium, coaching built upon trust often leads to an inclusive position for coaches in classrooms and enables facilitation of adult reflection and learning (Garmston & Wellman, 2009; Ryan & St-Laurent, 2016).

**Figure 12: Managing Conflicts**

<table>
<thead>
<tr>
<th>Conflict and Miscommunication Between Coaches and Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consider these pointers</td>
</tr>
<tr>
<td>- Emphasize personal <strong>goals</strong></td>
</tr>
<tr>
<td>- Build and <strong>sustain</strong> relationship</td>
</tr>
<tr>
<td>- Create <strong>trust</strong></td>
</tr>
<tr>
<td>- Consider <strong>online coaching</strong></td>
</tr>
</tbody>
</table>

*Good News:* Coaching built on trust often leads to inclusive position for coaches in the classroom and enables facilitation of adult reflection and learning (Garmston & Wellman, 2009; Ryan & St-Laurent, 2016).

**How the STEM Coaching Model Changes a Teacher’s Practice**

As a STEM Coach takes on new professional roles and identities, a new system of beliefs begins to emerge (Neuberger, 2012). Beliefs necessary for coaching include beliefs about change for adult learners (Heineke & Polnick, 2013), the critical role of relationships in adult learning (Garmston & Wellman, 2009), a deep commitment to reflection on experience for oneself and for teachers (York-Barr, Sommers, Ghere, & Montie, 2006), and believing that every teacher...
can change with support (Legros & Ryan, 2016; Garmston & Wellman, 2009). Loucks-Horsley et al. (2010) believe, “it is equally important [for teachers] to develop the knowledge, skills, and abilities of these facilitators of adult learning and to provide them with ongoing, sustained opportunities to reflect on and make improvements in their practice” (p. 8). Principal leadership support for STEM coaching has been identified as an important factor (Legros & Ryan, 2016; Sumner, 2011).

Sinay, Jaipal-Jamani, Nahornick, and Douglin (2016) suggest STEM Coaches help teachers make the “transition from STEM theory to STEM classroom practice, as this sustained coaching raises the rate of classroom implementation and skill transfer and positively impact teachers’ sense of self-efficacy” (p. 31). Indeed, there is support for “the STEM Learning Coaches model, which should be sustained and scaled up” (p.33). Heineke and Polnick (2013) stress the importance of clearly defining the STEM Coach’s role, which is widely communicated and acknowledged. At the same time ensure the STEM Coach receives current and ongoing professional development (Fulton & Britton, 2011). A recent TDSB study found,

Eighty percent of administrators and 73% of teachers viewed the STEM Learning Coach model as a very effective or moderately effective model. Sixty-eight percent of teachers felt that the coaching had a great or moderate impact on their understanding of STEM and 62% of teachers felt that the coaching had a great or moderate impact on their capacity to implement STEM. (Sinay et al., 2016, p. 33)

The need to provide STEM Learning Coaches with additional comprehensive STEM knowledge, supports previous research outcomes that found the importance of disciplinary integration, as educators’ access other disciplines of STEM to teach science (Bybee, 2013). Yet, Sinay et al. (2016) realized STEM Coaches “provided the least support in (1) developing success criteria and metrics to assess the effectiveness of the STEM program, (2) providing career information, and (3) providing assessment and evaluation strategies” (p. 33). Alternatively, Hobson et al. (2015) found teachers with one to five years of experience “. . . might benefit from the support of an
external mentor/coach for at least one of the subjects they teach” (p. 71). As a teacher, being receptive to coaching or mentoring means being open about your own teaching and needs and in this respect, it can be considered a risk-taking experience since you reveal your needs to others. The followings are suggested as requirements for STEM Coaching Success (see Figure 13).

**Figure 13: Requirements for STEM Coaching Success**

**Requirements for Coaching Success**

- Sustained and *scaled up* support for coaches
- Ongoing *professional development* for coaches
- Clearly *define* coaches roles
- Ensure educators are *open* to coaching

**METHODS AND DATA SOURCES**

Longitudinal mixed-methods via surveys, interviews and focus groups involving STEM Coaches, students, teachers, administrators, and program leadership teams were utilized in this investigation. The study was undertaken from 2014-15 to 2016-17. Information collected on STEM Coaching was based on the 2014-15 and 2015-16 school years.

Qualitative analysis involved an exploratory interview mode that Creswell (2015) endorses since, “data and results provide a general picture of the research problem” (p. 545). This approach allowed for further inquiry and provided an explanation to help us process and
understand data (Creswell, 2015). Data was collected from a representative sample of stakeholders including teachers, administrators, STEM Coaches, and students.

**Study Sample**

The target population for this study was TDSB employees (educators/administrators) and elementary school students in the TDSB participating in the K-12 STEM Strategy in 2014-15 and 2015-16. Our sample size in year one (2014-15) included 80 teachers, 50 administrators, 10 STEM Coaches, and 439 students. Our sample size in year two (2015-16) included a Program Coordinator, a Central Coordinating Principal, and four elementary school STEM Coaches.

**Survey Design**

According to Creswell (2015), a cross-sectional survey design (Hall, 2008) is commonly used to collect perspectives for education development purposes. Since “reliability and validity are two key features that determined the effectiveness of survey items (statements/questions)” (Fowler & Cosenza, 2008, p. 137), our survey items were chosen from previously tested and used surveys measuring similar constructs as the ones targeted in our study. Survey questions consisted of close-ended, categorical, and continuous-type questions with a Likert Scale consisting of ratings from strongly agree to strongly disagree (Irwin et al., 2014; Creswell, 2015). Surveys were standardized to decrease participant and research biases and ethical methodology was followed based on the procedures and guidelines established by the TDSB Research and Information Services Department (see Figures 7 and 14 for a summary of the research design).
EVIDENCE AND RESULTS

Based on the findings from our previous study from the first year of the implementation of the TDSB’s K-12 STEM strategy (Sinay et al., 2016), the coaching model appeared to be a highly viable model to promote STEM professional learning in TDSB schools. The results of that study showed that across multiple domains, STEM Coaches, students, and teachers displayed positive viewpoints towards a STEM Coaching Model. Specifically, STEM year one teachers’ indicated a positive reaction to the STEM strategy with 82% of those surveyed reporting that they would like to see the TDSB’s K-12 STEM initiative continued.

In general, teachers strongly believed in the value of STEM education to 1) develop students with the competencies needed for surviving in an ever changing world; 2) enhance student learning; and 3) help students solve real-world problems. Additionally, a majority of teachers (86%) believed STEM education would improve their teaching practice and over 90% of teachers strongly believed in the value of STEM for improving student learning as noted in Figure 15.
Overall, teachers expressed confidence in their ability to teach STEM to students since they believe they have the necessary understanding of the importance of STEM pedagogy. The majority of them (84%) reported they were confident in their ability to teach STEM effectively. However, 40% wondered if they have the necessary skills (see Figure 16).

**Source**: (Sinay et al., 2016, p. 128)
Figure 16: Confidence and Self-efficacy in STEM Subject Content and Teaching

<table>
<thead>
<tr>
<th>Please rate how much you agree or disagree with the following statements about your teaching</th>
<th>Strongly Disagree 1</th>
<th>Disagree 2</th>
<th>Somewhat Disagree 3</th>
<th>Somewhat Agree 4</th>
<th>Agree 5</th>
<th>Strongly Agree 6</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am continually improving my STEM teaching practice.</td>
<td>1% (1)</td>
<td>1% (1)</td>
<td>7% (5)</td>
<td>16% (11)</td>
<td>47% (33)</td>
<td>27% (19)</td>
<td>4.87</td>
</tr>
<tr>
<td>I am confident that I can teach STEM effectively.</td>
<td>1% (1)</td>
<td>3% (2)</td>
<td>12% (8)</td>
<td>30% (21)</td>
<td>38% (26)</td>
<td>16% (11)</td>
<td>4.48</td>
</tr>
<tr>
<td>I wonder if I have the necessary skills to teach STEM.</td>
<td>16% (11)</td>
<td>28% (19)</td>
<td>16% (11)</td>
<td>29% (20)</td>
<td>9% (6)</td>
<td>1% (1)</td>
<td>2.91</td>
</tr>
<tr>
<td>Given a choice, I would invite a colleague to evaluate my STEM teaching.</td>
<td>6% (4)</td>
<td>14% (10)</td>
<td>19% (13)</td>
<td>20% (14)</td>
<td>33% (23)</td>
<td>7% (5)</td>
<td>3.83</td>
</tr>
<tr>
<td>I know what to do to increase student interest in STEM.</td>
<td>1% (1)</td>
<td>4% (3)</td>
<td>13% (9)</td>
<td>40% (28)</td>
<td>30% (21)</td>
<td>11% (8)</td>
<td>4.27</td>
</tr>
<tr>
<td>Overall</td>
<td>5% (18)</td>
<td>10% (35)</td>
<td>13% (46)</td>
<td>27% (94)</td>
<td>32% (109)</td>
<td>13% (44)</td>
<td>4.08</td>
</tr>
</tbody>
</table>

Source: (Sinay et al., 2016, p. 137)

It is evident that it is important to provide sustained and ongoing STEM professional development to help with teachers feeling unfamiliar with STEM content or pedagogy. Seventy-seven percent (77%) of teachers surveyed felt that a majority of students in their class had learned STEM skills. In conjunction with this, 77% of secondary school students strongly agreed, agreed or somewhat agreed, that STEM education is relevant and meaningful to their lives (see Figures 17 and 18).

Figure 17: Current Teaching Related to STEM (Teachers’ Responses)

To what extent do you agree with the following statements about your current teaching? (Teachers)

<table>
<thead>
<tr>
<th>To what extent do you agree with the following statements about your current teaching?</th>
<th>Not Really</th>
<th>To a Minor Extent</th>
<th>To a Moderate Extent</th>
<th>To a Great Extent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have tried to develop students’ STEM skills.</td>
<td>3% (2)</td>
<td>16% (11)</td>
<td>53% (37)</td>
<td>29% (20)</td>
<td>70</td>
</tr>
<tr>
<td>Most students have learned STEM skills while in my class.</td>
<td>6% (4)</td>
<td>17% (12)</td>
<td>56% (39)</td>
<td>21% (15)</td>
<td>70</td>
</tr>
<tr>
<td>I have been able to effectively assess students’ STEM skills.</td>
<td>10% (7)</td>
<td>23% (16)</td>
<td>46% (32)</td>
<td>21% (15)</td>
<td>70</td>
</tr>
</tbody>
</table>

Source: (Sinay et al., 2016, p. 138)

Figure 18: Relevance of STEM (Secondary School Students’ Responses)

Relevance of STEM (Secondary)

<table>
<thead>
<tr>
<th>Relevance of STEM (Secondary)</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Somewhat Disagree</th>
<th>Somewhat Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I see STEM as personally meaningful and relevant to my life / my future career.</td>
<td>6% (8)</td>
<td>4% (5)</td>
<td>12% (16)</td>
<td>29% (37)</td>
<td>26% (34)</td>
<td>22% (29)</td>
</tr>
</tbody>
</table>

Source: (Sinay et al., p. 119)
Interviews with teachers and administrators affiliated with the TDSB’s K-12 STEM initiative backed these findings by highlighting high levels of student engagement. One administrator talked about STEM enthusiasm being developed within all the students in their school, noting that they took to STEM, “very enthusiastically and that’s straight from kindergarten all the way to grade 8.” Additionally, a STEM Coach mentioned how little resistance was observed in classrooms using STEM: “You know who is not resistant? The students! The students are zero percent resistant.” STEM Coach

These results further demonstrate that students are very interested in STEM careers. In fact, the most popular career interests among secondary school students included careers that allow them to: (1) create or design things, (2) use technology, and (3) work in science. Additionally, students showed very high interest and awareness of STEM competencies, such as collaboration, creativity, critical thinking, and citizenship. During interviews, some teachers confirmed the students’ self-assessment of their own growing competencies by noting the students’ improvements in terms of problem solving and metacognition.

I find that [the students] are able to present their thoughts or ideas and vocalize them. Even like the problem solving, I don’t know if it was clear enough for you, but to me that was really clear that they were able to describe their problem and explain what they did and then they are sharing their problem strategies as well. Teacher interviewed on students’ competencies
Based on the study findings from the first year of the implementation of the TDSB’s K-12 STEM strategy, several recommendations can be proposed (see Table 1).

Table 1: Recommendations for Improvement of the STEM Coaching Model (Sinay et al., 2016)

<table>
<thead>
<tr>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Engage more STEM Learning Coaches in TDSB schools to support smaller groups of 12 or less teachers</td>
</tr>
<tr>
<td>2. Engage STEM Learning Coaches who are preferably teaching at a participating school to provide frequent and consistent on-site presence</td>
</tr>
<tr>
<td>3. Designate local STEM Learning Coaches for a group of schools in the same area as their home school to facilitate consistent on-site access</td>
</tr>
<tr>
<td>4. Provide comprehensive STEM training for STEM Learning Coaches through a TDSB coaching orientation</td>
</tr>
<tr>
<td>5. Provide STEM Learning Coaches with opportunities to build specialized content knowledge of the STEM areas through online modules, webinars or free online training courses</td>
</tr>
</tbody>
</table>

Additionally, teachers believed that they have the necessary understanding of the importance of the STEM pedagogy. Over 90% of teachers felt they have an understanding of inquiry-based and problem-based learning and understood the importance of integrating content from different subject areas and disciplines when teaching. However, many teachers have not used STEM education resources on the TDSB’s STEM K-12 Academic Workplace (AW) Site. Therefore, more time needs to be invested to explicitly show and demonstrate the utility of the STEM resources available on the TDSB’s STEM K-12 AW (see Figure 19).

Figure 19: Teachers’ Beliefs about STEM-related Competencies

Source: (Sinay et al., p. 119).
The interviews completed during the 2015-16 school year endorsed the recommendations presented in the year one STEM report. The most commonly discussed area during both years of investigation was the access to STEM Coaches, followed by the assistance to generate lesson plans with teachers, and the provision for quality professional learning and co-teaching opportunities for teachers. The reason cited for a lack of access to STEM Coaches was often the provision of, or lack thereof, adequate time and resources that could be used to additionally facilitate collaboration with teachers.

An administrator talked about the difficulties in accessing their STEM Coach.

*If you have a [STEM Coach], and you say you are now the [STEM Coach] of 50 schools, you’re giving a little bit of …. If you really want change, you have to make it so that the [STEM Coach] is at least in a school half day week on a regular basis.*

STEM Coaches also felt that supplementary resources could further be applied to support professional learning opportunities for them in order to expand their coaching practice. In addition, more opportunities need to be created, along with teachers, to be more involved in the implementation of the STEM strategy.
DISCUSSIONS AND CONCLUSION

Results observed from the first two stages of the STEM research series clearly showed that the STEM Coaching Model is having a positive effect both in terms of developing teachers to teach in this area and overall implementation of STEM across the school board. Based on the recommendations previously mentioned, it appears that the addition of more STEM Coaches would support the continued use of the STEM Coaching Model and its potential expansion.

STEM Coaches improve teaching by increasing the sense self-efficacy teachers have in STEM. Further, STEM Coaches provide teachers with a resource to diversify and expand their lesson plans, confidence with technology, and overall pedagogical practise as it relates to STEM. These three areas of growth correlate with improved achievement with students (Ryan & Bagley, 2016).

STEM Coaches improve classroom learning as students are directly affected by improvements teachers make while teaching STEM. These improvements, surface via increased enthusiasm and engagement as well as the further development of classroom competencies, such as problem solving, collaboration, and critical thinking. Expansion of the STEM Coaching Model could potentially further increase the gains in these areas.

The STEM Coaching Model appears to be a successful model on which the TDSB can build and expand on. Investing in innovative approaches to teaching and learning, such the TDSB’s K-12 STEM Strategy, could potentially have further reaching positive results, not limited to classroom practices, student learning and teacher performance, but to the prosperity of our nation. This study’s conclusions are summarized in Figure 20.
While there are some areas of improvement, the coaching model should be continued and potentially expanded.
REFERENCES


