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Canvases of Professional Erudition in STEAM Education

Christopher Dignam
Governors State University, United States

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Abstract

The delivery of instruction in Science, Technology, Engineering, Art, and Mathematics (STEAM) requires layers upon layers of professional knowledge concerning STEAM pedagogy, methodologies, technology, and active involvement strategies to support student learning. A professional understanding of these critical areas is relevant for supporting student learning and is germane in actively involving parents in STEAM learning. While educators commonly engage in professional development opportunities, professional development is principally singular and typically ends without continuance or re-examination. Professional learning, on the other hand, is ongoing and revisits professional growth needs for educators. In this article, the researcher utilized targeted professional growth needs for STEAM educators that included qualities of site-based professional development and professional learning referred to as professional erudition. This study employed targeted professional erudition for providing high school science teachers skills related to constructivism, experiential learning, communications and dialogue, reflection and self-evaluation, and active parental involvement. Students and parents participating in the study maintained journals regarding their experiences during science inquiry learning and teachers maintained journals concerning their experiences and perceptions regarding targeted professional erudition. Qualitative data indicated providing professional erudition for STEAM teachers results in authentic professional growth, improved communications, and skills and strategies for supporting participatory science learning.

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Corresponding Author: Christopher Dignam, cdignam@govst.edu

Introduction

Many obstacles exist in Science, Technology, Engineering, Art, and Mathematics (STEAM) classrooms and investigatory spaces that impact teaching and learning and inhibit student comprehension. Some of these roadblocks consist of intrinsic factors, such as students' learning abilities, and others are extrinsic factors, such as the level of parent involvement. However, when teachers are provided professional development that they can apply in STEAM learning spaces, they are empowered to effectively support all learners (Levin & Schrum, 2016). Moreover, when teachers are provided specific ongoing professional learning they can apply towards their own practice, they are empowered to effectively improve professional capacity (Shahali & Halim, 2023).

STEAM teachers cannot adequately help students utilize technology, improve scientific inquiry and scientific literacy skills, employ specific instructional methodologies, or cultivate meaningful parental involvement without meaningful, targeted professional growth opportunities (Kirner & Lebrun-Griffin, 2013). In essence, authentic, improved professional practice will only occur if teachers develop these skills so they can employ directed pedagogical and methodological stratagems. Only then can success be passed down to students. There is also a need to provide authentic professional development and professional learning for teachers to learn up-to-date strategies for teaching high school STEAM content (Shahali & Halim, 2023).

Professional development typically takes place as singular seminars, workshops, meetings, etc. and concerns a particular topic that is addressed. When the session ends, so too does the learning regarding the singular focused item for developing professional skills. Subsequent professional development that takes place soon focused on yet another isolated topic and so on. Site-based professional development, however, is much more detailed, as it engages specific individuals with a specific purpose for promoting prolonged and more intense learning (Strike et al., 2019). Professional learning on the other hand is ongoing and thematic. Educators typically revisit the same topic or theme throughout the year for continued growth. Both professional development and professional learning have advantages and the key is to apply both forms of professional growth as targeted measures with specific purposes and outcomes (DuFour & DuFour, 2013). Teachers of STEAM require both professional development and professional learning opportunities that will enable them to support students in developing academic, social, emotional, and behavioral aptitudes, which are life-skills (Gulamhussein, 2013; Hebebci, 2021; 2023). In addition, students will not be able to utilize authentic technologies unless teachers are provided professional growth opportunities that enable practitioners to develop these same skills (Strike et al., 2019). Professional growth opportunities that utilize authentic STEAM technologies, instructional methodologies, and involvement strategies provide teachers with skills and a repertoire of techniques they can employ for improved student learning and transforming the learning environment (Harris & Jones, 2019).

Professional Erudition

Throughout this article, when collectively referring to both site-based professional development and professional learning, the researcher jointly refers to them as professional erudition. The researcher is a former high school science educator with approximately ten years of classroom experience and seventeen additional years of educational leadership experience as an administrator and in leading schools as a principal and district superintendent. The researcher began using the term professional erudition when leading professional growth opportunities, as the expression infers qualities of both site-based professional development and professional learning. Moreover, the researcher employs professional erudition within the article as he also utilizes this philosophical construct with students in higher education for developing a methodological approach in designing teacher professional supports.

Enlisting parental involvement for STEAM learning requires professional erudite opportunities for teachers to advance in the area of enlisting and collaborating with parents to enhance the effectiveness of parent involvement activities. Professional erudition enables teachers to learn about the importance of designing extended inquiry-based activities, interactive homework, and communication strategies such as dialogue journaling to increase collaboration, understanding, and partnerships with parents (Esterhazy et al., 2021; Kaufmann & Ryve, 2019). Employing a constructivist leadership philosophy in designing professional erudite opportunities enables relationships to develop to support improving scientific inquiry and literacy skills students can use throughout a lifetime of learning. Professional erudition related to involving parents enables authentic, constructivist leadership instructional strategies to be developed and increases professional capacity (Shen et al., 2020).

Forms of Professional Erudition

STEAM and Instructional Technologies

Schools should establish programs that provide technology training and parent awareness to encourage close communication and strong parental involvement at a school-wide level (Barrera & Warner, 2006). Professional erudition in the area of technology provides opportunities for all school-based personnel to prepare for the needs of the future. Teachers need to be provided opportunities to develop technology skills they can utilize in the classroom (Gaible & Burns, 2005). The technology utilized in the classroom should be authentic and relevant to the technology employed by scientists. Providing technology-based professional erudition in the areas of STEAM classroom and laboratory manipulatives, computer software, and digital communications platforms enables teachers to engage in authentic learning that is meaningful, relevant, and can be employed with students.

Engaging in Collegial Coaching

Employing a collegial coaching model between teachers is a constructivist strategy that better meets the professional erudite needs of all stakeholders in the learning organization (Røkenes, 2022). Collegial coaching creates opportunities for teachers engaged in non-evaluative dialogue with respect to instructional goals and practices for improving instruction (Dantonio, 2001; Management Mentors, 2013). A shared vision of effective STEAM instructional practices facilitates supporting all learners. Collegial coaching empowers teachers to observe one another's teaching performances and reflect on performances. Reflection provides an opportunity to engage in self-awareness regarding practice (Dantonio, 2001; Shahali & Halim, 2023). Self-reflective opportunities provided colleagues time to consider nuances and fine subtleties of practice to improve performance (Dantonio & Lynch, 2005). As a result, meaningful dialogue takes place between colleagues and serves as a catalyst in improving instructional delivery, performance and level of student learning. In addition, collegial coaching serves as a form of experiential learning for STEAM teachers, as they reflect on experiences and consider future actions (Kolb et al., 1984).

Change is constant in education and the collegial coaching model is a form of professional erudition for STEAM teachers that provides opportunities for all school-based personnel to improve the instruction and learning in school (Sheninger, 2019). Collegial coaching is also a form of professional development and professional learning that improves collegiality as well as teaching (Galbraith & Anstrom, 1996). Employing collegial coaching for professional growth increases parent involvement and student learning as a result of reducing teacher isolation and creating collaborative norms for reciprocal sharing of ideas (Guiney, 2001).

Constructing and Maintaining Portfolios

The utilization of professional portfolios by STEAM teachers enables teachers to utilize the self-reflective phase of both collegial coaching and experiential learning in planning, implementing, and participating in meaningful professional erudite opportunities. (Kolb, 2014; Kolb et al., 1984). Portfolios allow teachers to retain positive STEAM teaching exemplars for discussing and sharing as formative assessments of growth (Lee et al., 2020; Wolf, 1996). The process of reflective practice empowers teachers to develop dialogue with colleagues and grow as professionals (Harris & Jones, 2019; Shahali & Halim, 2023). Portfolios also enable teachers to self-evaluate and are thereby empowered (Lee et al., 2020; Lengeling, 1996). Furthermore, utilizing teacher portfolios provides a holistic view of instructional practice that is non-evaluative and self-reflective (Flottemesch, 2004). Professional portfolios serve as data collection tools that can be shared with colleagues to elucidate perspectives. Dialogue is key in transitioning from professional development towards professional learning that is active, participatory, and reciprocal (Esterhazy et al., 2021; Kaufmann & Ryve, 2019).

Student Self-Assessments

Professional erudition on employing student self-assessments in the forms of student journal entries, student-designed rubrics, and student-constructed exams provides STEAM teachers with skills they can employ for empowering student ownership of the learning (Yan, 2020). These skill sets are also central in developing relationships with students, as students are provided increased responsibilities for controlling their own outcomes (Howard et al., 2020; Osher et al., 2018). While teachers are very familiar with constructing rubrics and exams, students are not. Engaging in ongoing professional erudition centered on self-assessments that results in transference of this reflective practice skill from teachers to students. When students are enabled to self-reflect and self-assess, they are empowered to control their learning (Mahoney, et al., 2021). In addition, students are permitted to develop strategies for improving their own performance and creating rubrics to measure their own outcomes, resulting in success for students of all backgrounds (Shields & Hesbol, 2020).

Authentic Instructional Strategies

In order for students to improve their science reasoning skills for STEAM application, teachers need to be provided professional erudite opportunities that facilitate authentic instructional strategies (Ross & Hogaboam, 2011; Shahali & Halim, 2023). Providing teachers with professional erudition with respect to how students learn enables teachers to develop a deeper understanding and self-assess practice (Yan & Carless, 2022). In dynamic STEAM learning environments, students learn and develop knowledge through experiential learning (Kolb et al., 1984; Kolb, 2014). In addition students make connections about the world around them through discovery learning, constructivism, and inquiry-based activities (Dewey, 1933; Piaget, 1972; Vygotsky, 1978). Providing teachers with targeted erudition regarding experiential, student-centered learning affords teachers with knowledge concerning both methodology and pedagogy for establishing a supportive classroom environment for supporting all learners (Hickey & Riddle 2022; Shields & Hesbol, 2020).

Enlisting Parental Involvement

Most colleges and universities provide inadequate family and community engagement strategies for teachers and administrators (Epstein et al., 1999; Epstein & Sheldon 2022). A small percentage of teachers or administrators have engaged in education or professional erudition in engaging parents, families, and communities (Epstein & Connors, 1994). In addition, little teacher or administrator preparation includes preparing teachers or administrators to work with students, families, and schools (Epstein et al., 1999; Epstein & Sheldon, 2022). Although administrators are responsible for managing and leading schools and communities,

many lack sufficient background in enlisting meaningful parent involvement and fostering skills in teachers (Epstein & Sheldon, 2022).

When teachers engage in parental involvement professional erudition their ability to positively engage and interact with parents is enhanced (Rutherford et. al., 1995). Time must be provided for STEAM teachers to engage in professional erudition that links the importance of creative science homework with the creative science learning that takes place in classrooms (Epstein et al., 2021; Van Voorhis 2001). Parent involvement activities should focus on helping teachers develop skills they can utilize in collaborating to improve student achievement. Professional erudition provides STEAM teachers with strategies to help students and parents establish positive dispositions for home learning activities (Battle-Bailey, 2003; Epstein, 1995). Providing authentic professional erudite opportunities for STEAM teachers that are constructivist in design are important in facilitating inquiry skills students can use in science learning. Professional erudite opportunities focusing on employing interactive parent involvement in student learning opportunities is key to student science improvement. Parents are valuable resources that need to be utilized to foster the development of scientific inquiry and literacy skills in students.

Effective Dialogue for Collaboration

The development of new skills via effective dialogue and collaboration supports group processes and actualization (Lingard, 2021; Oliver et al., 2018). Social connections also impact collaborative efficacy, which serves to support collaborative goals (Schieffer, 2016; Woolley et al., 2015). Communications between parents, students, and teachers are particularly helpful in fostering active collaboration on inquiry activities. When students engage in socially supportive inquiry, they are more likely to achieve and succeed both academically and socially (Epstein & Sheldon, 2022; Woolley et al., 2015). Furthermore, employing self-reflections and self-evaluations are central components of collaborative processes that position active participants to learn from processes (Dusdal & Powell, 2021).

Constructivist STEAM Learning

Involving parents in myriad teaching and learning strategies and providing teachers authentic professional erudite opportunities empowers teachers, parents, and students to engage in constructive, meaningful learning opportunities (Epstein & Sheldon, 2022; Vygotsky, 1978). When constructivist science learning activities include parent participation, the utilization of ongoing performance assessments supports and enables parents to also engage in experiential learning processes (Kolb et al., 1984; Shymansky et al., 1999). Constructivist learning that incorporates interactive parental involvement fosters the development of scientific problem-

solving skills and enables students to take greater control of the learning (Wen, et al., 2020). In 1933, Dewey proposed his Theory of Inquiry, which is based on cognitive constructivism and provides a forum for learners to actively manipulate the environment in the process of learning to build knowledge. Constructivist problem-solving enables parents to be actively engaged with students as a result of taking control of the learning.

Parents are a primary resource for students. Home learning and engagement via interactive homework are highly influential for learners and for the development of content knowledge and skills acquisition for children (Epstein, et al., 2021; Rutherford et al., 1995). Home learning can include a variety of parental involvement and participation on homework assignments, scientific investigations, communications and dialogue between parents, teachers and students to support content objectives, and through dialogue journals or any other activity that supports student achievement (Chan & Aubrey, 2021; Epstein et al., 2021; Stillman et al., 2014). Home learning can be a single activity or a number of activities that individuals in the home and students actively engage in for supporting student academic growth (Rutherford et al., 1995). Targeted professional erudition centered on parental involvement and constructivist STEAM learning supports teacher growth and student learning.

Constructivist Dialogue

Successful home learning activities enlist active parental involvement to support students academically and socially. Dialogue presents opportunities for sharing the content students are engaged in, the understandings of students regarding content, and the academic interests of students (Chan & Aubrey, 2021; Luneburg & Irby, 2002). Teachers leading STEAM learning require professional erudition to create dynamic, communicative learning environments. Employing dialogue journals during scientific inquiry activities facilitates a forum for students to engage in active, participatory communications with parents (Stillman, et al., 2014). Dialogue journals afford parents and students opportunities to explain what was learned and provide feedback to one another. Students benefit from these types of informal, yet formalized discussions with parents, as parents do not necessarily need to understand STEAM content but can provide specific, encouraging responses on homework, activities, or investigations (Chan & Aubrey, 2021; Stillman et al., 2014). When parents provide specific feedback, they also provide reinforcement, which positively impacts student learning and self-efficacy (Walker et al., 2004).

In order for students to actively engage parents through interactive homework, constructivist learning opportunities, self-reflections and -assessments, and creating rubrics, the school environment must support resources for teachers to create positive relationships between the home and school. (Darling-Hammond, et al., 2002; Darling-Hammond et al., 2016). Parental involvement at the high school level provides the substrate for

a social network that supports student achievement and success. Social networks and social supports are significant for adolescent students as they develop and progress through the middle and high school grade levels.

Environmental Adaptation

When children interact with their environment, they are afforded opportunities to transform learning and accept knowledge (Piaget, 1972). Accordingly, increased child/student interactions with parents during the completion of school assignments provides experiential learning and a forum for students to develop deeper understanding (Battle-Bailey, 2003; Epstein et al., 2021). Cognition occurs via Piaget's processes of assimilation and accommodation, in which the transformation of preexisting cognitive structures (assimilation) and acceptance of knowledge (accommodation) enables learners to adapt to the environment. Assimilation and accommodation occur simultaneously and alternately throughout life. Through these processes, meaning is constructed and the adaptation of cognition occurs (Piaget, 1972).

Cognitive development of students (learners) is enhanced through the constructivist and social process of discovery learning. Discovery learning is an instructional technique that is a component of Piaget's theory of cognitive development that aids students in developing effective social skills essential to engage in collaboration. Utilizing discovery learning provides teachers with direction for employing cooperative learning for both the cognitive and social (behavioral) realm. Increased positive educational outcomes are observed in students with well-developed social networks, and likewise, the greater the social supports, the more likely a student will thrive in school (Darling-Hammond, 2020; Epstein & Sheldon, 2022). STEAM teacher professional erudition empowers teachers by providing insight teachers can employ themselves in creating STEAM learning environments conducive to teaching and learning.

Role of Constructivism in Parental Involvement and STEAM Education

Constructivism is based on and supported by the theoretical cognitive constructivists Piaget, Bruner, and Dewey and the theoretical social constructivism of Vygotsky and Piaget. Students are positioned to construct new ideas or concepts as a result of considering information, creating hypotheses, and formulating answers via discovery learning (Bruner, 1996). Dewey (1916) stated, "The scientific method is a trial of ideas" that is sometimes unsuccessful but permits students to "learn from failures when their endeavors are seriously thoughtful" (p. 152). The process of problem solving enables learners to utilize inquiry for constructing knowledge (Dewey, 1916). Through these processes, meaning is constructed and the adaptation of cognition occurs. Cognitive development of learners is enhanced through the constructivist and social process of

discovery learning (Piaget, 1972). Creating targeted professional erudite efforts for STEAM teachers on constructivism is proactive in positioning students to develop knowledge and consider new ideas.

Conceptual Framework

The conceptual framework of this qualitative phenomenological study involved utilizing multiple data sets to discern phenomenon and identify emergent themes from phenomenological attitudinal data (Creswell & Poth, 2018; Merriam & Tisdell, 2016; Teddlie & Tashakkori, 2009). Literature reviewed supports the assertion that science teachers and teachers in STEAM disciplines require targeted professional erudition in an effort to engage in inquiry-based, experiential, constructivist learning with both parents and students. In addition, professional erudite opportunities provide much needed background skills for teachers in STEAM disciplines in employing dialogue journals to document growth and performances. These personal reflections memorialize perceptions of parents, students, and teachers with respect to engaging one another, as well as providing insight regarding the social, emotional influences for students.

Research Objective

The objective of this study was to identify the perceptions of science teachers and the implications for teachers in STEAM disciplines as a result of actively engaging in targeted professional erudition. Attitudinal data was also collected to discern not only teacher perceptions, but also parent and student perceptions with respect to interactive science teaching and learning and impacts on student social, emotional development.

Research Questions

This study was conducted to determine the following research questions:

1. What are the most meaningful types of professional erudition engagements for STEAM teachers?
2. How does professional erudition impact parent-student-teacher communications for actively involving parents in high school science learning?
3. What are the implications of targeted professional erudition and communications during high school STEAM learning for supporting the social, emotional needs of students?

Method

This study employed a qualitative, emergent phenomenological design based in the tradition of portraiture. This study employed portraiture to include aspects of ethnography, case study, and narrative (Lawrence-Lightfoot & Davis, 1997). Portraiture methodology affords inquiry and documentation of the social and cultural contexts of the individuals negotiating phenomenon (Lawrence-Lightfoot & Davis, 1997). Portraiture was utilized for creating a narrative for tracing the interpretation of emergent themes for creating an aesthetic whole (Lawrence-Lightfoot & Davis, 1997). Utilizing a qualitative, emergent phenomenological construct provided insight regarding the shared experiences of students, parents, and teachers (Creswell & Poth, 2018). The intersectionalities of these shared experiences provided insight regarding the essence of the phenomenon being studied (Prosek & Gibson, 2021).

Data Collection Procedures

Two teachers participated in professional erudition related to STEAM instructional methodologies, communications, and enlisting and actively involving parents in STEAM learning between the home and school. Teachers maintained journal entries at the onset of professional erudition to memorialize perceptions and thoughts. The teachers maintained journal entries as they began initiating parental involvement STEAM learning with students. One hundred thirty-one parents and students created and maintained dialogue journal entries over the period of six-weeks in which they engaged in constructivist, interactive science learning. The dialogue journals were utilized by parents and students to record their perceptions regarding science inquiry and interactive learning opportunities. Students and parents also recorded perceptions with respect to their experiences in terms of working with one another. Students made initial journal entries followed by parents for memorializing dialogue. Students provided each classroom teacher with their respective dialogue journals at the end of each week. Teachers also made entries and then returned journals to students at the beginning of the following week.

During the course of this six-week study, teachers maintained journals reflecting beliefs regarding professional erudite experiences, collegial coaching, and perceptions concerning enlisting parental participation. These data provided an opportunity for examining the perspectives and experiences of the individuals and cultures observed (Lawrence-Lightfoot & Davis, 1997). The researcher provided the participating teachers ongoing professional erudition throughout the study. The participating teachers maintained their journals, which were collected by the researcher at the conclusion of the study.

Results

Professional Erudition

Participating classroom teachers were provided ongoing professional erudition by the researcher to build skills to guide students in constructing rubrics for use in self-assessing performances with parents. Classroom teachers modeled how rubrics are utilized in assessing growth and provided students with in-class opportunities to develop criteria to gauge and assess learning. Teachers modeled how to create criteria that students used to measure and assess actual knowledge and understanding.

The researcher provided professional erudition for the participating teachers in employing student self-assessments in the forms of student journal entries, student-designed rubrics, and student-constructed exams. In a journal entry, a teacher noted, “After all, there are advantages in shifting roles and putting students in the role of the self-evaluator. I was concerned about doing this and really didn’t think it would work. It sounded like more hard work for me and fluff. But after I worked with the students to show them how to make self-assessments they made changes to improve performances. Their rubrics and exams helped them determine grades they believe they earned based on the assessments they made.”

Participating teachers also used the professional erudite training they received from the researcher. This training enabled students to construct rubrics for self-assessing their performance on science inquiry activities with parents. Parent and student self-assessments became a component of student summative assessments regarding STEAM learning. This data source provided useful feedback that students utilized to share and communicate with parents in constructing self-assessments about learning. Self-assessment opportunities enabled students to grow and develop as a result of internalizing the information. A teacher journal entry noted, “When students are provided opportunities to reflect on their progress and performances they determine the changes and adjustments they need to make in order to be more successful.” This assisted students in developing self-regulation and ownership of the learning.

Keyword Search

The researcher utilized keyword search in dialogue journal entries to identify themes and relationships amongst parents, students, and teachers. The researcher reviewed the dialogue journal entries of the participants and noted the four most common words the participants repeated. The four words were noted and reviewed in the context of each journal entry that they appeared in. The utilization of keyword search provided insight with respect to recurring perceptions, beliefs, and experiences amongst parents, students, and teachers.

An analysis of keyword search for parents resulted in the identification of the frequent repetition of the words *interesting*, *fun*, *experience*, and *opportunity*. The use of these words referred to ideas, beliefs, and perceptions of parents related to ideas associated with collaborating with the parent's child (Figure 1).

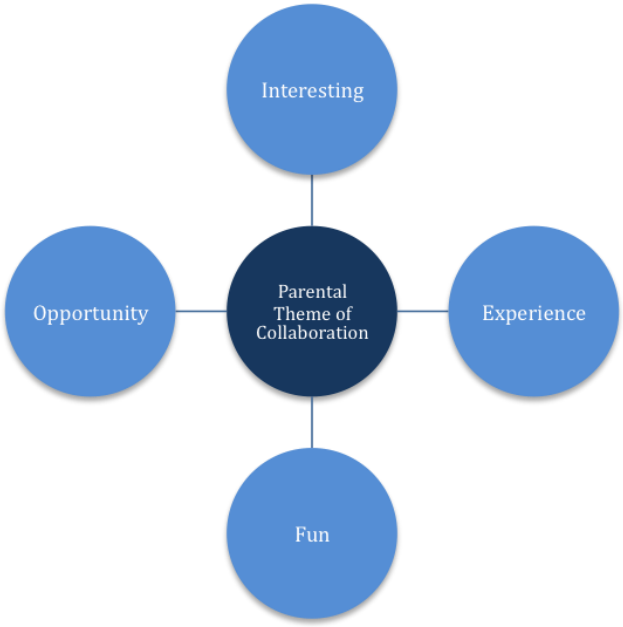

Figure 1. Frequent repetition of keyword search for parents

In addition, an analysis of keyword search for student journal entries resulted in the identification of the frequent repetition of the words *organize*, *plan*, *help*, and *think*. The use of these words referred to ideas, beliefs, and perceptions of students related to ideas associated with conditions related to support and efficacy development (Figure 2).

Figure 2. Frequent repetition of keyword search for students

Lastly, an analysis of keyword search for teachers who participated in this study resulted in the identification of the frequent repetition of the words *important*, *support*, *effective,* and *involve*. The use of these words referred to beliefs, feelings, and perceptions of teachers related to ideas associated with the conditions related to maintaining effective, interactive parental involvement during STEAM learning (Figure 3).

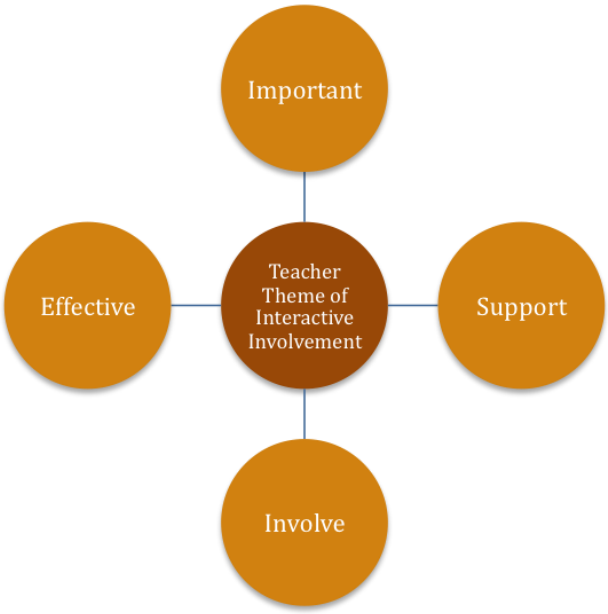

Figure 3. Frequent repetition of keyword search for teachers

Relationships Amongst Keyword Search Themes

Relationships between emergent themes and correlations between parents, students, and teachers were constructed to validate concepts and relationships. There was a clear relationship amongst all three themes. The relationships evident among all three themes were authentic communications (Figure 4). Parents enjoyed the opportunity to collaborate with their child. The inquiry activity provided parents with a *communicative*, learning experience. Students felt they were provided a supportive, *communicative* learning environment. Students self-assessed work and parents provided help and guidance. Students were able to take self-responsibility for their learning, which fostered acquisition of skills and improved efficacy. Teachers perceived the experiences of the study's participants to be supported by effective involvement strategies. These *communicative* involvement strategies (parental involvement, professional erudition, self-assessments and dialogue journals) led to an ownership of the learning not only in students, but also in parents and teachers.

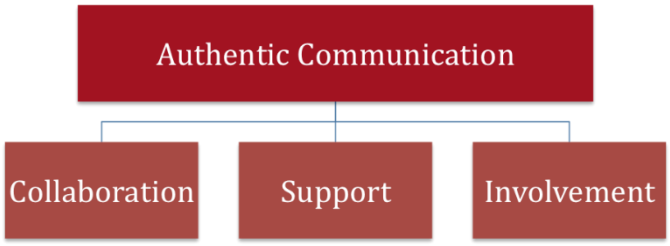

Figure 4. The relationship of authentic communication amongst emergent themes

The emergent themes were correlated by their use of consistent, communicative dialogue. The participants' experiences were unified by a collaborative, supportive, skill building, and self-motivating environment centered on authentic communication. Authentic communication was the common relationship amongst themes.

Discussion

Correlations between parent, student, and teacher data were utilized to validate themes and relationships (Figure 5). The relationships that were evident as a result of codification and triangulation of these data through inter-rater analysis and hierarchical coding were that parents, students, and teachers enjoyed the opportunity to be *proactively* connected to the instructional program. The environment this study provided afforded parents with direction, communication, and accessing skills they were able to utilize in collaborating with their child and classroom teacher. *Interactive* involvement led to a greater involvement in the learning. Parents and students utilized a variety of strategies in which they collaborated and controlled the learning. These involvement strategies (dialogue journals, student-constructed exams and rubric, and self-assessments) led to an ownership of the learning not only in students, but also in parents. Students effectively used questioning strategies to investigate phenomena and make self-reflections. The environment was *motivative* and supported students in developing a holistic mindset. This helped students find answers to questions they proposed related to their own natural curiosities and led to a more "natural" development of scientific inquiry and literacy skills.

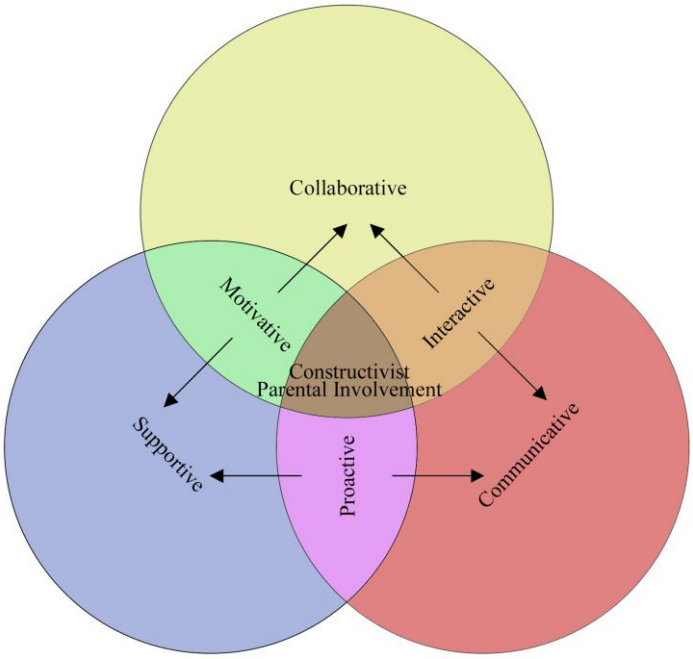

Figure 5. Relationships between collaborative, communicative, and supportive emergent themes

Conclusion

The common themes and relationships prevalent were examined by the researcher in relation to the study's research questions. Analysis of the themes provided the basis to respond to each of the study's questions in terms of the beliefs, perceptions, and feelings of the study's participants. In terms of the implications for teachers in STEAM disciplines, teachers felt they were positioned for success as a result of engaging in targeted professional erudition for professional growth. Teachers believed the professional erudition they engaged in was authentic and provided deep learning experiences that supported instructional delivery. Teachers also believed the professional erudition they participated in was relevant in terms of providing ongoing methodological development for delivering STEAM content and developing new technology skills.

Teachers also perceived professional erudition positively impacted parent-student-teacher communications for actively involving parents in high school science learning. Teachers identified much needed skills in terms of collaborating with parents and engaging in active, meaningful communications. Although teachers engage in regular communications with the home, they require professional erudition that is targeted and serves as professional growth for employing communications that forge participatory relationships. While the study employed interactive, constructivist inquiry for STEAM education via parent involvement, teachers require specific ongoing professional erudition when actively engaging and interacting with parents. Teachers believe the strategies employed during the study improved their communications skills for engaging stakeholders.

Attitudinal data was collected to discern not only teacher perceptions, but also parent and student perceptions regarding interactive STEAM teaching and learning. These data provided insight regarding positive impacts on student social, emotional development. Professional erudition resulted in improved communications during high school STEAM learning, which positively affected students' social, emotional learning. Parental involvement in inquiry activities resulted in a highly collaborative, reciprocal relationship and communications between all participants. The utilization of collaborative, communicative dialogue journals enabled and empowered all students and parents to actively engage and communicate with the school. These pro-social interactions resulted in student-improved efficacy.

In addition, English Second Language (ESL) parents and foreign language parents were actively engaged in dialogue with students and teachers. The parents of these students interacted in science activities by making dialogue journal entries in their native languages and having other family members write translations that followed. Parent involvement provided a forum for ESL and foreign language parents to be communicative, collaborative, and supportive. ESL and foreign language parents were provided a forum to share and learn about their child. These opportunities contributed to the robust nature of the study and increased involvement, which gave voice to individuals that would have otherwise not been involved nor heard.

Recommendations

Maintaining professional growth is central in supporting students. Empowering STEAM teachers to design and engage in targeted professional erudition creates layers upon layers of experiential learning atop canvases of practice. Targeted professional erudition results in an integration of professional capacity and communications to better support all learners and is analogous with the philosophical conceptualization of STEAM itself. There is an art and science to engaging in professional erudition and experiential learning is the layers of artistic medium upon scientific canvases of practice. When teachers design professional erudition, they engage in blending textural layers of STEAM pedagogy, methodologies, technology, and active involvement strategies to support student learning. A professional understanding of these critical areas is needed for supporting student learning and is connected to actively involving parents in STEAM learning. Educators require continual professional erudition for continually layering experiential learning upon canvases of practice. Professional growth results and affords educators with new instructional delivery methodologies and supports for sustaining pro-social relationships with the home and for supporting the cognitive and social, emotional needs of students. It is imperative school and district leaders provide teachers with professional erudite opportunities to not only support students and teachers, but to also contribute to and support the greater school community.

References

Battle-Bailey, L. (2003). *Training teachers to design interactive homework.* ERIC Digest on Teaching and Teacher Education. Washington DC.

Bruner, J. (1996). *The culture of education*. Cambridge, MA: Harvard University Press.

Chan, P. H., & Aubrey, S. (2021). Strengthening teacher-student rapport through the practice of guided dialogue journaling. *RELC Journal, 0*(0). https://doi.org/10.1177/00336882211044874

Creswell, J. W., & Poth, C. N. (2018). Qualitative inquiry and research design: Choosing among five traditions. Thousand Oaks, CA: Sage. https://doi.org/10.1177/1524839915580941

Dantonio, M. (2001). *Collegial coaching: Inquiry into the teaching self*. Bloomingtonm IN. Phi Delta Kappa.

Dantonio, M., & Lynch, K. (2005). To teach, to lead, to transform: Teacher leadership and the future of school reform. *Threshold*. Summer 2005. 22-25.

Darling-Hammond, L., Ancess, J., & Ort, S. W. (2002). Reinventing high school: Outcomes of the coalition campus schools project. *American Educational Research Journal, 39*(3), 639–673.

Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (2020). Implications for educational practice of the science of learning and development. *Applied developmental science, 24*(2), 97-140.

Darling-Hammond, L., Ramos-Beban, N., Altamirano, R. P., & Hyler, M. E. (2016). *Be the change: Reinventing school for student success*. New York: Teachers College Press.

Dewey, J. (1933). *How we think: A restatement of the relation of reflective thinking to the educative process.* DC Heath.

DuFour, R., & DuFour, R. (2013). *Learning by doing: A handbook for professional learning communities at work TM*. Solution Tree Press.

Dusdal, J., & Powell, J. J. W. (2021). Benefits, motivations, and challenges of international collaborative research: A sociology of science case study. Science and Public Policy, 48(2), 235–245. https://doi.org/10.1093/scipol/scab010

Epstein, J. L. (May 1995). School/family/community partnerships: Caring for the children we share. *Phi Delta Kappan, 76*(9), 701–712.

Epstein, J. L., Mac Iver, D. J., Mac Iver, M. A., & Sheldon, S. B. (2021). Interactive homework to engage parents with students on the transition from middle to high school. *Middle School Journal, 52*(1), 4-13.

Epstein, J.L., & Connors, L. (August, 1994). *School, family, and community partnerships in high schools, Report No. 24.* Johns Hopkins University. Baltimore, MD.

Epstein, J.L., & Sheldon, S.B. (2022). School, family, and community partnerships: Preparing educators and improving schools (3rd ed.). Routledge. https://doi.org/10.4324/9780429400780

Epstein, J.L., Sanders, M., & Clark, L. (1999). *Preparing educators for school-family-community partnerships: Results of a national survey of colleges and universities.* Center for Research on the Education of Students Placed At Risk (CRESPAR).

Esterhazy, R., de Lange, T., Bastiansen, S., & Wittek, A. L. (2021). Moving beyond peer review of teaching: A conceptual framework for collegial faculty development. Review of Educational Research, 91(2), 237-271. https://doi.org/10.3102/0034654321990721

Flottemesch, K. (2004). Teaching portfolios: Reflective practice of one's own learning. *Northwest Journal of Teacher Education 3*(1) 4. https://doi.org/10.15760/nwjte.2004.3.1.4

Gaible, E., & Burns, M. (2005). *Using Technology to Train Teachers: Appropriate Uses of ICT for Teacher Professional Development in Developing Countries*. Washington, DC: *info*Dev/World Bank.

Gulamhussein, A. (2013). Teaching the teachers: Effective professional development in an era of high stakes accountability. *Center for Public Education, 1*(1), 1-44.

Harris, A., & Jones, M. (2019). Teacher leadership and educational change. *School Leadership & Management, 39*(2), 123-126. https://doi.org/10.1080/13632434.2019.1574964

Hickey, A., & Riddle, S. (2022). Relational pedagogy and the role of informality in renegotiating learning and teaching encounters. *Pedagogy, Culture & Society, 30*(5), 787-799.

Hebebci, M. T. (2021). Investigation of teacher opinions on STEM education. In M. Shelley, I. Chiang, & O. T. Ozturk (Eds.), *Proceedings of ICRES 2021-- International Conference on Research in Education and Science* (pp. 56-72), Antalya, TURKEY.

Hebebci, M. T. (2023). A Systematic Review of Experimental Studies on STEM Education. *Journal of Education in Science Environment and Health*, *9*(1), 56-73.

Howard, J., Milner-McCall, T. and Howard, T. (2020). No more teaching without positive relationships. Heinemann.

Kaufmann, O. T., & Ryve, A. (2019, February). Construction of teachers' roles in collegial discussions. In Eleventh Congress of the European Society for Research in Mathematics Education (No. 35). Freudenthal Group; Freudenthal Institute; ERME. https://hal.science/hal-02422564/document

Kirner, M., & Lebrun-Griffin, M. (November, 2013). *Models of professional development*. Middletown, CT: State Education Resource Center (SERC).

Kolb, D. A. (2014). *Experiential learning: Experience as the source of learning and development*. FT press.

Kolb, D. A., Rubin, I. M., & McIntyre, J. M. (1984). *Organizational psychology: Readings on human behavior in organizations*. Englewood Cliffs, NJ: Prentice-Hall.

Lawrence-Lightfoot, S. & Davis, J. (1997). *The art and science of portraiture.* San Francisco, CA. Jossey-Bass.

Lee, H., Chung, H. Q., Zhang, Y., Abedi, J., & Warschauer, M. (2020). The effectiveness and features of formative assessment in US K-12 education: A systematic review. *Applied Measurement in Education, 33*(2), 124-140.

Lengeling, M. (1996). *The use of portfolios for teacher evaluation*. Speech Conference. March, 1996.

Levin, B. B., & Schrum, L. (2016). *Every Teacher a Leader: Developing the Needed Dispositions, Knowledge, and skills for teacher leadership.* Corwin Press.

Lingard, L. (2021). Collaborative writing: Strategies and activities for writing productively together. Perspect Med Educ 10, 163–166. https://doi.org/10.1007/s40037-021-00668-7

Mahoney, J. L., Weissberg, R. P., Greenberg, M. T., Dusenbury, L., Jagers, R. J., Niemi, K., Schlinger, M., Schlund, J., Shriver, T. P., VanAusdal, K., & Yoder, N. (2021). Systemic social and emotional learning: Promoting educational success for all preschool to high school students. *American Psychologist, 76*(7), 1128.

Management Mentors. (2013). *Coaching vs. mentoring: 25 ways they're different.* http://www.management-mentors.com

Merriam, S. B. & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey-Bass.

Oliver, S. K., Fergus, C. E., Skaff, N. K., Wagner, T., Tan, P. N., Cheruvelil, K. S., & Soranno, P. A. (2018). Strategies for effective collaborative manuscript development in interdisciplinary science teams. *Ecosphere, 9*(4), https://doi.org/10.1002/ecs2.2206

Osher, D., Cantor, P., Berg, J., Steyer, L., & Rose, T. (2018). Drivers of human development: How relationships and context shape learning and development. Applied Developmental Science. https://doi.org/10.1080/10888691.2017.1398650

Piaget, J. (1972). *The psychology of the child*. New York: Basic Books.

Prosek, E. A., & Gibson, D. M. (2021). Promoting rigorous research by examining lived experiences: A review of four qualitative traditions. *Journal of Counseling & Development*, *99*(2), 167-177. https://doi.org/10.1002/jcad.12364

Røkenes, F. M., Grüters, R., Skaalvik, C., Lie, T. G., Østerlie, O., Järnerot, A., ... & Letnes, M. A. (2022). Teacher educators' professional digital competence in primary and lower secondary school teacher education. *Nordic Journal of Digital Literacy,* 1, 46-60. https://doi.org/10.18261/njdl.17.1.4

Ross, J. A., & Hogaboam-Gray, A. (2011). Integrating mathematics, science, and technology: Effects on students. *International Journal of Science Education, 20*(9), 1119-1135. https://doi.org/10.1080/0950069980200908

Rutherford, B., Anderson, B., & Billig, S. (1995). *Studies of educational reform: Parent and community involvement in education*. RMC Research Corporation. U.S. Department of Education, Office of Educational Research and Improvement.

Schieffer, L. (2016). The benefits and barriers of virtual collaboration among online adjuncts. Journal of Instructional Research, 5, 109–125.

Shahali, E. H. M., & Halim, L. (2023). The influence of science teachers' beliefs, attitudes, self-efficacy and school context on integrated STEM teaching practices. *International Journal of Science and Mathematics Education,* 1-21.

Shen, J., Wu, H., Reeves, P., Zheng, Y., Ryan, L., & Anderson, D. (2020). The association between teacher leadership and student achievement: A meta-analysis. *Educational Research Review, 31,* 100357. https://doi.org/10.1016/j.edurev.2020.100357

Sheninger, E. (2019). *Digital leadership: Changing paradigms for changing times.* Corwin Press.

Shields, C. M., & Hesbol, K. A. (2020). Transformative leadership approaches to inclusion, equity, and social justice. *Journal of School Leadership, 30*(1), 3-22. https://doi.org/10.1177/1052684619873343

Shymansky, J., Yore, L., & Hand, B. (2010). *Empowering families in hands-on science programs.* Paper presented at the International Conference of the Association for Educating Teachers in Science, Austin, Texas, January 14-17, 1999. U.S. Department of Education. https://doi.org/10.1111/j.1949-8594.2000.tb17319.x

Stillman, J., Anderson, L., & Struthers, K. (2014). Returning to reciprocity: Using dialogue journals to teach and learn. *Language Arts*, *91*(3), 146–160. http://www.jstor.org/stable/24575021

Strike, K. T., Sims, P. A., Mann, S. L., & Wilhite, R. K. (2019). *Transforming professional practice: A framework for effective leadership.* Rowman & Littlefield Publishers.

Teddlie, C., & Tashakkori, A. (2009). *Foundations of mixed-methods research: Integrating quantitative and qualitative approaches in social behavior and sciences.* Sage.

Van Voorhis, F. (2001). *Teachers' use of interactive homework and its effects on family involvement and science achievement of middle grade students.* American Educational Research Association. Johns Hopkins University. Baltimore, MD.

Vygotsky, L. S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Walker, J., Hoover-Dempsey, K., Whetsel, D., & Green, C. (October, 2004). *Parental involvement in homework: A review of current research and its implications for teachers, after school program staff and parent leaders.* Harvard Family Research Project. Cambridge, MA.

Wen, C. T., Liu, C. C., Chang, H. Y., Chang, C. J., Chang, M. H., Chiang, S. H. F., & Hwang, F. K. (2020). Students' guided inquiry with simulation and its relation to school science achievement and scientific literacy. C*omputers & Education, 149,* 103830.

Wolf, K. (1996). Developing an effective teaching portfolio. *Educational Leadership (52)* 6. 34-37.

Woolley, R., Sánchez-Barrioluengo, M., Turpin, T., & Marceau, J. (2015). Research collaboration in the social sciences: What factors are associated with disciplinary and interdisciplinary collaboration? *Science and Public Policy, 42*(4), 567–582. https://doi.org/10.1093/scipol/scu074

Yan, Z. (2020). Self-assessment in the process of self-regulated learning and its relationship with academic achievement. *Assessment & Evaluation in Higher Education, 45*(2), 224-238.

Yan, Z., & Carless, D. (2022). Self-assessment is about more than self: the enabling role of feedback literacy. *Assessment & Evaluation in Higher Education, 47*(7), 1116-1128.

Author Information

Christopher Dignam
https://orcid.org/0009-0007-3185-4825
Governors State University
1 University Pkwy
University Park, Illinois 60484
United States