

**TWO TEACHERS' JOURNEY, ONE TEACHERS' TALE: AN
AUTOETHNOGRAPHIC NARRATIVE OF CREATING AN ASSESSMENT AND
EVALUATION SYSTEM USING A LEARNING COMMUNITY FRAMEWORK**

by

Christopher Ryan

B. Philosophy in Interdisciplinary Leadership (UNB, 2005), B. Education (STU, 2006)

A Thesis, Submitted in Partial Fulfillment
of the Requirements for the Degree of

Masters of Education

in the Graduate Academic Unit of Education

Supervisors: Ann Sherman, PhD, Faculty of Education

Ellen Rose, PhD, Faculty of Education

Examining Board: Lyle Hamm, PhD, Faculty of Education

Mary Blatherwick, PhD, Faculty of Education

Ray Williams, EdD, Dept. of Education, St Thomas University

**This thesis is accepted by the
Dean of Graduate Studies**

THE UNIVERSITY OF NEW BRUNSWICK

December, 2017

©Christopher Ryan, 2018

ABSTRACT

This thesis aims to explore how a learning community model of collaboration helped to create a system of assessment and evaluation in a high school physics course that has been used to navigate a number of challenges teachers face. Through an autoethnographic methodology the author explores his own experiences by relaying and analyzing a number of conversations with a colleague. By weaving together literature on assessment and learning communities with personal narratives, the author describes the formation of the assessment model and how it has impacted students. The results describe what the author learned about leveraging learning communities to build assessment and evaluation models. While the genesis of these models started in a physics course, the author demonstrates examples of working in other disciplines to build similar models.

DEDICATION

To Nadine, for all the support you give.

ACKNOWLEDGEMENTS

I would like to thank Dr. Ann Sherman and Dr. Ellen Rose for their guidance in working through this non-traditional thesis. Also, I would like to recognize UNB's contribution by sponsoring innovative learning environments that I have been able to work through parts of this process such as the UNB/RNS Learn2Learn conference, the UNB/EECD Universal Design for Learning Action Research Project, and hosting world class keynote speakers such as Dr. Ann Davies.

I could not have completed this research without the continuous support of my colleagues at Riverview High School and in Anglophone East. In particular Ian Fogarty, Tim Beatty, and Tracy Landry routinely acted as a sounding board through my learning. In addition I have received resource support from Anglophone East and the New Brunswick Teacher's Association to attend numerous conferences presenting this research and to continue my learning.

Finally I must recognize the continuous support I receive from my family. Specifically Nadine and Michael, who support me continuously, and Louise, Marcel, and Barb, whose support is too numerous to count.

Table of Contents

ABSTRACT.....	ii
ACKNOWLEDGEMENTS.....	iv
Table of Contents.....	v
Chapter One – Introduction	1
Chapter Two – Methodology.....	8
Autoethnography as Methodology.....	8
Defining autoethnographic methodology.	9
Collection and representation of data.	15
Generalizability and criticism.	17
Autoethnographic Narrative as Method.....	19
Action Research.....	25
Thesis Organization	28
Ethical Considerations	30
Chapter Three - Starting with Learning Communities	31
The Origins of Our Learning Communities.....	33
The first attempt at essentials.....	35
Learning Communities In Literature	40
Collaborating On Roller-coasters	45
Effective features of the learning community.....	45
From rollercoasters to Rube Goldberg machines.....	47
Leveraging Rube Goldberg machines for physics.....	52

Creating Curriculum-Based Learning Communities	57
Learning communities for physics.....	60
Assessment use in the study blocks.	63
Chapter Four: Disrupted by Technology and Problem Solving.....	66
Chapter Five: Changing Assessments and Evaluations	72
Echoing Initial Challenges in Changing Assessments.....	73
No zeros means more time for learning.	74
Disruption Two Brings Assessment Literature to Physics	82
Defining formative assessment and feedback.....	82
System limitations were aided by assessment literature.	84
Comparing other definitions from literature.	86
Global essentials migrate from ELA to physics.	90
Feedback is useful in earning a credit.....	94
Literature on student feedback.....	98
Personalization of Learning	100
Personalization/individualization in the literature.	100
Everyone does engineering.	102
Assessment for learning.....	105
Our final exam is all novel.....	113
Counter Arguments In Literature.....	116

Chapter Six: Products – Stories and Answers.....	119
Students Changed as a By-product of Assessment Changes	119
Small projects have a big impact.	120
Big ideas create big impacts: disruption three.	124
Moving beyond a physics class.....	134
Overarching Questions and Answers.....	139
Chapter Seven: Final Reflections and Results	146
Effective Learning Communities.....	146
Building an Assessment System	150
Further Research.....	151
Final Considerations	153
Bibliography	155
Appendix A: Complete Assessment and Evaluation Model.....	166
Appendix B: Timeline of Events in Creating the Assessment Model	172
Curriculum Vitae	

Chapter One – Introduction

From my experience working with teachers and district personnel, as well as presenting at various conferences, there sometimes exists a learning-doing gap in what teachers and administrators read in academic literature and what they do in their classrooms. It is my experience that teachers do not categorically resist change because they disagree with research but because they may not know how to make the changes they desire. I see and hear about the difficulties some classroom teachers have in creating a classroom assessment system that provides for inclusivity, student choice, mastery level learning, problem-based learning, formative assessment, systematic interventions, non-reliance on grades for feedback, and teaching of skills highlighted by the World Economic Forum (Gray, 2016) in a high school. Teachers often say that they do not have concrete practical examples of what an assessment system would look like based on the research and writing of Davies (2008, 2011, 2013, 2014), Burke (2010), Guskey (2001, 2009), Hattie (2012), O'Connor (2007), Reeves (2002, 2004, 2011) Stiggins (2005, 2007), and Wiliam (2011). From the perspective of a classroom teacher, it appears to me that much of the literature is written for an administrative audience in the form of concepts and plans for improvement. Many teachers I have talked to about assessment research say they feel that the research is disconnected from their own classroom practices. I believe it would benefit teachers to have additional concrete examples from the perspectives of a classroom teacher. It is my experience that an example that shows that the day to day, month to month, planning and design of an assessment system can

provide clarity to teachers about what they can accomplish in their classes and how they can overcome perceived obstacles they encounter.

I believe that current assessment and evaluation literature needs to be supplemented by a complete story that is highlighted by conversations about changing assessment strategies. In my literature review I found very little discussion regarding assessment changes and creation of an assessment system at the high school level. Some literature exists that examines specific aspects of assessment in post-secondary education. Examples include Boud and Molloy (2013), examining models of feedback; Christie et. al (2015), improving grading tools; Gezie et. al (2012), using rubrics for learning tools; and Grainger and Weir (2016), designing alternative grading tools. What is not included is literature on a community of practice or learning community examining their assessment system. This is confirmed by Grainger et. al (2017) stating, “Our review failed to identify any published research that targeted internal peer-review of assessment artefacts, such as criteria sheets, which was the focus of our own community of practice” (p. 412). This reaffirms my assertion that there exists a literature gap in how teachers, organized in learning communities, can design an assessment system based on current literature.

It has been my experience that many teachers I work with also perceive that research about learning communities is not relevant to them or their practices. The features and characteristics of well-functioning learning communities are well documented by DuFour, DuFour, Eaker, and Many (2006); Edwards (2012); Hord (1997); Lomos et. al (2011); Prytula (2012); and Tidwell, Wymore, Garza, Estrada, and Smith (2011) as development of trust, risk taking, teacher inquiry, and capacity building

through distributed leadership. What is sometimes lacking are examples of the real conversations that teachers have as they work through the many demands such as allowing students more time to master content with many iterations of feedback, and the real world demands of having a due date to submit report card marks. An article that provides an example for teachers is Davies, Busick, Herbst, and Sherman (2014). This article provides detailed insight on how to act as an assessment leader within a school or district. What I hope to expand on is an example of teacher-to-teacher conversations that happen in an effective learning community to make assessment change a reality. These conversations led to a new student assessment model that can be used in multiple disciplines. Examples of these conversations will help teachers understand how learning communities help improve assessment practices and see how a new assessment model works to alleviate many of the system pressures that teachers face when implementing current research.

My driving question in this thesis is, “How can classroom teachers work in learning communities to build an assessment and evaluation system at the high school level that incorporates current assessment research and addresses many challenges that teachers face?” Through an autoethnographic methodology I will explore how using an effective learning community model and elements of action research allowed myself and a colleague, Ian Fogarty, to incorporate a significant amount of assessment knowledge into our commonly taught Physics 112 and 122 courses over the last eleven years. This led to radical changes in our assessment practices, evaluation, instruction, student engagement, course objectives (such as students taking on an engineering project or exploring their passion), and failure rates; all of which are becoming co-opted to other

courses and disciplines. Through a narrative portrayal, I will provide an example of how using curriculum-based teacher learning communities allowed us to develop a non-traditional assessment system that increasingly meets the needs of diverse learners. I include throughout this thesis significant samples of reconstructed conversations in order to show how thinking about teaching and assessment have changed as we were exposed to new research and teaching expectations changed. These conversations are woven with accompanying research on learning communities and assessment in order to highlight how the research influenced our thinking and changes in practice as we created and tested this system. Many of these changes came about when adopting a learning community framework.

In the past decade, I have been witness to the adoption of learning community structures implemented at both the district and school level. I have had the privilege of working in a district that has brought in speakers such as Dufour (2007), Muhammad (2009), Reeves (2010), and Davies (2011), and work in a high school that has engaged in book studies on the works of Burke (2010), Guskey (2001, 2009), Hattie (2012), O'Connor (2007), Stiggins (2007), and Wiliam (2011). While this presents a great opportunity for dialogue and exposure to new ideas, it also creates a level of frustration for some classroom teachers. There can exist disconnections between the thinkers and presenters of educational ideas and the teachers who are trying to incorporate these complex ideas at the classroom level. Administrators can also encounter frustrations as their dual roles of school or district managers and educational leaders sometimes seem to exist in conflict with each other.

From a teacher perspective, I have sometimes witnessed frustrations from teachers navigating current assessment research. These frustrations fall into two broad categories of feeling like there are unrealistic demands placed on their time and energy and that they do not know how to change an assessment system ‘on the fly.’ From these two tensions arise the following set of questions. The responses to these questions, based on presented research, are explicitly stated in the final chapter at the end of this thesis. 1) Should teachers generate marks using the best example of student work, the most recent, the top five scores, or some combination? 2) If an outcome can only be assessed naturally at one point in a semester, how can teachers allow for more assessment opportunities with limited disruption? 3) What should teachers do if half of the class shows competence on an outcome or unit and the other half does not? 4) If students are allowed multiple attempts to demonstrate proficiency, is there a limit for top end students as many of them would take a test until they scored 100% and should that same limit still exist for students that are just trying to earn a credit to graduate? 5) How can teachers guard against simple memorization while promoting long term retention and higher order thinking? 6) How do teachers incorporate high quality Universal Design into an assessment system? 7) How can teachers allow more flexible learning environments and problem-based learning when there is a large amount of prescribed curriculum to deliver? 8) How do teachers balance individualization of student learning with maintaining an agreed upon standard of proficiency and content coverage? 9) How do teachers provide support for struggling students while increasing the standards of performance for all students? 10) How do teachers allow students to take more time for learning in a system that has fixed reporting periods? Although these do not each seem like dichotomous statements or significant

challenges to some readers, not all high school teachers can navigate such complexities, understandings, and nuances presented in the literature while being expected to change their day-to-day practice. Many teachers would benefit from more examples of how to accomplish the complex task of implementing current assessment research in their classroom. Part of the goal of this thesis is to present an example of an assessment and evaluation system that addresses these concerns and questions. I hope that the narrative presented provides teachers a detailed example of the types of conversations that need to happen in order to build a robust assessment system that can answer these questions and concerns.

The challenges faced by district and school administration are not necessarily greater than those faced by teachers but often have a wider impact. School leaders, ultimately, have the role of creating and supporting environments and cultures that help teachers and students be as successful as possible. This often includes helping to inform and educate teachers about new classroom practices or organizational structures. This is sometimes a tricky task for school leaders because perceived change and real visceral change can look the same to the untrained eye. Unfortunately, I have observed one school that seemed to be on the path to becoming a highly effective professional learning community fall apart. In fact, this school was showcased in one of the Dufour books as a school that was making progress and seemed to be successful. Within the next academic year, on threat of mutiny, the principal was transferred to another school as a vice principal. This coincided with the teaching staff apparently rejecting all learning community advances made under the former principal.

In addition to the identified gap in literature described above, Ian and I have been told at dozens of national and international conferences that this assessment system, and the conversations that have created it, have the potential to provide teachers an assessment and evaluation model that answers many of the current challenges teachers are facing in implementing assessment research into their classrooms. I write this with the secondary intent that it may also help administrators better understand how the professional learning community culture can be used to foster relationships that drive school improvement and increase student learning. The research, narration, and presentation described here are intended to be an accessible resource to classroom teachers and administrators who are looking for an example of how to change their assessment practices.

Chapter Two – Methodology

The research methodology I use in this thesis to answer the question, “How can classroom teachers work in learning communities to build an assessment and evaluation system at the high school level that incorporates current assessment research and addresses many challenges that teachers face?” is autoethnography. I used this methodology to address the problem of applying assessment literature at the classroom level and explore how a learning community approach to teacher professional growth fostered the development of a new assessment model. In addition to describing the use of autoethnography as the research method, I will outline in this chapter the use of narrative as a method of representation, the use of action research as a method to navigate changes Ian and I made in our practice, how the remainder of the thesis is organized, and, finally, I present the ethical considerations of this research.

Autoethnography as Methodology

In this section I use the literature on autoethnography to outline why this was my preferred methodology. To do this, I first define autoethnography and match my research to a particular autoethnographic practice. Second I describe how I gathered and interpreted data, including how I conducted a member check for validity. Finally, I present what I have read in the literature on the topics of generalizability and criticisms that autoethnographic authors face.

I am writing this thesis as an autoethnography in order to examine the process of creating an assessment model. I have spent considerable time reflecting on the reasons for and influences in creating the assessment system used by Ian and myself in our Physics

11 and 12 courses. This exploration places me at the center of the narrative that I tell and I am the chief researcher in this thesis. The answer to the guiding question comes from inquiry into my own learning and reflection. To gather data on this topic, I used my own reconstructed professional conversations, classroom observations, and personal reflections. The style of writing I use in representing this exploration uses a narrative method as a series of stories (identified more accurately as episodes) that are autoethnographic in nature. Each episode was examined in parallel with relevant literature in order to generate meaning on both the how and why of what we learned and how we changed our practice.

Defining autoethnographic methodology.

This thesis is an autoethnography, or what Reed-Danahay (1997) initially called a self narrative, as I am creating meaning from readings, conversations, and observations that I had in my teaching career that can best answer my driving question. This thesis is representative of my professional growth and learning and is paired with an exploration of how this growth has contributed to cultural changes in a learning community and fundamental changes in how assessment and evaluation are understood at the classroom level. The answer to my driving question is formed by reflecting on how assessment learning and learning community structures influenced my teaching. In this section, I start broad with some thoughts on ethnography, move into more specific descriptions of autoethnography, and describe why I have used analytic autoethnography as my methodology through this thesis.

Pole and Morrison's (2003) textbook titled, *Ethnography for Education* builds on authors such as Hammersley (1990) and Brewer (2000) to provide a definition for ethnography and outline its characteristics. Although I have employed an autoethnographic approach, much of what Pole and Morrison (2003) attribute to ethnography applies to my research as well. This book provides significant detail regarding ethnography while summarizing the literature on its use.

All ethnography is described by Pole and Morrison (2003) as having five broad characteristics and four objectives that a researcher should hope to achieve. My research matches four of the five characteristics and all of the objectives. The first characteristic I identify with in my thesis is, "a focus on a discrete location, event(s) or setting" (Pole and Morrison, 2003, p. 3), where I am examining a specific set of events that took place at a specific location. The second characteristic I identify with from Pole and Morrison (2003) is, "the use of a range of different research methods which may combine qualitative and quantitative approaches but where the emphasis is upon understanding social behaviour from inside the discrete location, event or setting" (p. 3). I am focusing on the understanding of how the social systems and behaviours influenced our creation of this assessment model. The third characteristic from Pole and Morrison (2003) is "an emphasis on data and analysis which moves from detailed description to the identification of concepts and theories which are grounded in the data collected within the location, event or setting" (p. 3). Throughout the thesis I move between observation and literature review moving from detailed description of events and conversations toward trying to tease out the concepts that other educators might be able to use in similar situations. The fourth characteristic that I resonate with from Pole and Morrison (2003) is, "an emphasis

on rigorous or thorough research, where the complexities of the discrete event, location or setting are of greater importance than overarching trends or generalizations” (p.3).

While I hope this thesis can contribute to other educators gaining a greater understanding about learning communities and assessment, the focus is on identifying what I learned about our particular learning community and the effects it had on our creation of the assessment model. The characteristic from Pole and Morrison (2003) that I do not find relevant to my research is having, “a concern with the full range of social behaviour within the location, event or setting” (p. 3). I am solely concerned with how our conversations and the school-wide structures supported our creation of an assessment model. I am not concerned with exploring or understanding any other aspects of our social behaviour or that of anyone else I have interacted with in this process. I feel that my thesis matches Morrison’s (2003) characteristics well as I am focused on creating meaning within a single location and in regards to a specific set of events. While I am looking to represent this in such a way that others can learn from our efforts, I have gathered data on social behaviour and am looking to move from raw data to the greater importance of representing the complexities of conversations from the setting.

Pole and Morrison (2003) also lay out some general objectives that ethnography should achieve.

“The collection of data, [a] comprehensive and contextualized description of the social action within the location, [t]he portrayal of an insider’s perspective, [and] [t]he construction of an account of the discrete location, event or setting which is grounded in the collected data and which incorporates a conceptual framework that facilitates understanding of social action...” (p. 4)

In terms of answering my driving question, I have collected data related to a specific social context that portrays a specific perspective by constructing an accurate insider's account of our situation and created a loose framework to understand our growth in the social construction of our assessment model. This most closely resembles autoethnography as a research methodology as described by Anderson (2006), Butz (2009), Denzin (2006), Ellis and Bocher (2006), Holt (2003), and Richardson (2000).

In the broadest sense Holt (2003) states that, "autoethnography is a genre of writing and research that connects the personal to the cultural, placing the self within a social context" (p. 2). There is a discussion in the literature in the difference between autoethnography and autobiography. The difference is summarized by Hamilton, Smith, and Worthington (2008), who suggest, "that autobiography focuses simply on self, while autoethnography brings forward the shifting aspects of self and creates ways to write about experiences in a broader social context" (p. 22). I focus on my own growth throughout the episodes by positioning myself as a central character in a dialogue or by describing events as I have witnessed them take place, but I often examine the culture I was embedded in and seeking to create.

Authors such as Ellis and Bocher (2006), and Richardson (2000) use autoethnography for personal narratives in the subjects of sexuality, culture, identity and political statements described as evocative autoethnography. The evocative form is largely used to entice an emotional response to the author's personal narrative in order to open up conversations. I am using it closer to the description of Hamdan (2012) and Hayler (2011), who advocate for its use in educational contexts, and Anderson (2006) and Butz (2009) who articulate an analytic autoethnography that is used to develop an

understanding of social events or situations. In order to explore my driving question I have used analytic autoethnography to understand the social phenomenon and cultural context in which Ian and I created an assessment model.

Placing myself in this cultural context allows me to become an analytic autoethnographer as described by Anderson (2006). Adding to the description of analytic autoethnography, Butz (2009) provides more clarity by defining five types of autoethnography. The type that I most closely identify with, complementing analytic autoethnography, is the insider or complete member research where, “Its practitioners are academic researchers who study a group or social circumstance they are part of, and use their insiderness as a methodological and interpretive tool” (Butz, 2009, p. 1669). The merger of these two descriptions from the literature describes my use of autoethnography.

Anderson (2006) identifies analytic autoethnography as entailing, “(1) complete member researcher (CMR) status, (2) analytic reflexivity, (3) narrative visibility of the researcher’s self, (4) dialogue with informants beyond the self, and (5) commitment to theoretical analysis” (p. 378). Throughout this thesis I will demonstrate how I identified with each of these characteristics. As a member researcher, I was a significant part of the research group I was studying through this thesis as there were only two participants in our learning community. Analytic reflexivity refers to adding a layer of analysis while taking into account a reflexive perspective. As I have stated, the purpose of this thesis is to analyze the narrative episode in order to determine how our culture has impacted our development as a team. While performing this analysis, I have attempted to remain mindful of reflexivity in the bidirectional relationship between Ian and I creating our culture and our culture influencing our interactions. When looking at visibility, I am a

central figure in each of the episodes as I am one of the primary speakers or the episode is seen through my experience. Finally, I am exploring the broader social phenomena of constructing a particular culture and then analyzing how that culture contributed to the creation of an assessment model.

A number of authors provide a variety of advice for researchers using autoethnography. Humphreys (2005) advocates the use of vignettes in order to relive the events and provide rich context. This is similar to the episodes that I include throughout the thesis which have the intent of immersing the reader into discussions and thinking patterns I experienced. Sparkes (2000) experienced that autoethnography was treated with suspicion because of the researcher being at its center or as its subject. The solution for Sparkes (2000) was recognizing that, “to become part of the academic enterprise, something must be added to stories in the form of theoretical abstraction or conceptual elaboration” (p. 21). As I have indicated, I have included analysis throughout the thesis that potentially helps the reader to abstract my learning to their situation. The last piece of advice comes from Butz (2009) who describes the need for researchers to take on autoethnographic sensibility.

[This] entails an effort by academics to: (i) perceive themselves inevitably (even if not intentionally) as part of what they are researching and signifying; (ii) understand their research subjects as autoethnographers in their own right, whose self-presentations in the context of research are reflexive; and (iii) conceive of research as unfolding in an expanded field where their own self-interested project of self-narration interacts with those of their research subjects in the context of an existing network of social relations. (p. 1671)

To achieve much of this Butz (2009) suggests that thinking autoethnographically can help researchers to think reflexively and understand how the research interacts with research subjects. This assertion suggests that autoethnographers have an advantage to

understanding their research subjects. This falls in line with my adoption of Anderson's (2006) description of analytic autoethnography and Butz's (2009) ideas around insiderness.

Collection and representation of data.

The data for this autoethnography comes from a wide range of sources from the past ten years. As Ian and I learned more about assessment and worked in a learning community, I often read books, attended workshops/conferences, and created and delivered presentations. Accompanying these artifacts I had notes that I would loosely describe as journals of my learning. Other artifacts that documented our changes to our assessment system include course outlines, assessments, rubrics, and assignments. Ian and I had a number of communications through email as well as collaborative works that documented our correspondence on various topics. All of these sources of data were synthesized with my reflections to draft a list of pivotal episodes, and then to write the episodes in a way that captured our journey through the creation of a learning community, learning about assessment, and working through various challenges to implement an assessment system based on current assessment literature.

I member checked with Ian on two different occasions during this process. The first was when the list of episodes was drafted. After his review of the list, we had a conversation confirming the accuracy of the timeframe and the nature of the episodes. The second member check was when the collection of episodes was written. Ian was sent an email in order to read through all of the episodes to confirm their accuracy in terms of timeframe, tone, content, and attribution of ideas to the correct agent. Ian made a few

comments to add particular details and we had a conversation to ensure accuracy before I updated some episodes to reflect his additions. Overall they were very accurate to both of our recollections with no substantial changes to content, tone, or attribution.

The episodes were created to represent our conversations and insights over the course of our learning. They detail explanations of significant events or epiphanies that we had while working through this process. The episodes were analyzed in conjunction with the literature in order to distill an answer to my driving question. The purpose of the analysis was to determine consistencies or discrepancies between what Ian and I had experienced and with what was presented in the literature. These led directly to the results of my learning about how teachers can use learning communities and assessment literature to create changes to their classroom based assessment system while helping to provide our own answers to the ten questions posed in chapter one.

Within each chapter there are two distinct types of episodes. The most common are episodes that advance the theme through a demonstration of the fruitful dialogue in a learning community. These dialogues are often reconstructed from conversations between Ian and I that happened over a number days, months, or years. While they are not verbatim transcripts, enough of the conversation is presented for the reader to understand how our ideas would evolve as new ideas presented themselves. This use of narrative is intended to allow me to create meaning for the reader at the same time as demonstrating how learning communities support the acquisition and implementation of assessment learning. The second type are episodes that I have termed 'disruptions'. These are single events that radically shifted a paradigm that Ian and I were operating in. These events

provided the impetus to radically change the way we thought about assessment and how it could impact our students.

As a reference for the reader, Appendix B: Timeline of Events in Creating the Assessment Model is included to help highlight the various connections that existed between the depicted episodes. While the thesis is separated into sections based on learning communities, assessment, and beyond the physics class, in reality, all of the conversations embedded in these sections happened concurrently. The nature of this assessment model necessitated many pieces coming together at the right time to answer all of the questions posed in Chapter One. This timeline is organized chronologically in order to juxtapose the arrangement of ideas in the rest of the thesis.

Generalizability and criticism.

The literature on generalization of ethnography, and by extension autoethnography, is murky at best. Hammersley (2001) makes the coherent argument that fuzzy generalization is to be expected in education and social research when there are so many interacting variables so that all generalizations are a matter of degree. My experience is that the assessment model presented through this thesis and much of my learning, especially our answers to the challenging questions, is being used by other teachers and disciplines as I have witnessed the transfer. While true generalization can only be attained through experimental means, I assert that teachers adopting our assessment model, while engaging in conversations about learning communities, constitutes Hammersley's (2001) fuzzy generalization. I have witnessed each teacher adopting the model taking into account their own constraints when creating their own

version of an assessment model similar to the one presented here. This is consistent with Hammersley's (2001) position as each situation provides unique challenges that need to be overcome in order to successfully design and implement assessment changes.

The largest criticism of autoethnography is found through the literature is summed up by Sparkes (2009) that, "...narcissism and related namings such as self-indulgence and self-absorption function as regulatory charges against certain forms of sociology and act to re-inscribe ethnographic orthodoxy" (p. 30). This means that if autoethnographic researchers are not careful to avoid narcissism, self-indulgence, and self-absorption, the peer review community will push the researcher toward adopting a more traditional approach to ethnography by taking the self out of any narrative. A response is found in Richardson (2000) as a set of suggestions for reviewing autoethnographic papers for peer review. Scholars should ensure papers make a substantive contribution, use a social scientific perspective to contribute to our understanding of social life, offer an aesthetically pleasing text that invites interpretive response, demonstrate reflexivity in that the author identifies himself or herself in the writing and interpretation of results, evoke a move to action or emotion response, and depict a sense of lived experience that seems real to the reader.

Through this thesis I have made every effort to incorporate each of these suggestions. I have identified a gap in the literature that should allow teachers and administrators to take action in examining their systems in an effort to improve. I am speaking specifically to an authentic social situation, and try to describe it in a manner that is easy to follow. Lastly, I identify myself clearly through the text in an effort to interpret my learnings.

Autoethnographic Narrative as Method

Narrative provides the means to tell the story of creating an assessment model based on what we learned about assessment and learning communities. The literature presented below on narrative focuses on how to use narrative, acceptable uses of narrative, and considerations of validity. I used narrative in my research to tie all the pieces of this story together into a format that was accessible to a broad range of readers. I believe that highlighting a story of professional development gives teachers a different perspective than the theoretical ideas presented in the literature. A narrative based at the classroom level allows teachers to relate to a familiar environment and provides greater substance to the literature. The following excerpt by Stiggins (2007) shows a typical example of narrative being used to discuss assessment:

If [Gail] had just avoided those careless mistakes and had also overcome this one gap in understanding, she might have received 100 percent, imagine that! If she could just do the test over . . . She can. Because Gail's teacher has mapped out precisely what each item on the test measures, the teacher and students can work in partnership to group the students according to the main concepts they haven't yet mastered. The teacher then provides differentiated instruction to the groups focused on their conceptual misunderstandings. (p. 25)

While the follow-up actions of the teacher are clear to the experienced teacher or the researcher, there is little discussion of the day-to-day actions or plans a teacher needs to have in place in order to implement a sustainable assessment system. I present here my own story with the intent of helping other teachers create greater meaning from literature on both assessment and learning communities. Any episodes containing references to students use pseudonyms, and where necessary inconsequential details have been altered to protect the identity of minors.

The purpose of this section is to explore framing the presentation of this thesis using the narrative method. Numerous articles were collated in an attempt to examine narrative inquiry as a research method to identify key criteria that needed to be included in a narrative in order to be considered valid and scholarly. These articles fall into the broad categories of defining narrative, the purpose of using narrative, considerations for validity, and the pros or cons of using narratives.

There are two sets of authors who are referenced consistently throughout much of the literature dealing with the narrative as a research tool: Connelly and Clandinin and Polkinghorne. Connelly and Clandinin (1990) state that, "...narrative ...is the study of the ways humans experience the world... education is the construction and reconstruction of personal and social stories; teachers and learners are storytellers and characters in their own and other's stories" (p. 2). They also emphasize that, "narrative is both phenomenon and method... we use the reasonably well-established device of calling the phenomenon 'story' and the inquiry 'narrative' ...Narrative is a way of characterizing the phenomena of human experience" (p. 2). Polkinghorne (1995) takes a slightly different approach in saying that,

...narrative meaning is one type of meaning produced by the mental realm. It principally works to draw together human actions and the events that affect human beings, and not relationships among inanimate objects. Narrative creates its meaning by noting the contributions that actions and events make to a particular outcome and then configures these parts into a whole episode. (p. 6)

These definitions are generally agreed upon by Clandinin, Pushor, and Orr (2007), Creswell (1998), Gudmundsdottir (2001), Kyrtziz and Green (1997), Moen (2006), and Savin-Baden and Van (2007).

One notable difference on the definition found in the literature comes from Denzin (1997), who states, “Language and speech do not mirror experience: They create experience and in the process of creation constantly transform and defer that which is being described. The meanings of a subject’s statements are, therefore, always in motion” (p. 5). While it is interesting to note this difference, I hold that my thesis more closely matches that of Connelly and Clandinin (1990) by representing experiences as reflections of events rather than constructions of reality. I have made specific effort to maintain an awareness of the tension between experience and language. The purpose of the narratives, or episodes, I have created are intended to reflect or represent reality as closely as possible. I have used language that is specific and detailed in order to accurately depict the speech of others when interviewing or reflecting on conversations. I have largely avoided Denzin’s (1997) idea of narrative as I believe a true account of conversations and events would have more impact on classroom based teachers.

Another notable difference is Heikkinen’s (2002) agreement, in contradiction to Denzin (1997), that, “Others have claimed that the narrative approach is not a method but, rather, a frame of reference in a research process, wherein narratives are seen as producers and transmitters of reality” (p. 2). While most authors agree that narrative inquiry is a methodology or method, this dissention needs to be explored. The best way to answer this question is to determine why a researcher would use this as a method of representation and what the benefits would be.

The research identifies numerous reasons for using narrative inquiry as a method for both research and representation. Clandinin, Pushor, and Orr (2007) state that the narrative approach may be the most useful to educators as it allows for stories to be told

that are retell-able and understandable to a wide variety of audiences (p. 33). Moen (2006) continues this idea of understanding by articulating three claims about how humans understand narratives:

...human beings organize their experiences of the world into narratives, ... narrative researchers maintain that the stories that are told depend on the individual's past and present experiences, her or his values, the people the stories are being told to, the addressees, and when and where they are being told, ... [and] the multivoicedness that occurs in the narratives. (Moen, p. 4)

Baumeister and Newman (1994) state that using narrative is superior to the logical processes of quantitative research as it,

...is well suited for reinterpreting and accommodating inconsistent information, as well as for helping people think about situations that involve conflicts or contradictions ...provides a way for the inevitable inconsistencies that one observes in human behavior to be more easily interpreted and retained in memory. (p. 678)

These ideas clearly suggest that narrative inquiry is valid when used in specific contexts. I have used narrative in this way when telling stories that are helping to clarify divergent ideas around teacher expectations and convey them to a wide audience. Because this research is dealing with human experience evolving over time, the use of narrative to depict the changes may make it easier for the reader to connect divergent thoughts.

There are two interrelated items found in the literature that discuss validity. These are data sources used and the evaluation of the quality of narrative inquiry as a research method. If a researcher has used quality data sources and followed some simple recommendations, the narrative and action research will hold up to scrutiny. The most comprehensive list of data sources comes from Savin-Baden (2007):

...data sources in narrative inquiry include: field notes of shared experiences, journal records of participants, interviews (usually unstructured), storytelling, letter writing, and autobiographical and biographical writing. ...Some important points to consider when undertaking narrative inquiry are that the researcher should: listen to participants' stories, acknowledge the mutual construction of the research relationship (both researcher and participant have a voice with which to tell their stories), acknowledge that people are both living their stories in an ongoing experiential text and telling their stories in words as they reflect on life and explain themselves to others. (p. 463)

This list is echoed by Connelly and Clandinin (1990). I have used the data sources of reflections on shared experience, journal records, interviews, and autobiographical writing.

Moen (2006) summarizes a qualitative list of items that can be used to ensure quality. These include,

... a focus on prolonged engagement and persistent observation in the field, whereby the researcher works with people day in and day out for a long period. This includes building trust with participants, learning the culture, and checking to ascertain whether there are any misunderstandings and misinformation. (p. 8)

Both Heikkinen, Huttunen, and Syrjala (2007) and Clandinin, Pushor, and Orr (2007) give a number of items that a narrative researcher needs to be aware of in order to ensure quality. Heikkinen, Huttunen, and Syrjala's (2007) suggest five principles that can be used to evaluate the quality of action research narrative:

... good action research narrative firstly acknowledges the past course of events that have shaped the present practices (the principle of historical continuity). Secondly and thirdly, it is reflexive (the principle of reflexivity) and elaborates the story dialectically (the principle of dialectics) [looking at both sides or points of view]. Fourthly, a decisive criterion for successful action research is that it produces some useable practices that, in one way or another, can be regarded as useful (the principle of workability). (p. 5)

Clandinin, Pushor, and Orr (2007) identify three commonplaces of temporality, sociality and place and outline eight elements of a narrative that need to be considered in

the designing, living out, and representing of ideas. These include justification, naming the phenomenon, describing the methods, analyzing and interpreting the process, positioning the work in context, identifying the reason for a use of a narrative, ethical considerations, and the process of representation.

Throughout my research, I have attempted to ensure that each of these depictions of quality are present in my research. I have worked with Ian teaching physics and sharing ideas about teaching for the past eleven years. We have established an internal culture of trust and taking calculated risks. I understand that the events I am writing about are events that I was a part of and built into my teaching practice. I understand the reflexivity of our conversations and attempt to take a dialectic view to the episodes as I try to siphon out meaning. Combined with using the data sources described above, this narrative is a valid representation of our process of learning.

I found that consideration should also be given to the pros and cons of narrative inquiry as outlined by Savin-Baden (2007). The pros are outlined as,

It is relatively easy to get people to tell stories..., [g]aining in-depth data is possible because this often occurs with ease in narrated events, [i]t is possible to gain in-depth meaning and reflection because participants are content to reveal themselves in stories and to reflect on their accounts at a later date as well, and [p]eople tend not to hide truths when telling their stories. (p. 466)

While the cons are identified as,

Stories can be difficult to interpret in terms of the relationship between the storytelling in the interview and the story-making in the presentation of data, [d]ecisions need to be made about whose story it is and how it is interpreted and reinterpreted, ... [i]t is often difficult to decide the relationship between the narrative account, the interpretation, and the retold story, and [t]he negotiation of data interpretation and presentation of data can be continually troublesome. (p. 466)

Taking these pros and cons into account along with appropriate types of data and guidelines to ensure quality has certified that the narrative is used as an effective research tool. When taken with the autoethnographic approach, I believe that many of these cons are diminished as I have addressed the concerns raised by the autoethnographic literature. I have done my best to represent and interpret my recollection of these events as accurately as possible. I am also confident that this is true for my research participants as I outline in the ethics section at the end of this chapter. While we have strived for accuracy, I accept that my own perceptions and biases have influenced my perception of any of the described events. I hope that the reader can recognize that many of the episodes are described as factually as possible to attempt to minimize any unintended bias creeping into my discussion.

Action Research

Even though action research was not explicitly employed during the period of time captured in the narrative episodes, it is the most accurate methodological description of the process Ian and I used to make changes to our assessment system in our physics courses. This is best exemplified through our discussions trying to work through our challenges of implementing research while being faced with the challenges described in Chapter One.

When reflecting on the process that Ian and I followed creating an assessment system, it becomes apparent, even though we did not set out to conduct an action research project, the nature of our conversations followed very closely the steps of an action research cycle as described by McNiff (2016):

In action research, researchers do research on themselves... research is an enquiry conducted by the self into the self. You, a practitioner, think about your own life and work, and this involves you asking yourself why you do the things that you do, and why you are the way that you are. When you produce your research report, it shows how you have carried out a systematic investigation into your own behaviour, and the reasons for that behaviour. The report shows the process you have gone through in order to achieve a better understanding of yourself, so that you can continue developing yourself and your work.

McNiff (2016) further outlines the research process as a cycle stating,

Action research...does not begin with a fixed hypothesis. It begins with an idea that you develop. The research process is the developmental process of following through the idea, seeing how it goes, and continually checking whether it is in line with what you wish to happen. Seen in this way, action research is a form of self evaluation.

Both the definition provided and the process outlined by McNiff match well with the reflective process that was used to slowly modify the assessment system. By continuously reading, discussing, evaluating, changing, and reflecting I have been able to improve my teaching practice.

As the reader will see in subsequent chapters, Ian and I consistently looked to improve our practice, asking the question, "How do we teach physics better?" This led to questions around improving science literacy, improving student achievement, increasing student ownership, increasing personalization, and increasing our achievement expectations, among others. Each of these questions would lead us to formulating a possible solution, implementing the solution and then reporting to each other on the effectiveness of the change. Often, these questions and answers overlapped, as seen in Chapters Three and Four, creating complications that made our research cycle span more than a semester.

For example, in working to improve our students' scientific literacy, we changed our lab instruction and design four times over four years. In each iteration, we discussed the changes we wanted to make and what we would identify as indicators of success. We would move through the semester with the implemented changes to instruction, process, and/or products. At the end of the semester we would spend some time talking about the success indicators and reflect on how students progressed. This would inform how we would change the lab structure in the next semester and we would go through the process again. Examples of changes we made through the course of creating the assessment model that is the subject of this thesis includes how students were organized in lab groups, how students conduct the labs, how students wrote lab reports, what technology students used to conduct and write lab reports, how reports would be evaluated and returned, what kind of feedback would be given to students, and others. We continue to explore how to improve our students' scientific literacy using this process. This is one example of how we used action research to work through identifiable issues we wanted to solve. We engaged in this process for most of the questions identified in Chapter One and much of the assessment content we were working through to create our assessment model.

Winter (2001) suggests how both narrative and action research can complement each other. Winter states that,

The central purpose of action research is to carry through some form of change in practice, so that an action research report necessarily describes a sequence of events developing through time; its form is, therefore, essentially that of a narrative... [it] also describes events in a particular context ... [and seeks to create] an account of a specific situation that gets sufficiently close to its underlying structure to enable others to see potential similarities with other situations. (p. 143)

As the development of the assessment model occurred over the span of about eight years, and continues to be refined, I can say that we used a model of action research in our discussing and implementing assessment changes. This action research process will become apparent through the narrative presented in this thesis.

Thesis Organization

The writing of the thesis followed the same linear progression as the presented narrative. The evolution of each piece of the assessment model happened after being exposed to a piece of literature, or a learning community conversation. In the same way, in this thesis each idea from the literature is presented and discussed linearly, pairing a section of literature with a complementary episode. The use of learning communities at Riverview High is a generally sustained practice in pockets of the school and I used my own reflections on this practice to make meaning of how this practice has helped us to create the assessment model. These two ideas of assessment and learning communities will be interconnected through the thesis.

Chapters Three, Four, and Five of this thesis are organized around conversations between Ian and I as co-teachers, my reflections on our conversations as co-teachers, correspondences between Ian and I, reflections on my teaching practice, reflections on my ideas about assessment, and re-examining primary documents (tests, rubrics, notes, journals) that I and/or Ian created as described in the above section on autoethnographic methodology. These methods have been used to explore the evolving ideas of assessment and the supportive role of learning communities.

Chapters are organized around three themes and are a weave of autoethnographic narrative, literature review, and analysis. The first theme is the creation of learning communities at Riverview High. Even though not directly related to assessment, learning communities provided a framework for our learning and discussions. The second theme is the reading and incorporation of assessment ideas to create an assessment and evaluation model. The differences between assessment and evaluation are discussed in Chapter Five, where I detail our working definition of assessment and evaluation. The third theme pushes beyond our traditional notion of curriculum to explain how the assessment model has been used to foster student inquiry, passion, and personalization. Together these themes show how Ian and I have been able to move from being frustrated that we were teaching in a system laden with constraints to understanding how to implement our own philosophy of assessment within the same system.

Within each chapter are embedded reflective methods in addition to the episodes that were previously described. This reflection is either a meta-analysis, in order to provide the reader a deeper insight into why our thought process evolved in a particular way, or a summary, to highlight elements that are connected to later sections. These reflections are collected in the final chapter on results and synthesized to answer my driving question. The hope is that the narrative presented in this way will help readers understand the evolution of our assessment model, the elements of support that were needed at each point, and what we learned along the way.

I would also note that the narratives have been *italicized* in an effort to distinguish them from presented research and reflective methods.

Ethical Considerations

Two major ethical considerations arise in this research and writing. The first is the fact that both Ian Fogarty and Armand Doucet are explicitly identified as research participants and collaborators. The second is that some of the episodes I describe include references to students who were minors in the school system. As per University of New Brunswick regulations, this research project has gone through the Research Ethics Board and been approved to ensure ethical integrity for Ian, Armand, and the students.

Both Ian and Armand signed a declaration of informed consent acknowledging that participation in the research was voluntary and that they would encounter no more risk than what they would encounter in a normal day at work. Once the section(s) were written that contained the participants' thoughts or opinions, they were given the opportunity to read the document and make revisions to ensure accuracy.

To ensure the anonymity of students, significant details have been changed within the episodes. Every student name has been changed as well as any other details that could be changed without changing the message of the text. Apart from knowing that a student attended Riverview High school and was taught by Ian and/or myself in the last eleven years, no identifiable features distinguish students referenced in this thesis from the approximately 2000 students we have taught in that time.

Chapter Three - Starting with Learning Communities

This chapter integrates a literature review of learning communities (also described as communities of practice) with episodes outlining the creation and use of our learning community. I present these items in parallel to highlight the direct connection between learning community ideas and how this was shaping our thoughts about teaching. Learning community ideas were being presented to all District 02 staff and these ideas were being gradually implemented in schools. The stories I present are compilations of conversations that Ian and I had often over a period of a few days or weeks during the initial implementation of these learning community ideas. They are condensed and expressed as a complete conversation to help the reader focus on the details of how the learning community ideas helped facilitate changes in our teaching practice. They are presented as complete episodes so the reader can more clearly see the train of thought we went through and to address my stated concern that there needs to be more literature containing examples of real stories that addresses teachers' concerns.

Foundational to creating our assessment system was our district and school adopting professional learning community ideas as a means of professional development. This establishing of a learning community is the first part of our story. While this assessment model might have been created without our being organized as a learning community, the learning community was a catalyst as it provided a rich opportunity for conversation and thought experiments that turned into real action and meaningful change.

I was first introduced to the idea of a professional learning community while taking a course on Leadership in Education during the 2006 spring semester of my Bachelor of Education degree at Saint Thomas University. This was only one year

removed from my studies at University of New Brunswick's Renaissance College where I earned a Bachelor's Degree in Interdisciplinary Leadership Studies. This foundation of leadership training at Renaissance College gave me an insight into what I was learning about learning communities. I was able to see the underlying features of the professional learning community movement in the work I had done in my previous leadership studies.

The following autumn, I was hired to teach math, economics, and, eventually, physics at Riverview High school. During that first year, I was exposed to a district that was taking on the immense task of implementing professional learning communities across the district. This was a purposefully slow task that we have been working at for eleven years. Along the way I have witnessed a variety of gains, resistances, setbacks, small wins, and profound benefits. These have been both in the school I teach in and across the district.

It was evident to me, in the early years of district professional learning community implementation, that the teaching profession would be hard pressed to adopt a seemingly radical shift in its mode of operation. By gaining experience within the education system, I soon realized that some of the same fundamental structures were not in place in the public education sector. Examples of structures that were missing were effective information feedback loops embedded through the system, an inter-reliability between system components that lead to success of the entire system, and an ability to pivot based on a shared vision and available resources. Each of these systems show up in various disciplines and are illustrated by Bennis and Biederman (2007), Champy (2006). Kouzes and Posner (1999 and 2012), Nanus (1995), Senge (2006), and Wheatley (2006) These missing structures would turn out to be a greater challenge at a school and district

level than for small curriculum-based teacher teams. By having a shared vision and the ability to pivot in our teaching, Ian and I have found that the learning community model has been an effective tool in helping us create the assessment and evaluation model presented here. While many factors have gone into creating this model, learning communities have been a fundamental means of having professional conversations that have led to change and innovation.

As Stiggins (2005) notes, there is increasing pressure on teachers and schools to have all students succeed academically and teachers are encouraged to think about the ways their own teaching practices can create environments where students can achieve greater success. A large part of increasing academic success lies in improving student assessment and evaluation as described by Davies, Herbst, and Reynolds (2008).

Fortunately, Ian and I were organized along the professional learning model as described by DuFour, DuFour, Eaker, and Many (2006) and Hord (1997) and used this as a means to create systemic changes around assessment, evaluation, and student engagement. The key features of the learning communities model that positively influenced the work of creating a new assessment model include the development of trust, risk taking, teacher inquiry, and capacity building through distributed leadership—elements I will discuss later in this chapter.

The Origins of Our Learning Communities

In the fall of 2007 all teachers in District 2 met at Moncton High school to hear a presentation discussing the need to establish essential outcomes in every subject area and course from kindergarten to courses at the grade 12 level. This presentation was based on

the work of both Richard DuFour and Douglas Reeves, whose ideas were used to shape teachers' understanding of the criteria for essential outcomes. This was summarized in four questions posed by DuFour (2006), as adapted from Sadler (1989), and supported in a framework by Reeves (2002) that establishes essential learnings. These were foundational pieces in creating and validating the essential skills and knowledge that we built on to create the assessment model.

DuFour's (2006) questions to help teacher teams set priorities in addressing student learning are summarized as:

What knowledge and skills should every student acquire as a result of this unit of instruction?
How will we know when each student has acquired the essential knowledge and skills?
How will we respond when some students do not learn?
How will we extend and enrich the learning for students who are already proficient? (p 28)

Ian and I found that, like many teachers trying to answer these questions, the answers created a list of daunting expectations. By building on Reeves' (2002) work in thinking about essential skills and knowledge we were able to take small steps towards establishing an assessment system that reduced the daunting nature of expectations raised by the ten questions posed in Chapter One.

Reeves (2002) provides clarification by challenging teachers to define essential learnings by answering these questions about learning:

Does it have endurance? Do we really expect our students to retain the knowledge and the skills over time as opposed to merely learning it for a test?
Does it have leverage? Will proficiency in this standard help the student in the other areas of curriculum and other academic disciplines?
Does it develop student readiness for the next level of learning? Is it essential for success in the next unit, course, or grade level? (p 283)

Eventually, many teachers I work with found that pairing Dufour's questions about student learning with Reeves' questions about teachers establishing essential skills and knowledge gave a concrete framework to begin discussing teaching, student learning, and assessment.

The first attempt at essentials.

At Moncton High teachers were divided up based on their subject area and grade level and tasked with determining what the essential learnings should be for each grade and content area. It was explained that teachers in each course would examine their curriculum and identify what knowledge a student needed to start the course with.

District staff would then collect and consolidate these and pass them to the lower grade teachers in order for them to create a list of essential learnings from kindergarten to grade twelve in all subject areas. Ian and I were both assigned to the physics teachers group. This conversation between us happened after a district wide session where teachers achieved a general sense of agreement about what curricular outcomes were essential in Physics 112 and 122 classes across our district.

Chris: How do you feel that went? You've been teaching physics a lot longer than I have.

Ian: I think it was OK. It was interesting to see the diversity in what is taught around the district.

Chris: Yeah, some teachers really feel their primary purpose is to get students ready for engineering or physics at university by really stressing a high level of content retention. I think it went well that everyone agreed that the curriculum was packed.

Ian: I wonder if the district is going to move toward district-wide exams. If they do it is going to take a lot of work to get all teachers teaching the same stuff at the same level of complexity.

Chris: I think that would be really hard without nailing down what exactly the essentials are for both Physics 11 and Physics 12. I think we have a pretty good list to try out. It seems like depending on the teacher and school, some courses would be much harder than others.

Ian: Definitely. I think so long as we are consistent between what we teach in the same building we are OK.

Chris: OK, I think we are pretty close in what we are teaching and if we use the essentials to guide us it will make sure we are even tighter.

Ian: I do too. I think we will need to refine the list after using it for a bit. I also wonder if we missed a bit of something in our discussion.

Chris: Like what?

Ian: I have had students come back from university and tell me that it was not the physics that they struggled with but the problem solving. This has changed my teaching a little bit from just moving through the textbook to thinking about teaching students to problem solve. I wonder if we want to think about how we can do more of this.

Chris: OK. So we have a list of essential outcomes and I think physics lends itself to being able to do some good problem solving. How do we do more of that? We already said that only about 15 of the 20 or so outcomes are essential. Does that mean we won't teach them all?

Ian: No, I think we will still teach them all but what we focus on is different. We can still teach everything but if there are a few snow days we know what is safe to cut out. I wonder if it also means we can spend more time doing some problem solving with certain topics and not others.

Chris: So if something is essential we need to keep it and we could build on it to reinforce problem solving skills. I like it. I am not sure what it will look like but let's try that and see how it works.

In the winter of 2008 all teachers were invited back to Moncton High to refine their lists and have discussions about the implementation of the essentials in their classrooms. Ian was asked to work with the chemistry teachers as the list essentials for the Chemistry 11 and 12 courses generated previously was quite lengthy and needed to be refined. This conversation happened at Riverview High over the days following the refining.

Chris: How was the chemistry session on essentials?

Ian: Interesting. There was lots of discussion about how prepared students are for university chemistry. There was a sense that we want all students to be ready for that first class by having enough content knowledge.

Chris: So were you able to come to a consensus on what the essentials are?

Ian: Well, in the morning, we talked a lot about which of the outcomes were essential and which were not. We needed to spend some time talking about the ideas of whether all of the outcomes have endurance and leverage.

Chris: Yeah, chemistry is a bit odd. Apart from more chemistry and a bit of physics there is not much leverage to other courses. Not like math or English where it carries over into other courses or just life in general.

Ian: It depends how you teach some of the topics.

Chris: What do you mean?

Ian: Just like in physics, much of the content is repeated in first year chem but the way that we can think about chemistry as problem solving practice has lots of endurance and leverage. It all depends on how we teach it. For example, naming compounds and balancing equations is a basic component of all introductory Chemistry courses.

Chris: Right, so they are essential.

Ian: I would say they are essential for two reasons and for two different types of students. Students who are going to study chemistry need to have those skills and will get lots of practice learning how to do those. The second type of student are those who are not going to study chemistry beyond my class.

Chris: Why would they need to know those outcomes if they were not going to keep studying chemistry?

Ian: It all depends how it is taught. When I teach balancing equations, I teach a little bit of chemistry and then the rest of the lesson is about teaching about ratios. It is a problem solving activity to help students become better at using ratios to help problem solve.

Chris: That is more of a learned skill that they can transfer to math or physics or accounting. What did the essentials group think of that?

Ian: It was a good conversation. A lot of it comes down to what we think the purpose of teaching chemistry is. If the teacher is a teacher of chemistry then they are going to focus on the chemistry content. If they see themselves as a teacher of

students who have a variety of paths, then they might approach it differently and use chemistry as a tool to teach some skills and problem solving I like this point.

Chris: Speaking of skills, did you get to talk about lab skills as essentials? We talked about it briefly in the physics group.

Ian: We agreed that we need to do labs that support the curriculum outcomes but we were really focused on narrowing the outcomes down to a more manageable list that we could all agree on as essential. We put a list together but I am not sure it won't need to be re-examined later. What did the physics group talk about with labs?

Chris: It was really a mixed bag. We all agreed that we want to do labs but are really pressed for time. What do we cut out in order to do a lab? It all depends what the school has for lab gear too, right?

Ian: Yeah, and I think it goes back to DuFour's three questions. How do we make our labs have leverage, endurance, or get ready for their next level of learning?

Chris: I think physics has more flexibility compared to chemistry in that I am not worried about someone spilling acids or lighting themselves on fire when we are trying to calculate the speed of a falling ball.

Ian: I wonder if that makes it easier for us to do some things in physics.

Chris: Like what?

Ian: Right now we have a list of outcomes that we deem essential but what about the skills? We want students to be able to do more than just use the physics equations, right?

Chris: Yeah but how would we mark that? I am not even sure I know how to teach that or what I would teach.

Ian: I know. This is something we will need to keep thinking about.

Although teams of teachers were given time to develop a list of essentials for core courses, neither the district or teachers had engaged in this process before. This resulted in some vague expectations about what each set of essentials should look like and what they would be used for. After a few iterations of essentials, Ian and I would use this as a key pillar in the assessment system. Because we were the only two physics teachers at Riverview High, we formed a learning community to work on these ideas.

Learning Communities In Literature

Even though our district was relying on readings and presentations by DuFour and DuFour (2007) and Muhammad (2009), there exists a wider scope of literature about learning communities. To truly understand the structures in place to form an effective assessment system that meets the challenges teachers are facing, I believe it is important to recognize other learning community research.

Literature points to learning communities evolving from two separate sources. Barrett (1986) first used the term learning communities in the field of public management. Lave and Wenger (1991) describe situated learning and communities of practice that have evolved into what is commonly known as learning communities in the education academic community and professional learning communities among classroom teachers. The hybridization of these two independent sources encompass what is largely presented through the literature.

Barrett's (1986) original use of the phrase "learning community" in the field of public management defined it as, "a community of learners for whom learning was about gaining confidence, knowledge and skills...which all resources were shared, and responsibility for individual satisfaction and achievement was the concern of all" (Barrett, 1986 p. 12). While this definition was not being used for the purposes of education, the idea of learning from peers and creating peer groups is clearly articulated.

Similarly, Lave and Wenger (1991) examined the social aspects of apprenticeship and peer groups of learners outside educational contexts. What has become known as "learning communities" was originally defined as a community of practice where "learners inevitably participate in communities of practitioners and that the mastery of knowledge and skill requires newcomers to move toward full participation in the sociocultural practices of a community" (Lave & Wenger, 1991, p. 29). This aspect of a social process in which practitioners can learn from each other is seen throughout learning community models. The interest in applying this model to the education system is apparent when Lave and Wenger (1991) acknowledge the gap in their work and suggest that, "...we are persuaded that rethinking schooling from the perspective afforded by legitimate peripheral participation [in a community of practice] will turn out to be a fruitful exercise" (Lave & Wenger, 1991, p. 41). While education literature discusses learning communities that are slightly different than Lave and Wenger's community of practice, it does represent a means for schools and teachers to engage in some peripheral participation.

Even though peripheral participation can clearly be recognized as a building block of the learning community model adopted by many schools and districts, it is not the

focus of this thesis. Because my district adopted a learning communities model largely drawn from DuFour, Muhamad, and Reeves, Lave and Wenger are left out of my analysis because this work did not directly influence our creation of the assessment model. With that said, I can say that we did not participate in a community of practice as articulated in Lave and Wenger (1991) or Wenger (1998). They describe peripheral participation as new members of a community of practice gradually taking on more complex tasks in order to move toward the center of the community in order to take over practice. This does not describe the relationship between Ian and I as we entered this community at the same time and had the same professional obligations to teach our individual classes and collaborate on specific tasks related to classes that we both taught. Our collaboration more closely resembled the description of learning communities as outlined in this thesis.

Since educators have adapted the idea of learning communities to the education sector, a series of lengthier descriptions have developed. Two foundational descriptions were adapted to our needs. Louis, Kruse, and Bryk (1994) describe five interconnected variables that form genuine professional communities. They are reflective dialogue, deprivatization of practice or feedback on instruction, collaborative activity, shared sense of purpose, and a collective focus on student learning. This is modified by Hord (1997) who adds the continuous need for improvement. Hord also outlines,

the requirements necessary for organizational arrangements [to] produce such outcomes [as] the collegial and facilitative participation of the principal who shares leadership and thus power and authority through inviting staff input in decision making, a shared vision that is developed from an unswerving commitment on the part of staff to students' learning and that is consistently articulated and referenced for the staff's work, collective learning among staff and application of the learning to solutions that address students' needs, the visitation and review of each teacher's classroom behavior by peers as a feedback and

assistance activity to support individual and community improvement, [and] physical conditions and human capacities that support such an operation. (p. 18)

These descriptions, along with identifiable effective feature from various other authors explored in subsequent sections, reflects the learning community that we formed.

DuFour and Eaker (1998) popularized the phrase professional learning communities that built on the educational literature of the time that I presented above. Hord (1997) stated that at the time, “what the researchers have not given us is guidance about initiating and developing such structures - a necessary next step.” DuFour and Eaker (1998) built on this literature about learning communities to provide this next step by integrating a significant amount of leadership theory within an educational context. DuFour and Eaker (1998) created a resource that administrators could use to understand how to change culture in their schools by drawing on authors such as Bennis and Biederman (2007), Champy (2006), Deal and Peterson (1999), and Senge (2006) to show how effective organizations are run and Gardner (1988), Kouzes and Posner (1999 and 2012), and Nanus (1995) to define the traits of effective leaders. It is with this context that teachers and administrators in District 2 started to work in learning communities.

Working in their new learning communities, many of the District 02 teachers initially tackled the task of identifying essentials by developing a summary of curriculum outcomes with either minor editing or a listing based on priority. This did not provide teachers or students any direction on what should be taught in a given course. Through two more iterations, teachers created an essential list of outcomes and formed into a set of student friendly statements in the form of, “Students will be able to...” Teachers were requested to post the statements pertinent to a given topic or unit either in the classroom

or at the beginning of a daily lesson. Most courses ended up with a subset of outcomes that became the focus of instruction. Students were expected to understand what essential skill or knowledge they were working on at a particular time. Additionally, the focus of any interventions were to be on the agreed upon essentials as these were deemed to be the building blocks needed to start the next course.

Many teachers felt relieved that they could help struggling students focus on a subset of outcomes but felt hesitant that they might not be teaching as much content as in previous years. This idea of essentials and the complications that accompanied them would occupy many of Ian and my discussions in the coming years. While this seemed to be a step in the right direction in terms of changing teaching and assessment, it still did not address the challenges of when and how to create a mark, how to integrate skills into a course, how to allow for personalization or enrichment, and how to balance teacher time between struggling learners and students who need to be pushed to do more. This would need many more conversations, readings, and presentations to create a system that would satisfy all of these challenges.

In reality, Ian and I now use the third version of essentials in the physics courses we teach. Establishing and refining essential skills and knowledge of a unit or course was, perhaps, one of the most challenging aspects of creating a systemic assessment and evaluation framework. When deciphering what topics are extension to most students, teachers need to understand that much of the fine detail and minutia of a physics course is only intended for future physicists and will, therefore, not be mastered by the masses. The model I present in this thesis (see Appendix A) took three years to solidify the essentials and extensions, and another year to incorporate them into the assessment

model. Only in the two years following our using this model did we realize the magnitude of effect that a model like this could have to liberate teachers and students to pursue their passions.

Collaborating On Roller-coasters

When looking for effective features of learning communities seeking to make substantive changes in their teaching practice, a list of five features can be identified in the literature. Each feature of trust, collaboration, risk taking, teacher inquiry, collective vision, and capacity building through distributed leadership are evident in how we progressed through the creation of the essentials assessment system. The following set of episodes offer concrete examples of the features of collaboration, risk taking, and teacher inquiry. Distributed leadership and collective vision are addressed later in this chapter. These features are evident in the day to day operations of our professional learning community and have become embedded in the ongoing work of our team.

Effective features of the learning community.

The learning community features that are most commonly identified by Edwards (2012), Prytula (2012), and Tidwell, Wymore, Garza, Estrada, and Smith (2011) are trust and collaboration. This is portrayed as professionals engaging in open dialogue with the ability to share and support new ideas while actively reflecting on their own practice. While these features are common, each author identifies others that may be specific to their own context.

In Tidwell, et al. (2011), trust among teachers is the definable feature that helped a school create bilingual classrooms at the kindergarten to grade five level. While

Melville and Wallace (2007) identify trust as key, they also observe that communities with positive interactions collaborate on ideas, engage in professional dialogue, and use reflective inquiry to build departmental capacity at the high school level. This idea of trust and dialogue is reinforced by Talbert's (2002) description of changes to mathematics instruction across the state of California. Added to these are contexts in which teachers engage in professional inquiry through readings and research of their own. This is exemplified in Talbert (2002); Deni and Malakolunthus (2013); and Hackmann, Walker, and Wanat (2006), who apply the professional learning communities model at the post-secondary level. Ian and I engaged in professional dialogue about teaching and assessment throughout our time at Riverview High. This led us to trust each other's professional opinion and helped to establish a culture that we were able to take risks in our teaching.

Lomos et. al (2011) add to the discussion that a culture of risk taking and collaboration, "...enhances living an inquiry stance toward teaching: a shift to uncertainty and a shift to community" (p. 243). This support of risks in a community, and living with an inquiry stance towards teaching, promotes teachers' ability to recognize the impact that dialogue has on their professional practice and supports a culture of uncertainty and change. Ian and I consistently sought to improve our teaching practices by taking an inquiry stance and, ultimately adopted an action research approach to improve our instruction. Throughout the episodes presented in the following chapters the reader will see that we took risks throughout developing our assessment system. Sometimes they were instructional risks that changed the way we taught content. Sometimes they were

institutional risks that challenged systems such as grading and reporting. In either case we embraced a culture of trust and risk taking through professional dialogue.

Extending the idea of discussion with meaningful reflection, Prytula (2012) endorses teachers' use of metacognition to enhance their professional practice. Prytula asserts that greater professional growth occurs as professionals engage in a metacognitive process and that the professional learning community model provides a means to accomplish that goal: "When teachers are engaged in this collaborative problem solving, deeper thinking, or a degree of metacognition is likely to occur" (Prytula, 2012, p. 113).

Following is an episode that exemplifies how we collaborated to improve our teaching practice. It is evident when reflecting on these conversations that we were open to taking risks in our classrooms and trusted each other as professionals to have meaningful dialogue about changing our approach and continuing to reflect on the products as well as the student process. While these features are highlighted here, they pervade our conversations and provide a rich environment to move our teaching and assessment practices forward.

From rollercoasters to Rube Goldberg machines.

This conversation happened during the second semester of the 2007 – 2008 school year. I was completing my second year teaching and first year teaching physics. Ian and I had already realized that our individual teaching philosophies matched well and were looking to bring consistency to all Physics 11 and Physics 12 taught at Riverview High.

Ian: I was thinking about Physics 11 and 12 next year and I would like students to do something more hands-on. Especially in Physics 11.

Chris: Like what?

Ian: Well, it feels like we are doing a good job with the problem solving and we seem to be pretty consistent in terms of what we expect from students but it feels like we are missing something.

Chris: Like what?

Ian: Well, many of our students that do well in physics are going into engineering because they like physics and math but they have never done any engineering.

Chris: And those are two very different disciplines. The thinking in engineering can be much more trial and error and design than just the physics part.

Ian: I know. I would like to find a way to allow students to be able to work through something and maybe fail a bit along the way to get better.

Chris: What about something like doing an egg drop challenge? We have the balcony that they could drop them from and it ties into the mechanical energy unit we do?

Ian: I have seen that done before but I would like them to do a bit more. It seems a bit gimmicky. I would like them to be able to calculate something and test it and make it better.

Chris: We have all of the probe ware. I wonder if we could use some of that to do some testing or data collection. It would be nice to tie it into the energy unit at the end of the semester.

Ian: Sure. We have motion sensors and we teach them how to collect data in the picket fence lab.

Chris: What about a rollercoaster? We could have them build rollercoasters in small groups.

Ian: OK. What would that look like?

Chris: We could teach them about energy and give them a few problems to do but then instead of a test, we could give them time to design, build, and then test a rollercoaster.

Ian: I would like them to design it and have to calculate some things like maximum velocity, the time of the ride, and the braking distance needed.

Chris: We would need to give them some guidelines too like minimum and maximum dimensions and what materials they can use.

Ian: What materials would they use?

Chris: I think anything they want. They will have to do some materials testing to find out some things like the coefficient of friction.

Ian: That would be good. We can make sure that we do the coefficient of friction lab so they will have already done an experiment that they need to use the probe ware and calculate that value.

Chris: We did that lab last year so we will just need to tweak it so that it will match up with the rollercoaster a bit more.

Ian: OK. How do we mark it?

Chris: We could make a rubric that allows us to check things off. Things like their calculations being accurate and staying within the dimensions.

Ian: If we are going to use the probe ware then part of the mark could come from a percent error calculation. The smaller the error then the better the mark.

Chris: Sure, we could use a range for that part to determine how many points they get on that section. I can make up a rubric. I will send it to you when I have it done.

Ian: Sounds good. I am looking forward to students doing more than just working through pages of word problems and then having a test. We already know if they can write a test or not and don't need to see them write another one.

In the first year that Ian and I incorporated this project in our physics classes there were mixed reviews from both the students and teachers. The rubrics were made available in order for students to clearly understand the expectations of the project. Students worked in pairs and triples to create and test their rollercoasters. The following conversation happened near the end of the semester, when students were finishing their projects.

Chris: How are the roller coasters going?

Ian: Some groups are doing well. Others are struggling. They are definitely doing something different.

Chris: Some of mine are having a rough time too. There are lots of different materials being used but they are getting lots of good practice with the probe ware.

Ian: Yeah. They are definitely doing more individual experiments in this small project than most of my past students did in a whole year. Do we think we want to do it again?

Chris: I think so. What do we like about it? Using the probe ware, testing materials...

Ian: the planning, the building, the messing it up and having to do it over again.

Chris: So the engineering part of it. That what you do on paper does not always work out?

Ian: Yeah! There is an important lesson in there about coming up with a plan, trying it, failing, and being able to fix your plan and build it better.

Chris: OK. It sounds like we like it and we want to keep it. What do we want to change for next year? I know it's not perfect.

Ian: We definitely want to keep the engineering and the challenge of working to success. I think we need to allow them to be able to get some credit for the learning that happens when they get to work through their problem.

Chris: What if we had a conference with them and they had to present their rollercoaster to one of us? We could ask them about their design and what they struggled with.

Ian: We should have a spot for that on the rubric.

Chris: You know how they get a mark for how large their percent error is between their calculations and what the probe ware picks up? What if they could explain what went wrong to influence their percent error, we would give them half of the value that they lost from that criteria?

Ian: So, if they understand what went wrong and explained it, they would get some of the value? OK. I think that is good. I wonder, too, if we should streamline the rubric so that it is only dealing with physics.

Chris: Yeah, we can get rid of the “decorated” criteria.

Ian: I was thinking about getting rid of the dimensions too.

Chris: Alright. We put that in so we would have something manageable to bring into the school.

Ian: I don't think we need to worry about that. Maybe it is not important. We let them pick whatever material they want so why not make it something that fits for them? I wonder if allowing more flexibility will enable them to be more creative in their designs.

Chris: Sure. It doesn't matter to me. I have been thinking about next semester too in Physics 12. Do we want to do a similar project?

Ian: I would like to. I don't know what but yeah, we should do something. It could focus on some of the topics that are only in that curriculum, like electricity.

This example shows how we regularly collaborated and problem solved in an effort to improve our practice. This same collaboration is evident throughout the following episodes about creating the assessment model. In addition to the collaborative approach, this episode highlights that we felt that we needed to move our students to a more problem-based approach to their learning. This would also come in later iterations of our physics classes.

Leveraging Rube Goldberg machines for physics.

As we continued to collaboratively re-think the way we taught physics and gain some confidence in how our experiment with roller coasters went, we saw the opportunity to continue to expand our view of the physics classroom. By taking measured

risks in our teaching and assessment practice we fostered a peer to peer environment of trust and problem solving. In the following episode we build off of conversations and reflect on our learning to continue exploring the limits of our courses.

During first semester exams and before the start of second semester Ian and I had a conversation about how we could expand on the rollercoaster project into second semester.

Chris: Have you ever heard of a Rube Goldberg Machine?

Ian: That is the complicated machine designed to complete a simple task. Yeah, I have. Why do you ask?

Chris: What if in Physics 11 students made a rollercoaster and in Physics 12 they made a Rube Goldberg that incorporated each of the topics? It wouldn't really matter what they get the machine to do so long as it has all of the pieces.

Ian: So it would not matter what they made it accomplish so long as they had an inclined plane, something that rotates, a pendulum, an example of torque, and a projectile.

Chris: I don't know how they would incorporate universal gravitation or electricity into a design.

Ian: Well, for electricity they might be able to put a switch in somewhere or a lever that makes something move.

Chris: We could give them time throughout the semester too to work on it. Like every Friday would be Rube Goldberg day.

Ian: I think we should let them know about it at the beginning of the semester. I don't know that we need to designate that much time in class but we should give

them some. We give them time almost every week to work on problems. Do we trust them enough to use some of their time to meet with group members and maybe spend some time planning and building?

Chris: I think we trust them enough and we can give them some time later in the semester to finish things up and present to us. How would we mark these?

Ian: The same as the rollercoasters.

Chris: So keep it simple. Maybe a checklist of each of the elements that need to be included?

Ian: Yeah, and I would like to have them be able to conference and explain what they did and what challenges they overcame.

Chris: It would be nice to chat with each student to find out what each student knows rather than just giving them a group mark.

Ian: I agree. It is important to hear from every student. They should all work together but we want to make sure that every student understands the basics of each component.

Ian and I implemented the Rube Goldberg project in Physics 12 for two years. It worked well to allow students to demonstrate specific topics and to be evaluated as individuals. This conversation happened after at the end of second semester as Ian and I were planning the next school year.

Ian: What did you think of the Rube Goldbergs? Did you get to see any of the interesting ones?

Chris: I did. Some of them are pretty creative. I think most of them have been able to incorporate all of the topics we said they needed to include. Are you happy with how they have been doing?

Ian: I'm happy with some parts of it. I like that I am talking to every one of my students to see how much they know about the physics. I would like them to do more engineering.

Chris: OK, how?

Ian: One of the things that my students get to do in Science 12 is that they get to be something. Even when the project is on Xenotransplants and they are learning about the biology, they might get to act like a journalist or a lawmaker for a few weeks. It does not have to be for the entire course but the little bit of time lets them know if they have an aptitude or interest in that field. It would be nice to let them do that in physics.

Chris: So, what if we expanded the projects a bit? Maybe we don't have to stick to the roller coaster and Rube Goldberg. Could we let students just do anything they want?

Ian: But that is so hard to do in physics. When they come to us in September, they really don't know enough physics to start something.

Chris: Well maybe in Physics 11 we say that they have to do it later in the semester but they start Physics 12 half way through the year so they should know enough to get started with something. Do we open it way up? Do we say that they can do anything they want so long as it is related to physics?

Ian: Yeah. Why not? I think we can tap into some personal interest in the students. If they have something interesting that they want to learn about or build, shouldn't we let them?

Chris: I agree. There might be some really interesting projects. We might also have some students who do not know what they want to do. We could always have the roller coaster or the Rube Goldberg as a backup if they are really don't have a project.

Ian: I think we should have the Physics 12 project have some electricity element in it. Electricity is in that curriculum so I think we should see that in the projects.

Chris: OK. I wonder too if students can start a project in Physics 11 and then continue it in Physics 12. What if they build a prototype in January and then finish it for June. Are we OK with that?

Ian: I think so. I am not sure we know what we are getting into. The thought of it scares me a bit. But, yeah, I think we open it up to have students really explore their passions.

Chris: It means that they are going to be doing things that we are not experts in. Are we OK with that?

Ian: I think we have to be.

The features of trust, collaboration, risk taking, teacher inquiry, and collective vision explicitly contributed to creating a learning community that contributed to creating our assessment system. Through these conversations we were able to develop a level of professional trust leading to the ability to take risk. We realized early on in our conversations that we had a common view of what teaching physics could look like and

how we could improve our teaching practice. This collaborative community would be key to changing our assessment and our associated teaching practices.

Creating Curriculum-Based Learning Communities

At the same time as we were working on creating essentials and trying to adapt and build our capacity to improve our instruction, the district and school leadership were continuing to learn about the learning communities model. The primary reference for the development of learning communities was the key pillars outlined in DuFour, DuFour, Eaker, and Many (2006) supported by Pyramid Response to Intervention in Buffum, Mattos, and Weber (2009). There is also significant other literature supporting a distributed leadership model to enhance the growth of teacher learning communities. Each of these ideas supported the creation and endurance of curriculum-based learning communities at Riverview High. Below, a discussion of the literature regarding the foundational features of a learning community is followed by an episode of formal learning community development.

DuFour, DuFour, Eaker, and Many (2006) clearly outline mission (what is the purpose of the learning community?), vision (what must the learning community become in order to accomplish the purpose?), values (what behaviours will lead to the purpose?), and goals, (how will the community know if it is achieving its purpose?), as foundations of strong learning communities (p. 30). While I have seen many schools adopt these foundational pillars into their yearly operations, it is also important for teacher-based teams to embrace these ideas. Ian and I continuously discussed what the purpose of teaching and learning physics is, how we needed to change as educators in order to better

meet the diverse needs of our students, how we committed to working together and with students, and whether we were seeing the results in student development that we were hoping for. Because of a shared sense of purpose and vision, we were able to continuously reflect on our teaching and assessment practices. This would not have happened to the extent it has without the creation of protected learning community time in our regular work week.

Concurrent with this work was the district leadership on pushing schools to implement a Pyramid Response to Intervention (PRTI) as described in Buffum, Mattos, and Weber (2009). The episode below shows how time was created in the regular work day for teachers to meet as learning communities as well as provide a space for tier two supports as described in PRTI. Tier two interventions are, ideally, organized by a team of teachers to intervene with students who are not meeting curriculum standards with typical classroom based, or tier one, interventions. A requirement of a tier two intervention is for students to have additional time with subject-based teachers to focus on specific skills or knowledge gaps. This intervention block would eventually be called Directed Study Block and would become a foundational system in implementing our assessment model as we were able to intervene for specific student needs in a timely manner.

The last feature of effective learning communities that is evident in our learning community is that of distributed leadership. This feature shows up in multiple places in the literature on learning communities. Most notably, Edwards' (2012) examination of the growth and effectiveness of learning communities in New Zealand identifies a number of other factors as indicators of effectiveness. These include,

Capacity-building,... leadership, ... the conceptualisation of the growth and change seen in a learning community as a lifecycle or a series of phases, ... the use of monitoring of effectiveness of learning communities, ... using sustainability as an indicator,... [and] connections with other communities. (Edwards, 2012, p. 27)

It is noted that Edwards is particularly concerned with a large scale change taking place over the entire country of New Zealand and it was mandated that each learning community was to be monitored and assessed on their sustainability and connectedness to other communities. While this is not relevant to smaller communities created for finite periods of time or with simplified mandates, the idea of capacity building and leadership promotes teachers taking ownership of their ability to direct their own growth.

Leithwood, Harris, and Hopkins (2008) also make the point that leadership is important for the creation and maintenance of the professional learning community. They identify the leadership practices of, “Building vision and setting directions, understanding and developing people, redesigning the organization, and managing the teaching and learning programme” (p. 30) as key features that are used by successful leaders in context sensitive situations to move change forward. Hackmann, Walker, and Wanat (2006) agree, asserting that learning communities operate best when a distributed leadership model is invoked to leverage participants’ personal investment in the change process. Each of these studies offer examples of how successful professional learning communities that were looking to make substantive changes to their constituents incorporated this aspect of distributed leadership.

Distributed leadership allowed Ian and me to set our own vision and direct our own learning, which gave us the feeling that we could make significant changes to our

professional practices. This could only be accomplished by our school and district leadership believing in a distributed leadership model that trusts teachers to set a vision for their learning community and support them to accomplish it.

In the episode below, the ideas of learning communities are put into practice at the school level. This implementation provided the framework for Ian and I to start working as a curriculum based learning community. Ian and I have been the only two physics teachers at Riverview High for the past ten years and, as such, constituted the physics team. The purpose of implementing these system changes was to provide both time for teachers to meet and time for students to receive more support for their learning. Following this episode is a brief description of how implementing learning community ideas started to influence our thinking about assessment.

Learning communities for physics.

The administration and leadership team at Riverview High school have been a fundamental partner in creating a collaborative environment for Ian and I to sustain a professional dialogue that created this assessment model. They have supported research-based changes in teaching styles and practices as well as creating systems that support student learning and appropriate interventions. One of the first systemic changes that was made when working through much of the Learning Community literature was a change in the daily schedule of the school. This was implemented with the dual focus of supporting teacher collaboration and student learning.

While this has gone through multiple iterations, the basic tenets remained the same. First, teachers need devoted time built into the weekly schedule to be able to meet

and have professional discussions. Second, there needs to be devoted time in the weekly schedule for students to receive support greater than at the classroom level. By modifying the daily bell schedule both of these time slots were created and protected from interruption. Many of the conversations between Ian and I took place in this protected time during the instructional day.

The first iteration to building time into the instructional day reduced transition times and the lunch hour to create a thirty-minute block of time each day. Students would remain in class and have the opportunity to do homework or study. By using all available staff to supervise students, teachers of common teaching duties would be able to meet once a week to collaborate. It was expected that teachers would work toward creating common unit plans, assessments, and evaluations.

While this first attempt provided the opportunity for structured collaboration time that teachers used to create common exams and course outlines, it did not provide a rich opportunity for students to access teachers for interventions and the teacher meeting time was not long enough to make substantial improvement. Students were still in a laissez-faire situation when it came to making improvements in their learning. It was decided that a more directive approach to interventions was needed and that more time needed to be given to teachers to truly make teaching and assessment common between classrooms where the same course was being taught. To do this, the entire staff needed to accept three shifts in culture allowing more creativity within the daily schedule which allowed for greater teacher collaboration and student achievement.

The first shift was that not all students need to be in a classroom to be supervised and many students would use extra time in their day to take on other activities if given

more freedom in their schedule. The second shift was that teams of teachers could be responsible for a student's success. For example a student taking Grade 10 Math should be able to receive targeted interventions from any of the Grade 10 Math teachers. The third shift was that teachers would need to devote some of their morning routine to either supervising students or collaborating with other teachers. These three shifts allowed the daily schedule to be modified to create two blocks of time in the student schedule.

One, called Directed Study Block (DSB), is a thirty minute block of time devoted to supporting students who struggle in one or more courses. This block of time takes place after classes in the morning before lunch. Teachers identify struggling students and direct them to an intervention that is supported by a curriculum team (such as Math 10). Teams are responsible to plan and implement interventions based on course work on a three-week cycle. The cycling nature is in place so that students can rotate through any courses they may struggle in. Students not assigned to a DSB are free to take an extended lunch, work in the library, use the gym, work on extra/co-curricular activities, or attend DSB themselves. DSB happens every Monday, Wednesday, and Friday. The purpose of DSB is clearly stated as a time for students to receive interventions.

The second, called Optional Study Block (OSB), is a fifty minute block of time that occurs before classes on Tuesday and Thursday. The normal start time for classes was 8:30 am and teachers were required to be on campus at 8:10am. By moving classes to a start time of 9:00am, using the same thirty minutes, and teachers agreeing to start curriculum-based meetings at 8:10, each team was able to meet once per week for a protected block of time. Teachers who are meeting in teams are expected to use this time to create a common scope and sequence, assessments, evaluations, and compare student

progress. Teachers who are not scheduled to meet a team on a given day are responsible to either supervise students in a common area, run an extra-curricular activity, or provide optional support to students. Students still arrive on campus at the same time and are encouraged to attend optional activities. The purpose of OSB is for teacher teams to meet and collaborate in planning for student success. This is the venue in which Ian and I had many of our conversations as they constituted the physics team.

Assessment use in the study blocks.

In the assessment model presented in Appendix A, there are two distinct uses of the Study Block system. More details on the specifics are provided in subsequent chapters but I provide a brief outline here to understand where and when some of these conversations happened. During DSB times, students are encouraged to work on Essentials topics with a teacher who they are potentially assigned to for a three-week period of intervention. This takes the form of groups of students learning together on content or skills and students having assessment conversations with their teachers. Because OSB is reserved for teacher discussions about pedagogy, assessment, course planning, etc., most of the conversations described between Ian and I took place in this once-a-week block of time. There is a top-down expectation that students in different classrooms would have common assessments, evaluation, and time on a given outcome regardless of which teacher they had. This was part of the thrust to create an assessment system that would fit all students and match both of these teachers' pedagogical philosophies. The literature on assessment and the associated conversations that Ian and I had are explored in detail in Chapter Five.

As outlined in the literature introducing this chapter, there are a variety of examples of schools using a professional learning community model as a means to achieve significant change. Our significant change started when our district and school started building systems associated with the learning community literature. Ian and I were able to leverage some district-wide learning about what we want students to learn in a course through the idea of essentials. These discussions between ourselves and with other professionals helped us realize how different priorities exist among different teachers and schools. In order to build an assessment system that would meet the challenges we were facing Ian and I built a culture of trust and collaboration. By taking risks to incorporate engineering projects, we took on an inquiry stance that we should improve our practice by trying something new, paying attention to how it worked, and then making modifications in subsequent semesters. This action research model of inquiry and culture of collaboration and risk taking, plays out in the remaining episodes describing how we continued to learn about assessment and used the learning community resources to work through our identifiable constraints to create an assessment system.

It is apparent that, although there are similarities between schools or jurisdictions, individual contexts that learning communities operate in vary. Thus, their impetuses for change will cause each learning community to adapt to unique circumstances creating characteristics that may exist on only a few contexts. For us, this variance was the list of challenging questions presented in Chapter One. We faced these challenges in our particular system with our particular constraints. The assessment model we created for our physics courses was created to address those concerns, supported by our blend of learning community, and influenced by various disruptions to our thinking about teaching

and assessment. While learning communities are the foundation of this story, there are specific disruptive events and conversations that propelled our physics classes to a different paradigm of teaching and learning. The next chapter is the first disruption we faced in our story. This episode challenged how we thought about our students, planned our classes, and rubbed up against the established system of grading.

Chapter Four: Disrupted by Technology and Problem Solving

In this chapter, I describe the first disruption that took place in our learning community. It is significant to the development of our assessment system because it drastically changed how Ian and I understood some aspects of student motivation and what assumptions we make about our students' abilities. This interaction with students showed us that we have the ability to increase and decrease a student's sense of self-worth and purpose depending on how we structure a lesson or question. This drastically changed our vision of physics and what we believed physics could do for some students in terms of helping them find their passion and learning about what it means to be a scientist.

This conversation happened as I walked into Ian's classroom the end of a Friday in May. This was a Friday in which the school year was winding down and many students were out of regular classes for sports, band trip, student government activities, or other reasons. At the time Ian had three interactive whiteboards and a class set of laptops in his classroom and was eager to use this new technology as a means of engaging students. Up to this point, the laptops and the interactive whiteboards were seen as complementary but independent tools.

Ian: Hey, Chris how was your day?

Chris: Good. You?

Ian: I had a really interesting physics class today.

Chris: Oh?

Ian: Yeah. You know James and Carl?

Chris: Yeah, I teach James and coach him on the football team. I don't teach Carl but I know him.

Ian: OK, so I don't know about in your class but in my class James does not take any notes and just gets by on his innate abilities when it comes time for a test.

Chris: Yeah, that sounds about right. If he is doing a lab or something with a group he will help them out but is not really interested in writing any of it down or doing a lot of homework outside of class. And I have seen James in your room. I think he spends more time on his cell phone than watching you on the board.

Ian: He is on his phone most of the time but, surprisingly, he contributes to the class.

Chris: Really? Is he gifted or something?

Ian: I don't think so. The high end of average but he pays attention even if he is playing around. I think he is going to pass my class even though the only time I have seen him use a pen in my room is on a test.

Chris: OK, so what happened today?

Ian: Well, I was going to do a lecture but since so many students were out, I thought I would get them to go through a simulation on the laptops. Once we got up and running, I remembered that I loaned out half the laptops so I put some groups together at the interactive whiteboards. I used all three whiteboards so I put James and Carl together; Jessica, Sarah, and Britany together (three students in the running for top five grad class ranking); and Stephanie, Ray, and Max together. I figured James and Carl were going to be messing around and I wanted the other groups to be able to focus.

So, I got them all to open the simulation and I told them to play with it and see if they could design an experiment that could replicate the theory we have been talking about in class.

Chris: How long did it take the girls to figure it out?

Ian: That's the thing. The group with Jessica, Sarah, and Britany couldn't get it. I showed the whole class how to operate the simulation but they really struggled when I left it as a puzzle with no direction on how to solve it.

Chris: Of course they would get frustrated. I find most students hate solving novel problems, they want to repeat the problems they have already seen me do or have in their notes.

Ian: But James and Carl figured it out. They were just playing with it and figuring it out. They had the theory reproduced while the other groups were still complaining that they had never seen this problem before.

Chris: Had they played with the simulation already?

Ian: No. They just jumped into it and were not scared to fail. Eventually they were helping the other two groups at the boards navigate the simulation and test variables. I think the girls were really frustrated at first and then a little embarrassed that they, the top students, needed to be helped by the jock.

Chris: And you just sat back and watched, didn't you?

Ian: Yeah (chuckles), it was fascinating but it made me think. What if this was not a one-off event? How much do we dictate who is top of the grad class and who scrapes by? Who gets the big scholarship and who just misses on university?

Chris: That is interesting. James seems to like puzzle solving and I have noticed that he likes the challenge. When I look at his work most of the theory and process are correct but small errors creep into the math most of the time and that is where he loses marks.

Ian: And the opposite is true of some of our top end students. Some of them will tell us that they can score one hundred on a test as long as it is material that they have seen before.

Chris: Or if you ask them a question a few days after the test, they can't apply the knowledge. It is like they just learn it for the test and then it leaks away.

Ian: So I wonder if we need to spend some time thinking about changes in our physics class. I think we need to give more opportunities for the James and Carls in our classes to show the ways in which they are smart too. Can we change the class ranking based on what types of questions we put on a test? Do we decide who thinks they are 'smart' by the questions we ask? And if so, that makes me a bit squeamish. Shouldn't we be looking to create opportunities for all students to feel 'smart' and have a chance to lead the class?

Chris: So I think we need a balance. Can we find a way to allow both types of students to do well in our class? We need to find a way to allow both types of 'smart' to show their stuff.

Ian: So we need a way to not rely on tests so much and find a way to highlight those other skills of problem solving and taking academic risks.

While this built off of our vision of having students do more engineering type of tasks, it certainly caused a disruption in the way that we needed to think about how we

structured our lessons in order to build on different student strengths. This meant a further rethinking of our essential skills and content and an increasing emphasis on teaching and assessing problem solving. This turned out to be a bigger challenge in practice than in theory.

Because we taught within a system with bells, walls, schedules, and an end to a semester, we found it initially very challenging to only change one aspect of the system. For example, if we wanted to give students time to work on an engineering project that would mean that we would need to eliminate some curricular content. If we wanted to let a student re-write an assessment then, in the interest of fairness (for grad ranking, scholarships, university entrance, etc.) we would need to let every student re-write. This would be upwards of 120 students. We had many conversations that would end in, “...well, that would mean we would have to change the report card structure/students’ schedules/the end date of semester one/how students are accepted to post-secondary/etc...” and we did not have the influence to make those changes. Fortunately for us, we maintained our work as a learning community and were able to continue these conversations in order to find a way around these obstacles.

This thinking about the purpose of physics for our different types of students became central to our conversations in the next section of this story. Through continued discourse and continued reading about assessment and evaluation practices, we came to an assessment model that addresses many of the challenges we were experiencing. It is not perfect but it has helped move our teaching along the continuum to increased validity in results, increased success rates, and increased student engagement.

The next chapter outlines how our story continued to evolve as we learned more about current assessment and evaluation literature. By using our established learning community structures we were able to incorporate this learning about assessment into our courses and start building an assessment system that addresses many of the challenges articulated in Chapter One. The episodes are paired with assessment literature to outline how we, ultimately, created and implemented the assessment model.

Chapter Five: Changing Assessments and Evaluations

Even though learning communities were fundamental to our professional conversations, the greatest impact on this story was our learning and discussions about assessment and evaluation. This chapter continues by building on the structures established in our learning community and concepts of essential skills and knowledge. Much of our learning about assessment would force us to think about challenges like decoupling behavior from marks, giving timely formative assessment, and personalizing learning. Through this we realized that essential skills and knowledge are a key component to creating an assessment system. A by-product of the system we created is that we, as teachers, now became focused on students mastering skills and knowledge instead of on students passing our course. This chapter focuses on the literature that contributed to how we changed our thinking about assessment and the associated episodes that helped bring our model to life.

Similar to Chapter Three, this chapter integrates a literature review of assessment and evaluation and episodes of our evolving assessment system. As previously stated, I present these items in parallel to highlight the direct connection between what we were learning about assessment and the ongoing conversation about how to integrate these ideas into a coherent system. As in the previous chapter, the episodes I present are compilations of conversations that Ian and I had often over a period of a few days or weeks. They are condensed and expressed as a complete conversation to help the reader focus on the details of how assessment research impacted our thinking about creating an assessment system, and they are presented as complete episodes so the reader can more clearly see the train of thought we went through and to address my stated concern that

there needs to be more literature containing examples of real stories that addresses teachers' concerns.

There is a significant amount of literature on classroom-based and formative assessment. Much of that presented in this chapter has overlapped with my school's creation of an assessment framework. Through helping to create an assessment framework in my school, I have had the opportunity to read much of this literature as part of my professional development over the past ten years. It is important to understand that, through this chapter, I am highlighting a small sample of the academic literature that exists on these complex topics. I am emphasizing literature here that has had a direct impact on my growth as an educator.

Echoing Initial Challenges in Changing Assessments

There are two challenges teachers encounter when attempting to change their classroom based assessment systems. The first is that teachers are instructed not to give a mark of zero by a number of authors, including Guskey and Bailey (2001); Heflebower (2009); O'Connor (2007); and Reeves (2004). At the same time, they are told to disaggregate between providing marks for students' behaviours in a course (such as submitting work on time) and academic abilities (such as curricular outcomes) by Marzano (2010), O'Connor (2007), Reeves (2011), and Stiggins, Arter, Chappuis, and Chappuis (2007). This contradicts some expectations created in a marks-based system that rewards good students and the attitudes that are valued such as resiliency and commendable study habits. Often, students feel pressured to amass enough "points" to earn scholarships and post-secondary admittance, and teachers are burdened with

navigating student needs and new evaluation requirements when school leadership attempts to implement pedagogy or policy changes.

In trying to implement some of the ideas found in the assessment literature, we realized very quickly that many system changes needed to be made concurrently. The first step was to continue building from the idea of essentials and extensions. We spent significant time clarifying our essentials by identifying what we believed is the purpose of teaching physics. This helped us to solidify our essential skills and knowledge for the physics course and moved us closer to being able to tackle some of the larger challenges we faced.

No zeros means more time for learning.

The following three episodes brought us one step closer to creating a set of essential skills and knowledge that would become the core of our work. These conversations took place over a number of months. In this time we were struggling with how to change our course within a rigid system and implement some of the learning community practices we were learning about. On top of establishing essentials for each course, our district and school were exploring ways to create flexibility in how much time students could spend learning a topic in an attempt to guarantee students' learning. To establish essentials and create more flexibility, we found that having a shared vision between teachers, even for a single course, can lead to transformative practice.

Chris: I was thinking about our essentials. We have been talking about the need for skills as well as content. I wonder if we need to think about the purpose of physics.

Ian: You mean why students take physics?

Chris: Kind of. What do we want students to get out of taking a good Physics 11 course?

Ian: Well, I think we have a couple of different types of students that take our class.

Chris: Yeah. There are the students who have more physics in their future like those going on to study engineering, computer science, or sciences.

Ian: There is also the trades group that don't need to know a lot about formulas but it would be nice for them to know about practical things like levers or pulleys or gear ratios.

Chris: We also have a large group that are just jumping through the hoops to get into a post-secondary program.

Ian: Like a Kinesiology or Marine Biology program where they will take some applied physics courses tailored to their field but are still required to take it for admittance.

Chris: Exactly. We are trying to run one class with so many groups in it. I wonder if we can create a system that lets each of these types of student get what they will need for their future. Ideally we could create an individual program for each student but we don't have the resources to do that.

Ian: OK, so we are looking for the similarities that everyone would need from a physics course?

Chris: Well, I wonder if we can identify what a student should get from the course that they can then transfer to other disciplines or careers.

Ian: Well there are some physics concepts that are absolutely essential.

Chris: Of course. From our grade 11 curriculum I would not give a student a credit if they did not know Newton's Laws of Motion and how to use the kinematics equations.

Ian: Sure. I think there is some content from the Waves unit like knowing wave behaviour and anatomy that a good cross section of our students will need later in their studies. I think they should be able to use the equation for the speed of sound and there is the energy section with the equations for the different types of mechanical energy.

Chris: Hmm. I wonder about some of the formula use. Don't we want them to be able to use any formula? And, even more, we really want them to understand the physics enough that they can build their own formula to model the problem and solve.

Ian: I think there are some other skills too. There are some good lab skills like collecting and analyzing data that are transferrable to any type of science or business application. We both agree that they need to be building resiliency through problem solving. It is a learned skill to be able to work through a novel problem.

Chris: It sounds like we are saying that we want them to be able to do all of these skills and, for lots of our students, these are more important than the physics content. I worry about how we are going to mark all of this.

Ian: I don't know how to mark it. I just know it is important and, like you say, some students will use more of the scientific skills than the physics content. I

worry too that we might be adding more expectations to a course that students already struggle to wrap their head around.

Chris: Yeah, they struggle so much just to learn the content.

Ian: It takes some students a long while for the light to click on and them to start understanding how they build a formula and use the theory to solve a problem.

Chris: And it seems like once they get it, it seems to stick but, yeah, it can take a while for some of them. Some of them do so badly on that first test and it hurts their mark for the rest of the semester. But once they get what we are trying to do, it seems like the content “clicks” and no matter what the new content is they are okay with it.

Ian: I have seen that too. I had one student who struggled through both Physics 11 and 12 but got through it and into first-year physics at university. They emailed me an email before their final exam at Christmas, “I get it. I finally get what you used to say all the time. I need to make the formula. I need to make the formula that will answer the question, not find the formula that fits the question. I get it that I can make the formula to solve any question! Thanks, off to write my Physics 1000 exam.” I have had lots of students say similar things at various points in their learning, but if they do poorly on the first test they are only working towards a mediocre mark regardless of how well they do in everything else.

Chris: It is really unfortunate that they are stuck with that mark. It does not seem to go along with the idea of growth and trying to determine what they really know by the end of the course.

Ian: That is what I worry about. If we want to introduce new skills that they will take a while to learn, is that going to be something else that is going to hinder their marks?

Chris: It would be nice to be able to find a way to give them the time that they need to understand the content before it counted in their mark. If we could do that with the content, we could do that with the skills too.

Ian: I agree but we need to cover the curriculum and we are not looking at the same content through the whole semester. It would be nice to do one topic until every student understood it but that is not a reality. We also have skills that are in the curriculum that we just don't have time to focus on when we need to get the content covered.

From the discussions about essentials and wanting to give students more time to master content, we started to change our assessment practices in February of 2009. This would have been during our second semester of Physics 12. We took our content outcomes that had been accepted as essential by the district working group and started to reformat each unit test.

A portion of each test was designated as essential. This portion of the test was based on core content, assessed with multiple choice questions, and well-defined as essential for students. Because these questions were essential, we expected students to be able to answer every one of them correctly. This meant that many students would take multiple attempts to correctly answer questions. Instead of creating multiple versions of the same test, we decided that students could conference with either one of us in order to prove their understanding.

We agreed that a student's first attempt at the essential portion would be written in a traditional test environment. Subsequent attempts at the same content would be made up of questions that were initially incorrect and would be accompanied by a conference. Students re-attempted incorrect questions and then had a short conversation with one of us. We would verify a correct answer and then ask a follow up question to ensure the student understood at a mastery level. Only when a student could answer any and all of the follow up questions correctly would we sign off that the concept was complete. The non-essential portion of the test was written as a normal test and marked as a traditional test. Student marks for the test were determined by simply treating this as two halves of one test.

Although Ian and I had not read extensively about feedback or formative assessment yet, we felt that short conversations during an essentials test could allow students to gain some clarity and succeed at the task. During the essential tests we wanted to give students a chance to demonstrate their understanding of the essential content through any means of representation. Most often this turned into a formative conversation.

Chris: for the essentials tests and exam are we going to mark it right in front of them? I think there would be some benefit to them for this.

Ian: I think so. We want to give them feedback as timely as possible. So will we mark it and give it back to them to correct it and then bring it back to correct again?

Chris: Yeah. I like that they can fix their small mistakes, like missed negatives, and have a chance to spend more time thinking about the big errors.

Ian: When they bring it back the second time do we just mark it or do we want to dig a little bit?

Chris: Oh, we need to make sure they understand. I would like us to ask a follow-up question.

Ian: I agree. If they got everything the first time, then I can make the assumption that they know what they are doing if they got 100%. If not, then I need to make sure because it is essential. They need this content to do the next course.

Chris: Some students might feel more comfortable explaining something too. Are we okay with them talking through an answer?

Ian: I am. We want them to have any opportunity to show what they know. The first try is to put it on paper and the second attempt can be them taking us through their thought process.

Chris: Okay. And I think we are more concerned with, just that, the process is more important than a math error. Sometimes that can happen better when talking about their thinking than focusing on a calculation.

The following conversation is a summary of the discussions Ian and I had during the first semester of using the essentials and extensions model to ensure full student understanding of the essentials content.

Ian: Some things happened that I did not expect.

Chris: Oh? Like what?

Ian: They didn't like it.

Chris: Well, it is a lot more work for them if they don't get a question right on their first try.

Ian: They are not used to having to do more work than just give the right answer. Just a number.

Chris: Or to have to verbally express their thoughts. I think it is good for them.

Ian: Oh, I do too. I think it makes certain that they really do know what they are saying is right and it gives them another means of explaining their way through an answer. For some of them that is really helping them learn.

Chris: I have seen that too. They are learning in the conversations they are having either with us or between themselves while they are waiting to conference again.

Ian: Yeah. They are really focused on learning the material and trying to anticipate what the next question will be that they will get asked.

Chris: That seems to be one of the best parts. They are really focused on their learning. They already know that they have to get it all right so there has been a shift from trying to accumulate enough points to pass to actually learning the content.

Over the course of the past years of using this assessment model and having conversations with students in this way Ian and I have consistently observed the majority of students engage in this way. Students consistently seek a deep understanding of the material and routinely collaborate with peers to gain that understanding. Students understand what is expected and have conversations that are geared towards understanding the content rather than getting a good mark.

It is important to note that, at this point, Ian and I covered all the same content as previous years. The major change was in how we interacted with students based on their

learning needs. Students who struggled with the essentials were afforded more time to grow their understanding while students who achieved the essentials had a firm deadline for extension content assessments. This seemed to help students still work within deadlines but gave reasonable flexibility when needed. It did not address all of the challenges of trying to build a system that truly decoupled grades from behaviours, gave continuous feedback, and personalized learning. For that, we needed to learn a lot more about assessment.

Disruption Two Brings Assessment Literature to Physics

The second disruption that occurred in our teaching consisted of two events. The first was a series of readings, conversations, and a workshop about assessment that shifted our thinking about when students should demonstrate mastery and what that meant in terms of marks and credits. The second was a conversation about moving our ideas of essentials closer to what was found in English Language Arts (ELA) curricula. These two events happening in a relatively close timeframe propelled our thinking beyond the constraints we felt in changing our practice. This section starts with the working definition of assessment that was used at Riverview High at the time of our learning and then describes two episodes that bridge the knowing-doing gap in our attempt to change assessment and instruction for our students.

Defining formative assessment and feedback.

Formative assessment has been reported in meta-analyses by Black and Wiliam (1998) and Hattie (2012) as a statistically significant factor impacting learning and

achievement. Black and Wiliam are often cited in literature on formative assessment as foundational in claiming the benefits of formative assessment for student achievement.

Because this thesis is reflective in nature, I present the definition of formative assessment that guided my work when creating the assessment model. This is a working definition of formative assessment used in my classroom and school. It is a distillation of the most common elements found in my reading on the topic of formative assessment and corroborated by an established assessment framework for Riverview High.

Formative assessments are well planned frequent events that give students specific descriptive feedback on their progress toward well-defined achievement targets and give teachers feedback on how to adjust future instruction (Burke, 2010; Chappuis, et. al 2006; Davies, Herbst, & Reynolds, 2008; Hattie, 2012; Jakicic in Guskey 2009). While it is believed by teachers that much of this research is readily applied at the elementary level, there is less mention in the literature of examples about high school classes, let alone in courses intended to prepare students for post-secondary studies. Justified or not, it is my experience that high school teachers perceive that powers outside of the classroom (curriculum, community, university acceptance) expect a level of objectivity and high academic expectations that are delivered, in part, by more traditional assessment strategies. While I do not share this perception, it is important to understand that even a functional definition of formative assessment based on research might not be enough to convince some teachers of the need to adopt these practices.

This next section explores some of the significant systemic limitations Ian and I encountered during this creation process. Our experience has been that many teachers

face these same limitations when trying to implement assessment changes. Many of these systemic issues are linked to the questions highlighted in Chapter One.

System limitations were aided by assessment literature.

Ian and I had consistent conversations about how we wanted to change our practices but felt that there needed to be a domino effect to change interconnected systems. Every solution we would ponder to address personalization or allowing students to take more time to learn something was tied to other, more rigid systems. These included report cards, university acceptance, and end of semester reporting, among others. The following episode elaborates on some of these restrictions and finishes with the variety of assessment learning opportunities we had that helped us to overcome these challenges.

System limitations explained.

Ian and I have frequently discussed the limitations placed on us and our students by the formal system as well as the informal expectations of students, parents, other staff, and administrators. This consistent willingness to reflect on how to improve the physics class while pushing the boundaries of the system we worked in allowed us to easily incorporate new ideas into our discussions. This became particularly useful during the 2010-2011 school year as School District 2 (currently Anglophone School District, East) placed a significant professional learning emphasis on improving assessment practices in all classrooms.

Ian and I were already trying to reconfigure our assessment system to allow students to have more flexibility in when and how they demonstrated their learning, to

give students opportunities to solve real world problems, and to move away from a system so dependent on valuing students through a mark. While having conversations about how to change a system, they kept running into complications. For example, Ian and I knew from experience that physics content was challenging for students to understand and saw that, for many students, the complex thinking will come with time. This often meant that the first test of the course was a much lower mark than the remainder of the course, regardless of the content that was covered. Unfortunately, there is a definite timeframe for the course and content needs to be covered in a linear fashion. This is one example of a system that involved report cards that have specific deadlines for student grades, a packed curriculum, expectations that students need grades for admission to post-secondary institutions, while teachers were expected to differentiate instruction.

It seemed as though all of these interconnected pieces limited how assessment systems could change until the entire system changed all at once. Students could not have more flexibility in their learning without more time to master content and improve on skills defined by the curriculum. Where would this time come from when content had to be taught and assessed in time to have a mark on a report card? How could teachers cover all of the content in the curriculum while teaching the skills embedded in the curriculum or important skills identified by agencies like 21st Century Learning Canada or the World Economic Forum (Gray, 2016)? How are teachers to ensure students had enough content to move on to the next course while simultaneously giving them enough choice to engineer something they were interested in? How do you fit these nice ideas into an established system?

Fortunately for Ian and I, over the course of one academic year we were exposed to the literature of Davies (2008), Burke (2010), Guskey (2001, 2009), O'Connor (2007), Reeves (2002, 2004), and Stiggins (2005, 2007), and I also attended a workshop by Davies (2011). Having already had meaningful background conversations on essentials and a vision of teaching physics, we were able to bring the research on assessments into focus. This research, combined with conversations with other educators, helped to provide a framework that allowed us to start liberating Physics 11 and 12 courses in terms of assessment and evaluation. Future conversations about how they created their assessment system were fundamentally based on research and learning from this intense period.

Combining these challenges with our learning about assessment caused a creative frustration in which we could tell that, all though we did not have all the answers, we felt close to breaking through systemic blockages in order to create something new. Other definitions exist beyond what has been established in my school and I present them next in order to highlight that the model we have created does not stray significantly from the body of accepted literature. Following this extended definition is the second episode depicted in this disruption that connects English Language Arts thinking to teaching physics content.

Comparing other definitions from literature.

The literature contains wide-ranging definitions of formative assessment. While not articulated in the literature, it is important to note one area of inconsistency that may cause confusion: the distinction between formal formative assessment (i.e., a quiz or

piece of writing submitted to the teacher and used to guide further instruction or evaluation) and informal formative assessment (i.e., verbal interactions or homework intended for practice that inform the teacher and students of progress). It seems that there is disconnect between how teachers view these two related forms of assessment and how authors of the literature view these forms. By comparing a number of definitions found in the literature it is evident that, although inconsistencies exist, as exemplified by Bennet (2011) later in this section, a learning community would be able to create a definition of formative assessment based on the literature that would work for that community with their particular constraints.

There are two other positions within the literature that need to be highlighted to fully understand formative assessment before I present the working definition that guided some of our ideas about assessment. They are the overlap between formative and summative assessments as well as the further distinction of process and interaction in using formative assessment.

One group of authors (Bennet, 2011; Biggs, 1998; Brookheart, 2001) takes a similar stance in saying that there is a potential overlap between formative assessment and summative assessment. Brookheart (2001) summarizes the irregularity in the literature by stating,

Some authors see all classroom assessment as formative and discuss summative assessments primarily in terms of external assessments. Some authors agree all classroom assessment can be formative, but only if students use the information for formative purposes. Some authors recognise that some classroom assessment can serve summative purposes, too. (p. 153)

Biggs (1998) agrees that, "...in the broad picture of the whole teaching context—incorporating curriculum, teaching itself... and summative assessment—instead of two tree-trunks [of formative and summative assessment], the backside of an elephant appears" (p. 108), identifying that the line between formative and summative is blurred at worst and integrated at best. More recently Bennet (2011) asserts that, "Formative assessment then might be best conceived as neither a test nor a process, but some thoughtful integration of process *and* purposefully designed methodology or instrumentation" (p. 7). These authors identify that teachers can use assessments in a variety of ways and for a variety of purposes and to simply identify an assessment as formative or summative does not make it so.

Further clarity comes by authors who identify when an assessment becomes formative. Cowie and Bell (1996) identify that, "the process used by teachers and students to recognize and respond to student learning in order to enhance that learning, during the learning" (p. 3) is a formative process regardless of the process incorporating a concrete assessment tool such as an assignment or test. A notion of process is echoed by Boston (2003) who states, "Under this definition, assessment encompasses teacher observation, classroom discussion, and analysis of student work, including homework and tests. Assessments become formative when the information is used to adapt teaching and learning to meet student needs" (Boston, 2003, p. 2). These authors are clear in defining that it is the role of the teacher after and during an assessment that determines whether or not the assessment is formative. In other words, assessment is formative when it is used to re-form students' skills and content understanding by adapting future teaching.

Black and Wiliam (2009) take a different view emphasizing the student use of feedback in decision making through interaction. They describe “A formative interaction [as] one in which an interactive situation influences cognition, i.e., it is an interaction between external stimulus and feedback, and internal production by the individual learner” (Black & Wiliam, 2009, p. 11). They provide definite focus on classroom-based interactions as they outline five types of activities to be used in formative assessment: “sharing success criteria with learners, classroom questioning, comment only marking, peer- and self-assessment, and formative use of summative tests” (p. 7). This results in the following definition of formative assessment:

Practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions [the student] would have taken in the absence of the evidence that was elicited (Black & Wiliam, 2009, p. 8)

Black and Wiliam fall farthest on the informal end of the continuum while not contradicting earlier authors’ claims that most classroom tasks (including summative assessments) can be used in a formative nature.

Our working definition

Our working definition of assessment, evaluation, and formative assessment draws largely on Davies, Herbst, and Reynolds (2008). They provided a definition for assessment as a tool that is used for teachers to gain an understanding of a student’s level of proficiency while an evaluation is a tool used to generate a grade to report a student’s progress for a given standard. These definitions closely align with how we viewed assessment and evaluation when creating this model. Building on Davies, Herbst, and

Reynolds (2008) we found ourselves agreeing with Black and Wiliam (2009) that almost any task in which feedback is given and Boston (2003) that any classroom activity in which students were engaged in could be formative. The research was guiding us to incorporating formative assessment and evaluation as two different concepts but we did not yet have understanding of how to teach skills and give feedback in the way we would need to. Fortunately, our ELA colleagues had experience teaching skills along side content. The following episode describes how we learned from our ELA colleagues and were able to build their understanding of assessment into our model.

Global essentials migrate from ELA to physics.

Starting in September of 2010, I took on the role of Supplementary Position of Responsibility (SPR), a position similar to a department head. In addition to teaching responsibilities, SPRs are also tasked with working with curriculum-based teacher teams to improve their teaching practices. Typically, SPRs work with two to four teams in a semester and this gave me the chance to work with a team of English Language Arts (ELA) teachers and learn about the intricacies of that discipline. The resulting conversation between me and Ian occurred at the end of a day when I had been working with an ELA team thinking about assessment practices.

Ian: Hi. How are things?

Chris: Good. I have been working with the English eleven team on assessment stuff.

Ian: Yeah? How are you liking that?

Chris: It is OK. Different than physics or math, that's for sure.

Ian: Oh? How so?

Chris: They are struggling with this idea of defining essentials. The English curriculum documents just don't lend themselves to creating discrete assessments. It is all about big ideas rather than the minutia of a story or a poem. But making a list of quotes to match to characters or marking the grammar of an essay is more tangible than what the curriculum expects.

Ian: So what does the curriculum say they should be doing?

Chris: It is vague and nuanced. There are three broad strands that students are expected to improve on through a semester: writing and representing, reading and viewing, and speaking and listening. The teacher is expected to understand the nuance of the curriculum and tailor tasks and readings to gradually increase complexity as students move through the grades. There is a spiraling that intertwines all the strands. It becomes very challenging for them to create definable and measurable sets of essentials that can be easily reported on and assessed independently of one another. And that is what the district is pushing for.

Ian: I can understand that. In physics I know that a student has a particular skill if they are able to answer a question or two that address that skill. But in English, that vagueness of, "Write a good opening paragraph" would be hard because it would depend on what they are writing for and so many other things. I would not know how to do that.

Chris: Yeah, it is a different challenge than we are having in physics. They have three broad strands that everything fits into and there is not one that is more important or more essential. They almost need to think in terms of levels of

competency than specific items to teach or learn. That is the opposite problem we are having where we have so many outcomes and specifics that it is hard to pick out what are the essentials.

Ian: Hmmm. What if we had global outcomes for physics?

Chris: What do you mean?

Ian: Well, what if we had essentials that were more global in nature? What if we thought about somethings we do in physics like it is in English.

Chris: Like what? The content is pretty defined. How would it be placed in broad terms?

Ian: What about the skills? Like, we want them to be able to act like scientists, what if that was an outcome? If an English outcome is to improve paragraph writing, it does not matter if they do that when studying poetry or a novel or short stories. They probably get to work on those skills in every unit. Could we do something like that?

Chris: OK, so our skills are in labs. What do we want them to do in the labs? We want them to design the labs and collect data.

Ian: We want them to interpret the data too and report it. I wonder if there is a broad outcome of “Act like a Scientist” with subcategories of “collect and interpret data” and “write a lab report.”

Chris: OK. What else?

Ian: Well, what is the point of taking physics? What is the fundamental thing students should learn and they would get to practice no matter what content we

are learning? Is it less important to know as much content or to be able to do something with it?

Chris: Well, mathematically modeling real-world situations with physics equations is something they should be able to do in each unit and practice throughout the course.

Ian: OK. What does that look like?

Chris: I think there is also some fundamental content, like Newton's laws or the kinematics equations, that I cannot give them a credit for not knowing how to use. They have to be able to use them to build the equation that solves the problem at hand. That building an equation is a key skill of being a physicist and it is something that students struggle with. We need to emphasize that more in our teaching and assessment if we want to do this.

Ian: I like it. I think that goes along with what we have been trying to teach in that it is not just the use of a formula that gets a mark. They have to understand that even though the equations don't change, they have to be used differently for each novel situation.

Chris: Is that another essential? Being able to solve novel questions?

Ian: Absolutely. Or at least attempt them.

Chris: So is that it, are those our new essentials?

Ian: Act like a scientist, mathematically model real world problems, know some content, and solve novel problems?

Chris: Yeah, that sounds like a broad list like English.

Ian: I think we do all of those in every unit. I don't think it would change our teaching too much.

Chris: No, I think we might move a few things around to emphasize the mathematical modeling but we can keep all of our labs and stuff.

Ian: How do we mark it? Does it need to be different than what we do now? I am not going to collect a lab report from every student every time we do a lab...

Chris: I have no idea. How do we make sure they are solving novel problems? Can we put truly novel questions on a test? Do we need to create a number for everything, like collecting data?

Ian: I like the idea. I am not sure if we are there yet. We still have report cards that need a mark. I think we are onto something.

Coupling these ideas from our colleagues in ELA with our learning about assessment and evaluation we could see a clear path to how we wanted to engage students and teach physics. The final piece was how to create and report a student mark at predetermined intervals. The answer was to reimagine how marks were created and incorporate various feedback structures in place throughout any course. This forced us to create an assessment and evaluation system rather than to think about assessment in terms of as a particular task or product.

Feedback is useful in earning a credit.

The next episode moved Ian and I into a new pedagogical paradigm. The changing of what we value for assessment and evaluation finally manifested into a system that could meet pressures to change from what we were learning about balanced

assessment within the systemic structures we found ourselves working in. While not articulated explicitly in this episode, the idea of effective feedback is paramount in this model. It is for that reason that literature on feedback is included in this section.

Here is what you need for a sixty.

The largest challenge Ian and I faced was fitting the philosophy we both valued into the system that we worked in. Ideally, we would be able to allow students to take as long as they needed to demonstrate their learning in multiple ways but the system dictated that students needed to have a mark at definite time intervals. At the same time, they understood that learning how to manage deadlines are an important academic skill and students will need to understand how to deal with stress as they move on to post-secondary studies. The following conversations brought all of these considerations together in an elegant solution. These conversations happened over a two-week span and, ultimately, led to the creation of the assessment system.

Ian: I was just talking with the biology team and they are going to try something we might want to consider.

Chris: Oh? In what regards?

Ian: What if we think about the essentials a bit differently? What if a student completes their essentials stuff, they get a 60%? They would pass the course.

Chris: Okay. So we still teach all the same content? We are just going to evaluate them differently?

Ian: Yeah. What if we rethink how we are doing essentials tests? We still break it into two parts. The first part would be essential. They have to pass it to get a

credit in the class. The second part would be extensions and it would be a chance to ask those harder questions and introduce the novel questions.

Chris: So what mark would they need to get on the essential portion?

Ian: Hmmm. I guess they would need to get all of it.

Chris: If we are saying it is absolutely essential in order to get the credit then they do need to get 100% on it. They will need to have multiple chances.

Ian: Yeah, and I think now that we have DSB, we can use that time to either conference with students who need another attempt or just give them the time to do it again.

Chris: I think we would just mark each question as pass or fail. No partial marks or anything.

Ian: Definitely. And if they mess up one question, they just need to do that question.

Chris: Will we allow them to work with other students if they need to try it a second time?

Ian: I think so. We want them to use a textbook or chat with a friend or find a video online to figure it out. I think at that point it is up to them to find a way to learn it.

Chris: So we will need to follow up with them for each question they get wrong to make sure they understand it. We want to dig a little deeper than just seeing the right answer on the page.

Ian: Definitely. And if they cannot answer the question, they have more work to do and will have to go and figure it out until they can answer every question we ask.

Chris: Okay. What about the extension test? We don't want them to be able to do that as many times as they want. The keepers will do it until they get 100%.

Ian: NO. I think it is a one-time test. Everyone writes it at the same time on the same day regardless of how you did on the essentials.

Chris: So when they pass the essentials, they would get a 60% on the test and then their mark on the extensions would bring them from a 61% to a 100%?

Ian: Yeah. That way a struggling student gets as much time as they need to pass and the top end students still need to put the work in to get the top end marks for scholarships and such.

Chris: It is a different way to think about assessment. I think it will get around that talk of "no zeros" and giving students time but not getting rid of deadlines. We will need to be really careful about what is essential and how the extensions fit into it.

Ian: I agree. We will have to sit down and make sure for every unit.

By adopting this model, students needed to have the essential skills and content made explicitly clear. Our role as teachers was to use whole class instruction to deliver some basic content and then gradually increase the student ownership of their learning. Students would receive feedback in class on work that they were doing and gradually progress to more challenging problems. Essential tests became another source of feedback allowing students to question and learn while doing an assessment that they

were required to master. Immediate feedback on performance became a cornerstone for success.

Literature on student feedback.

Due to the dominance of the term “feedback” in the definition of formative assessment it would be remiss not to elaborate on the definition of feedback found in the literature. Ramaprasad’s (1983) seems to be the most often-referenced definition in the literature: “Feedback is information about the gap between the actual level and the reference level of a system parameter which is used to alter the gap in some way” (p. 4).

Ramaprasad elaborates that,

...feedback emphasizes three crucial points: [t]he focus of feedback may be any system parameter: input, process, or output; [t]he necessary conditions for feedback are the existence of data on the reference level of the parameter, data on the actual level of the parameter, and a mechanism for comparing the two to generate information about the gap between the two levels ... there cannot be any feedback if any one of the three (data on the reference level, mechanism for comparing) is absent; [and] the information on the gap between the actual level and the reference level is feedback only when it is used to alter the gap... if the information is stored in memory it is not feedback. (Ramaprasad, 1983, p. 5)

Meaning that feedback only exists when specific information is gathered and used to alter a gap in student skill or understanding. In educational terms, this has been understood to mean that teachers use feedback to narrow students’ gaps in learning by gathering evidence of learning and then sharing that evidence with students along with strategies for improvement.

Although Ramprasad is not writing specifically about education, both Sadler (1989) and Boston (2003) incorporate this definition into their work in the context of education. Boston (2003) explains that feedback is part of the formative assessment

process adding, "...learners can also play an important role in formative assessment through self-evaluation [and] teachers need to make sure to ask thoughtful, reflective questions rather than simple, factual ones and then give students adequate time to respond" (Boston, p. 3).

The effectiveness of feedback in teaching and learning is presented in a meta-analysis by Shute (2008), who writes that descriptions of feedback are "inconsistent...contradictory, ... and highly variable. [feedback is]...widely cited as an important facilitator of learning and performance but quite a few studies have reported that feedback has either no effect or debilitating effects on learning" (Shute, 2008, p. 156). Shute offers several concrete feedback guidelines to educators:

...feedback that tend to impede learning include: providing grades or overall scores indicating the student's standing relative to peers, and coupling such normative feedback with low levels of specificity [and] when a student is actively engaged in problem solving and interrupted by feedback from an external source, this too has been shown to inhibit learning. (p. 156)

The takeaway from the feedback literature is that feedback needs to be specific to student needs and used to reduce a gap between established expectations and current levels of achievement.

By implementing a pass-fail scale for each question on the essentials tests with accompanying anecdotal feedback and discussion, Ian and I found that students focused on improving their understanding of content. The research supports our efforts to give feedback specific to one content item or question per conversation. We found that students were more receptive to having a genuine conversation about their learning when no mark was attached to their conversation. This also allowed for students to take academic risks and start to explore their passions in an effort to personalize their learning.

Personalization of Learning

While personalization or individualization of learning was not a goal of ours in creating an assessment model, it developed into one of the most important features for some students. Literature on individualization of learning outlines how this approach to teaching can have significant impacts on student learning and we would agree. The development of an engineering component and optional labs in our course and assessment model has given ample room for students to personalize their learning. Students have often remarked that this was the most worthwhile aspect of instruction in physics at Riverview high.

Even though much of the literature uses the word individualization, I will use personalization throughout to be consistent with the usage in New Brunswick educational contexts. In New Brunswick, individualization refers to significant changes to a student's programme of study because of an exceptionality. Because we operate in a fully inclusive system students having Down's Syndrome or Autism Spectrum Disorder would be commonplace in our schools. Students with such exceptionalities are individualized to create an education plan that meets their cognitive and social needs. Conversely, personalization refers to a differentiation strategy teachers can employ to allow students more ownership of their learning.

Personalization/individualization in the literature.

Bloom (1971) was one of the first authors to suggest the need for individualization in the form of formative feedback and allowing different students varying timeframes to prove mastery. Guskey (2005) explains some of Bloom's

observations, summarizing, “little variation in teaching resulted in great variation in student learning” (p. 10). I do not go into great detail here concerning the literature dealing with personalization because only a specific set of authors influenced our thinking on assessment and personalization took on a very narrow meaning for us.

Many recent authors (Burgstahler 2010; Davies, Herbst, & Reynolds 2008; O’Connor 2007; Stiggins 2005) are often cited by school and district administrators advocating for students to be given as much time as needed to learn all prescribed material and demonstrate their learning. Providing this extra time became one of the key pillars in our assessment model. While this would, theoretically, mean that all students mastered all content, the reality is that not all students seek to master all content due to a variety of factors. Some students take a course because it is required and a passing credit will suffice.

The other challenges teachers face with this aspect of the research are real time pressures that come with the end of a term. Since we can reasonably guarantee that students will have all of their essential skills and knowledge complete by the end of the course, we allow personalization as a means for students to pursue their passions. This second aspect of personalizing content allowed us to give individual students feedback on their engineering projects while providing flexible timeframes within the course. As is described in the following episode, bringing personalization into our assessment model relieved some of the time pressures teachers and students regularly face.

Everyone does engineering.

Our push to have students engineer real solutions for real problems came about because we recognized that engineering is a different type of science thinking than that of a physicist. This also gave us the opportunity to allow students to personalize their learning by pursuing a passion and connect to an aspect of science not exclusive to physics content. In our initial conversations about doing more engineering we were comfortable taking the risk to allow more personalization because we could always fall back on the roller coasters and Rube Goldbergs.

Students can solve real problems too.

Ian: How do we do more engineering? I want students to solve real problems for real people.

Chris: Like what? I mean, they are not going to build a bridge across the river.

Ian: No, but I think there are things that students can do that are real. Sometimes the projects are just a demonstration of physics principles. I think we can push them a bit more.

Chris: We can move away from the roller coasters and Rube Goldberg machines. I think it would be good for them to build something, test it, and rework it to do what they want. We will have to be clear on what we expect and be able to give them some examples of what they can do.

Ian: As far as what they can do, I think we want them to solve a problem.

Chris: We want them to do something they are interested in but, yeah, solving a problem is the engineering thinking that is different than just the physics thinking.

So we will need to create a rubric that clearly outlines the expectations. What does the highest level of performance look like? We can build a rubric right now.

Ian: I would like to see them find a problem and solve it.

Chris: It would be nice if they solved a problem for someone else too. I would also like to see them do some testing or experimentation to either prove a prototype or create a working model.

Ian: If they are going to develop something for someone else then they should present a final product to them too.

Chris: Okay. How are we marking this? Are we going to expect them to present this to us as well?

Ian: I think we have to. We need to be able to establish how much they have learned about some physics and what kind of problem solving they did.

Chris: So they will need to be given a rubric of some sort. There should be some minimum requirements and opportunities for them to show their growth and progress.

After a lengthy discussion, Ian and I established a rubric that allowed students to understand what was expected of them and how they needed to show their learning. The final two marks of the ten come from students presenting to an outside audience that would be interested in their project.

Physics Final Project Rubric

The purpose of this project is for students to engage in an engineering experience. Students are tasked to build something that shows or demonstrates an example of physics.

The project will be marked out of ten (10). Up to eight marks come from the rubric below. The remaining two points will come from the following:

- Students can fully articulate the principles of physics taking place in their project.
- Students have showcased their project to a person or organization outside the school who has an interest in their project.

Baseline project description	Point Value
Students create a product that shows an example of an application of physics. There is little understanding or explanation of the physics principles and the product looks largely unfinished. There is little originality in the project.	2
Students create a product that demonstrates a principle of physics. The product is functional even if it is not complete.	4
Students create a product that solves a problem. The product is complete and functions well. Students have replicated from an external source to design or build the product using schematics or examples from others.	6
Students create a novel product that solves a problem. The solution has been generated by students and there has been little use of external schematics or designs. The presented product is a complete working model.	8

Note that you and your partner may not receive identical marks based on the conversation that happens with the teacher about your project.

This rubric has been consistently used for the past six years in all Physics 11 and 12 classes. Students are made aware of the requirements and given the entire semester to work on their engineering projects. While it is rare for students to achieve a mark of ten points, there are consistently many students who solve a problem and create a prototype. This engineering project and associated rubric give students a clear opportunity to investigate something that is of personal interest to them. We have found that this often

increases student engagement, which creates a channel to give students feedback on their learning.

Assessment for learning.

The idea of assessment for learning was strongly encouraged at both the school and district level while we were learning about assessment. Reading Stiggins (2005) and attending Davies' (2007) workshop clarified this idea so that Ian and I could put it into practice. When we were wrapping our heads around all of these ideas, it felt that the logical conclusion of all of the research would be to let students take as much time to learn any content and then truly evaluate their abilities at an appropriate time near the end of the semester. Below I outline two challenges that have been greatly diminished by embracing assessment for learning and an episode that demonstrates how assessment for learning can be used by classroom teachers at a high school level.

In my opinion, there are two other challenges teachers face when attempting to improve assessment methods that do not receive a meaningful space in current literature. The first is that many teachers hope that students can demonstrate long-term retention. Teachers are hesitant to give students credit for a learnt topic if they demonstrate learning early in a cycle and cannot replicate that learning at the end of a unit or course. The second challenge is that content areas also have content specific skills students are supposed to learn in conjunction with the content. I have had many conversations with teachers that it is much easier to assess content and it takes increased time and energy to teach and assess skills. Timely feedback seems to be key in teaching skills even more so than content. In my reading of the research, I have found few instances of how an

assessment system can be implemented at the high school level based on current assessment research that accounts for these concerns. The most notable exception is Davies, Herbst, and Busick (2013). This book gives a series of strategies in a variety of curricular areas that teachers can implement to improve their assessment practices. While this is useful to many teachers, it does not give teachers an assessment system that addresses the many concerns teachers encounter that I have outlined throughout this thesis.

The following episode depicts a conversation that happened over a two-day period. We were struggling with how to allow students to take as much time as they need to demonstrate mastery and retain content. Within the collaborative tone of our learning community, we felt free to bounce ideas off of one another, no matter how seemingly absurd. This conversation proved to be the first reasonable stepping stone to pushing on the boundaries of our education system.

No marks until the end.

This conversation occurred at the end of the day as I was walking out of the school and walked by Ian's physics lab.

Chris: I was thinking about this essentials thing.

Ian: Oh?

Chris: What happens if we take this idea to the extreme? If we really don't care when students learn the content or skills, shouldn't we give them the entire semester to get any of the essentials content?

Ian: Okay. I guess so.

Chris: Does that mean that we don't really care about their extensions mark either? If they can solve the novel, higher order problems at the end of the semester, shouldn't they get the credit for it? Isn't the whole semester about practicing and getting better?

Ian: I follow your logic. (pauses) But that would mean having a final exam worth 100% of their mark!

Chris: And we want them to retain the information. We don't want them to learn something in September and not know it in January. So we have to have a final exam.

Ian: But it does not make pedagogical sense to have their whole mark based on a single two-hour test!

Chris: I know. And, is that what we want? Is that where this is taking us?

Ian: No. we can't do that.

Chris: (Laughing) No, I didn't think so. Can you imagine a high school physics class with a 100% final? Have a good night.

Ian: You too. See you tomorrow.

The next day, after thinking about assessment and evaluation overnight, this conversation took place.

Chris: I think we are going to end up with a 100% final.

Ian: I agree. I have been thinking about it and I wonder if it is a way that we work in the lab writing and data gathering.

Chris: So, what will it look like? If we are going to do this, we need to make sure it is very well thought out.

Ian: Well, we want to give students enough time to practice and get feedback in order to get better, so that we are only giving them a mark when they are ready.

Chris: Right.

Ian: And we want them to keep doing an engineering project, right?

Chris: Yeah. And we want them to still have an exam to keep that accountability piece.

Ian: What type of final exam do we want, essentials or extensions?

Chris: What if we had both? We want an extension one that gets at that piece of novel problems and deep problem solving. I think we want an essentials one to be absolutely certain that they have the essential content nailed.

Ian: So, it comes down to timing. I think it is natural that the extensions exam will take place during the exam period at the end of the semester.

Chris: Yeah, that works. If we are going to give them an essentials exam do they need to get 100% on it?

Ian: Yeah, I think so. Don't we?

Chris: Okay, so that means we are going to need to give them time to come in during DSB to conference. I am guessing the essentials exam will be a compilation of the essentials tests.

Ian: Yeah, that makes sense. We don't want them doing something else. We want to see retention. As far as timing for it, what if the essentials exam took place the week before Christmas break?

Chris: Then it would give them the three weeks after Christmas to conference. We have been using that time for the engineering projects and the last bit of content we teach. Are we sacrificing that time or blending it?

Ian: I think it is a blend. I think we want to have an essentials exam for lab writing too?

Chris: Oh?

Ian: Well, if we are treating acting like a scientist as essential, they should have a final chance to prove that they got it.

Chris: Some of them will find that really easy but some will take some time with it.

Ian: For sure. If they have been working hard in their lab groups and not letting everyone else make the graphs and write the reports then it should be a piece of cake. You and I both know that not all students do that.

Chris: So, we want them to collect data, make a graph, and write a report?

Ian: I wonder if we need them to do all of it for one lab or if we could divide it up.

Chris: If we divided it up then we could do it over multiple days. One day could be just using the probe-ware to grab data and put it in an excel sheet then create a graph with a trend line.

Ian: And I think the lab writing is important but do we need them to do a complete lab?

Chris: What if we did a demo in front of the class and then gave them the materials list, and the raw data and graphs? Do it for something that they are already familiar with but have not done, like looking at acceleration of a block on

a surface. They would be responsible to write the background, do some analysis of the data, and write a conclusion.

Ian: I like it. Should we do that before Christmas too? Have Monday be word problem essentials, Tuesday be data gathering essentials, Wednesday would be lab writing essentials, Thursday gives us a buffer for a snow day, and Friday they can start conferencing.

Chris: And if they need more time they can continue working and conferencing after Christmas. If they have finished their essentials then they can work on their project.

Ian: Right. They can spend the time working on getting ready for the final exam too. There is lots of practice for that. So, we are going to have a week of essential exams and the only thing that counts in their mark is what happens in the last four weeks of the course. How do we explain that to students and parents?

Chris: I think we just say it as straight forward as possible. Physics is hard and requires a different way of thinking than other courses. We want to give them as much time as possible to wrap their heads around challenging topics and give them as much time as possible to get ready for when it counts. Will we still have essentials and extensions unit tests?

Ian: Yeah. I think they are the practice. We won't put a mark on them. The essentials are just right or wrong and the extensions we will mark the same way. Any parent who asks we will be able to say if they are doing well or not but we will not have a concrete mark.

Chris: We will need to talk to administration to make sure we are not missing anything and I think we should send a letter home to parents explaining what we are doing.

Ian: Agreed to both. We really are taking a “marks don’t count until the end” approach.

Because of the reduced timeframe to cover all curriculum content, Ian and I also needed to come up with a creative way for students to be exposed to content that we deemed extension topics and would not be able to cover in a traditional lecture during instructional time. We recognized that there were specific self-contained topics that students would be able to build on from essentials content either on their own or from an outside source. From this was born the idea of extension labs. These are pockets of content that individuals or small groups of students engage with in a format that is more interactive than a lecture and will not appear on an assessment. Examples would be watching a video on wave particle duality, investigating closed tube resonance, or working with a small set of hydraulic pumps. Each of these would take about thirty minutes to accomplish, one DSB or OSB, and be accompanied by a short conversation with a teacher to show some learning.

Assessments are learning tools.

It became evident to us that assessments were about learning. Finding out where students are in reference to a particular skill or content area and helping them move to where they need to be is the purpose of assessment. Thus assessment FOR learning needs to be what happens daily in class and built into the assessment system. Evaluation

is defined by Davies, Herbst & Reynolds (2008) as a tool that communicates an achievement level at the end of the learning cycle. In our case this is a numerical grade from zero to one hundred. The logical conclusion to this thought process was to use assessment for learning while the learning was happening and use evaluation at the end of the course to produce a mark. This was done with content through essentials tests and the final extension exam. It was done with scientific skills through lab work, on the final essentials lab exam, and through the engineering project.

Perhaps the best example of formative assessment, or assessment for learning, in our Physics 11 and 12 courses is how we build students' skills as a scientist through our labs. Students conduct four to five labs in a course that are loosely related to the content of the unit they are in. We explicitly tell the students that, although correct answers are nice, that is not the point of doing any of our labs. The point of conducting a lab is to practice designing, conducting, analyzing, and writing a lab. We purposefully are vague on instructions in order to not contaminate their thinking on how to best design a lab to control variables and take measurements. We monitor conversations of lab groups to be able to answer questions and give immediate feedback while students are conducting a lab. We only expect to see one lab report per lab group of three to four students and encourage them to collaborate on analyzing their data and creating a report. Our lab is equipped with multiple interactive whiteboards and we require students to use them to write their lab reports. Students gather around a board and have arguments about topic sentences, semi-colon use, and how to format a scatter plot during class time in the physics lab. We interact with students and give them feedback as they go while they sort through their skills of being a scientist. It takes time and energy but the struggle of design

thinking and solving novel problems is an essential part of our course and helps them overcome other academic challenges to solve novel problems.

Our final exam is all novel.

Because we emphasize mastery learning of essential knowledge and have identified as essential the taking on novel problems, having a two-part final exam is necessary. The essentials exam gives students an explicit chance to demonstrate their retention of basic content and skills. The conversation below underscores how the extension exam combines our expectation that students take on novel problems while working in a system that requires the use of a numerical grade to convey a level of proficiency.

How hard can we make the exam?

The first iteration of using essentials and extensions was done before the philosophy of “no marks till the end” was adopted. In that semester Ian and I discovered very quickly that if we did not adjust the difficulty level of the extensions tests, there would be an inflation of marks because students would already have attained a 60% from completing the essentials test. This conversation happened at the beginning of the semester when planning to create both the essentials and extensions exam.

Chris: What are we going to do with the exam?

Ian: What do you mean?

Chris: We need to make sure that it does not inflate student marks beyond what they have when taking into consideration the essentials mark.

Ian: Right. Maybe we don't ask any essential questions on the exam.

Chris: So, it really would be just extensions questions. We need some that are just a bit of an extension and some that really push the limits of the curriculum.

Ian: I think there needs to be a few that most students should be able to get but yeah, most of the exam needs to be made up of truly novel questions.

Chris: Just how hard do we want or need it to be? And I think we want it a bit shorter as far as points go because we want them to be able to take the time to think through the challenges.

Ian: Well, think about it this way. If a student has their essentials exam complete, that should be 60%. So, we are really thinking about 40% of their exam mark. That means if they get half of their extensions exam correct they end up with an 80% on their exam. Am I right?

Chris: Yeah. The average, good student should be able to attempt most of the questions. Struggling students will only attempt the first few and the students looking to keep their 95% average will need to work through all of it.

Ian: And the questions should not just get hard but increase in complexity.

Chris: Well, the final question could be something that involves every aspect of the course. We could have it use a formula or idea from each unit and build it into one question. I can try and build something like that.

Ian: I think there could be some questions from the labs that we have done too. A mid-range question in which we get them to design a lab given some constraints.

Chris: Okay. On that note, I wonder if we can put something from one of the extension labs. If they did the lab about power, then they will have seen that

formula before and might have done some word problems on their own but nothing explicit in class.

Ian: I think we are on to something. We should book off the next OSB to work on this. We should be able to use some of last year's exam as a point of reference too.

Chris: Sounds good. This is going to be a much harder exam than we have given in the past.

Ian: Are we worried about that?

Chris: I think, so long as we do a good job mirroring aspects of the exam in extension tests that don't count toward a mark but are used as practice, it will be okay. I think we want to have the same philosophy on the tests – not all students are going to be able to answer all of the questions and that is fine.

After administering this new exam both Ian and I asked various students about how the test went. We made sure to ask students who struggled through the whole semester and those who excelled in the course. The resounding opinion from students was that the stress level they perceived and difficulty they encountered were at an appropriate level for their end goal in the course.

Students who simply needed a science credit to graduate already knew they had passed because they completed their essentials. This meant that they no longer had to perform at a high level on challenging content just to keep their mark. Students who needed the course for enrolment into post-secondary prepared as if it was a traditional exam and were able to be reasonably assured of their mark leaving the exam if they had put in the appropriate work beforehand. Students who were seeking acceptance into

prestigious university programs or in the running for major scholarships understood the pressure and met the challenge. Students were challenged at the appropriate level, as they expected. This was the first year I had been teaching physics that students had not felt large amounts of stress when sitting the exam and no students cried during the exam. This positive change has been observed during every exam since implementing this model.

This philosophy of the purpose of a final exam gives students greater opportunity to receive feedback on their learning in order to master the essentials exam and improve possible results on the extensions exam. By making this change to our assessment thinking, we have shifted the mindset to seeing our assessment tools as a means to enable students to improve their learning. Shifting students' thinking to a focus on learning instead of focusing on the accumulation of marks has helped to answer many of the questions that were posed in Chapter One.

Counter Arguments In Literature

Despite our success in using formative assessment in our assessment system, I present here the dissenting opinion on its effectiveness. This dissenting opinion about assessment comes from Bennet (2011). While Hattie's (2012) meta-analysis has merit due to its scope, Bennet (2011) roundly criticizes the consensus view of formative assessment's benefit citing Black and Wiliam's (1998) contribution as, "...a mischaracterisation that has essentially become the educational equivalent of urban legend" (p. 12). Bennet also addresses inconsistencies and misrepresentations in pieces by Bloom (1984), Meisels et al. (2003), Nyquist (2003), Rodriguez (2004), and Slavin

(1987) as works who are often cited as foundational documents by other authors continuing this line of writing and research. The greatest concern raised by Bennet is that there is inconsistency in both the definition of formative assessment and the ability for researchers to identify valid and reliable means of measuring effectiveness of formative assessment. This concern of Bennet's should cause any researcher to be careful in making any definitive claims about formative assessment.

If a change to assessment structures are the end goal, there exists advice to heed from the literature. Bennet (2009) outlines the need for assessments to be internally coherent to ensure that formative and summative assessment are aligned, as well as ensuring assessments are externally coherent in that they must align with curriculum, theories of learning, and socially valued learning outcomes. Even in this context, Bennet (2009) acknowledges that,

...we have to change the system, not just the approach we take to formative assessment, if we want to have maximum impact on learning and instruction. Changing the system means remaking our [external summative] tests and that is a very big challenge indeed. (p. 19)

In order to accomplish this goal of changing the broader educational system, Black et al. (2010) provide a set of recommendations for communities of teachers working toward this objective. These include,

Formulating agreed criteria for validity amongst those teaching any one subject...developing amongst teachers an improved understanding of criteria for reliability of their summative judgements; ... [u]sing, ... a personal portfolio, composed, within an agreed structure, of a collection of a diverse range of pieces of work, so designed that the collection overall is as valid a measure as possible of attainment in the subject; [r]igorous and transparent procedures for moderation of sample portfolios, for use both within and between schools, to develop collegial understanding of criteria and ensure overall comparability of assessment results; [g]uidelines for teachers in handling the formative/summative interface; and

[w]ays to share understanding with students and parents about assessment procedures. (p. 228)

As it is the goal of this thesis to outline the changes made in an existing system, it is important to understand and incorporate recommendations made by other authors. While not all of these ideas about assessment are effectively implemented in the system that I am advocating, hopefully, I have shown that our system was created through a mindset of continuous growth and reflection as part of a learning community.

This continuous professional development has led me to believe that true reform of assessment practices requires dedicated use of learning communities to build professional capacity and integration of many aspects of assessment literature. The identified learning community features allow teachers to truly collaborate in creating an alternative assessment system. It is my experience that bringing together a wide array of assessment literature and examining it through the lens of creating an assessment system allowed Ian and I to overcome many of the systemic difficulties teachers face in assessment. All of the assessment literature discussed has been used in creating a new assessment model at the high school level.

This model has led to many surprising products that are highlighted in the next chapter. We did not set out to create a new assessment model but do appreciate that many students have achieved remarkable feats that extend the curriculum when this model is used. We have also found that this model provides a set of answers to the challenges posed in Chapter One. These answers are also provided in the next chapter.

Chapter Six: Products – Stories and Answers

The final two chapters highlight some the products and results from this investigation into assessment reform. There are three interesting products and one set of learnings that have come about through this entire process of assessment reform. The most tangible product is the system itself that we are using and that is being adapted by other teachers to their courses and disciplines. A full explanation of this model is described in Appendix A. The second product are student centered episodes that regularly challenge any notion that high school students are limited in what they can accomplish by their age or knowledge base. A sample of student episodes are included in this chapter to highlight how I believe this assessment system can be used as a catalyst for greater movement in education. The third product are our answers to the ten questions posed in the opening chapter. They are presented at the end of this chapter in order to help other teachers understand our perspective if they try and integrate this assessment system into their practice. The results presented in the next chapter are my own learnings in reference to the research question posed at the beginning of this thesis. Altogether these items represent a wide array of learning that has happened in order to understand current assessment research applied at the classroom level and to develop an understanding of how teachers can work to create assessment systems that address many daily challenges.

Students Changed as a By-product of Assessment Changes

This cross section of student-centered episodes are products that extend the story beyond simply teaching and learning physics. The final part of our story came about unexpectedly when we embraced this assessment model and fully applied it to our

courses. While our assessment model continues to grow and evolve, the anecdotes below show what happens when we embrace the idea of using an essentials model to guarantee a standard of learning and then allow students the freedom to control the rest of their learning. Overall these episodes showcase that students and teachers can push beyond the bounds of their curriculum to achieve notable outcomes.

In our physics classes many engineering projects students have worked on through the years have yielded working prototypes and/or have given students a sense of purpose in their studies. Ian and I have seen small projects that involve one or two students learning about something they did not think was possible. We have also had larger projects that lead students on a new career path or have an impact on a wider community. Because of the level of engagement we see in our students and the increase in student success rates this philosophy of assessment has spread to other courses. Although this has primarily been in the sciences and mathematics, we are beginning to see it used in economics, philosophy, history, and world issues. The segments in this chapter span all of these disciplines.

Small projects have a big impact.

Each semester we task our students with taking on an engineering problem. Students are encouraged to find a problem to solve, learn some physics, and design a prototype that addresses that problem. Over the years we have seen multiple cell phone chargers, musical instruments, and applications to sport. Included here are two of our favorite examples from the hundreds that we have seen in the past seven years.

Electric violin.

One semester we had a pair of female students that had no idea what they wanted to do for a project and were only taking Physics 11 or 12 as a pre-requisite for acceptance to a post-secondary institution. At one point in the semester Ian came to possess an electric violin that belonged to a middle school student. The problem was that the electrical pickup was not working so it could not be used. Ian informed the two students that he had a project for them; they would fix the violin. Even though neither of them were musicians nor had any interest in electronics they agreed to take on the project.

They started to search for online tutorials on how to disassemble, re-wire, and re-assemble an electric violin and were in luck. Once the violin was disassembled, Ian told them where the violin came from. It belonged to another student that was hoping to use it at a coffee house to play a love song for a girl. The physics students were mortified that he had kept this detail from them and that they now had a real-world problem to solve – helping a young lad woo his potential sweetheart. They vowed that they would get the violin ready before the coffee house.

The students spent lunch hours and study blocks learning how electric instruments worked, how to read electronic diagrams, how to solder, and eventually got the violin working. They were so dedicated to the task that they took time out of getting ready for the winter formal to stop in and finish soldering the pickups. They came back to the school between hair appointments and putting on their dresses to make sure the violin would be ready for use the next day. We observed these students work through a manageable level of stress and frustration to direct their own learning and take ownership for solving a problem.

Simulating planets.

We want students to pursue their interests and make connections to other content areas when possible. I had a pair of students that were interested in studying outer-space and were looking at a career path in computer science. They wanted to do an engineering project that combined these two interests. After some discussion I helped them settle on designing a simulation to model how our solar system was formed based on user inputs. I am not an astrophysicist or a computer programmer so my help to them was not as a content specialist but as a facilitator in their learning.

Once we agreed on the project, they wanted to know what the formulas were that governed the creation of stars and planets. I was blunt with them and informed them that I did not know but gave them some terms to type into Google and said I would check in with them in a week. I did not speak to them for that week but did provide them with computer access so they could start doing some reading.

After a week I inquired how they were doing. Although they had not found the formulas they were looking for they had managed to find a social media group that put them in touch with an astrophysicist whose specialty was star formation. They had a genuine interaction with an expert and, by the end of the semester, had produced a two-minute animation showing how our star was formed. Through using technology they were able to access information far beyond what I knew and created a working model that combined this new knowledge with their passion for computer science.

Foot for Dad.

When we stress to some students that they have the skill to solve real-world problems and that we want them to do something that could make a difference in someone's life, some students take it personally. We have a 3D printer in the physics lab that allows students to create small objects for their projects. One student saw the printer making a set of gears once and immediately thought of their dad.

This student's father had been in an accident and recently had the lower part of his leg amputated. Prosthetics are both expensive and awkward and the father was having a difficult time adjusting to using the prosthetic. The student thought that they might be able to design a prosthetic that would better meet their father's needs by using the 3D printer. Although it took more than the standard semester to learn about servos, order muscle sensors, learn to 3D print, design the prosthetic, and assemble it, the student did create a working prototype that they could test on a live subject.

This is one example of how a student following their passion can change their future. Before this project the student was on a career path that was previously determined by what they liked and what they were good at. This project gave them the chance to try something new and dramatically altered their choices for post-secondary education. They have leveraged their learning into potential career opportunities and mentorships at post-secondary institutions. We find that this happens best when we can allow student passions and personal interest drive learning.

While these projects are remarkable in many ways, they are consistent with projects that we would consider high quality. They represent a cross section of the quality of projects students are capable of producing when given the freedom to invest time and

energy into something they are interested in learning. They also represent students who would score on the high end of academically average; they are not our highest achievers. This unexpected result in student learning has since been expanded upon and we are starting to see students using their projects to bridge courses that traditionally do not align. Students are using their physics learning to help solve problems they find in economics, world issues, or environmental sciences. I expect that this story will continue to grow as our assessment model grows.

Big ideas create big impacts: disruption three.

The following two episodes came about with the help of the University of New Brunswick (UNB) and the New Brunswick Department of Education and Early Childhood development (EECD). In the fall of 2014 UNB and EECD partnered together to create an opportunity for teachers to learn more about Universal Design for Learning (UDL) and increase its use at the classroom level. This provided the impetus for the third disruption to the way that Ian and I thought about using ideas in this essentials and extensions model of assessment and evaluation to engage in problems beyond the confines of the physics classroom.

Following are two episodes that have helped us connect our physics students to the outside world, again, in the vein of tackling real world problems. The first recounts a UDL project called the Saxby Gale from the perspective of our Physics 122 course. The full description of the project and its impact was first presented in Dealy, Ryan, Fowler, and Flinn (2017). The second is about our work with teachers from Preston Middle school in Fort Collins Colorado and our efforts to bring solar powered light to poor

regions in developing countries. In the years after this initial conversation, Ian and colleagues in Colorado have established a Philanthropic Engineering entity in order to create a network of schools to build and distribute lanterns. It is because of our established ideas around essentials and extensions and the supportive nature of operating as a learning community that we felt we could bring our physics courses into these ventures. Since we knew that we have a core curriculum that all students master by the end of our course, we have the flexibility to take detours down some interesting paths.

Saxby gale and disaster day.

In the fall semester of the 2013-2014 school year a small group of teachers from RHS embarked on an action research project to embed a greater rate of Universal Design for Learning (UDL) among teachers at RHS. This was done by creating an authentic case study that any course could use as an entry point to create rich context in order to teach skills or content. The lead group would work with teachers to incorporate UDL into the project with the hope that these practices would migrate to other courses or areas that the teacher taught. This project became known as the Saxby Gale project. The end of the project culminated in a day in May of student presentations, a mock command center set up by the municipality, students displaying work related to the project in a science fair style, and the Canadian Red Cross practicing the set-up of a disaster center with their local volunteers.

I was part of the lead team that learned about both action research and UDL. With this in mind I wanted to layer this rich learning context onto the idea of engineering in physics class.

Chris: I was thinking about physics and the Saxby project.

Ian: Oh, what were you thinking?

Chris: I know my economics class is going to be involved in some way but I would like to have physics take part too.

Ian: OK, what did you have in mind? The Saxby was a historical event, how would a physics student take part in research or writing about something.

Chris: It looks like we are going to broaden the topic. We want any student involved in the project through a given class to at least have a sense of what happened and that it could happen again.

Ian: I know it was a storm...

Chris: In 1869, Lt Saxby, a British Navel officer and amateur astronomer, predicted that the Bay of Fundy would have higher than normal tides and if a hurricane came up the eastern seaboard it would have a devastating impact on this whole region.

Ian: I am guessing it happened?

Chris: Yeah. Very few people listened to his warning and there was massive flooding all up the Petitcodiac including in Riverview. And, it might happen again.

Ian: Oh? How so?

Chris: We had someone from the Department of Emergency Measures at our last meeting and they talked about a real possibility that we could see even higher tides and flooding. If we had an early start to winter where the ground froze quickly, a winter of heavy snowfalls, with an early and warm spring, there would

be no water captivation into the soil. Combine this with a high tide event and an early season storm and we could see tide levels two to three meters higher than Saxby. And they predict that these conditions could happen every one hundred and fifty years, give or take.

Ian: Oh, so this could happen again? What would be the effect of that on the Town of Riverview?

Chris: Well, we would basically be an island. The two bridges would be submerged. The east and west exits of the town run along the river and portions of those roads would be underwater and then the last exit has a culvert that would only be able to handle half of the water, meaning the road would wash out.

Ian: So we would be cut off from hospitals, airports, highway, and everything until the water receded.

Chris: Yeah. Emergency Measures advise that it would take three days to restore access to roads. Also, there are a few gas stations that would end up below the water line and the old dump would be submerged.

Ian: That is no good. So, how does it fit in physics?

Chris: Well, what if they had to engineer a solution to some aspect of a similar disaster?

Ian: So, like helping in a medical emergency or working with evacuations.

Chris: Yeah, I think we want to brainstorm some ideas of things they could work on but we want them to come up with a solution to a problem that could help people in a disaster situation.

Ian: When do we do this? Where do we work it into our course?

Chris: I think it fits if we maintain the essentials model. We want to have students present in a science fair style on the disaster day and physics students could be part of that. That will take place the end of May.

Ian: OK. So we will move the final project from the end of the course more to the middle of the course. We can still give them the same amount of class time just flip the order a bit. Does that work?

Chris: I think so. They can still work on essential topics if they want but I think most of them will want to work on this project.

Ian: I am curious to see what they will want to work on. So long as we cover the essentials in the course we are good. I wonder if this model gives us the flexibility to do less traditional lecture-and-test style of instruction.

Chris: It might. We will have to be careful not to get sucked in to the project and spend too much time. I think we need to make sure our essentials are solid. A student needs to be OK going into first year physics or engineering.

Ian: Well, if we have a specific date then we know there is a point that it will end. We need to make sure we have enough time to cover the essentials and some other extensions topics but, you are right, we don't want to spend the whole semester on this and making sure that they can be successful next year is key.

Ian and I examined our established essentials to ensure that enough time would be spent over the course that students would be prepared for their first year of university. Once this was established, a timeframe for introducing the topic to students, using instructional time to research and construct projects, and the presentation of projects at disaster day was drafted and given to students. Time was spent in each class

brainstorming problems that would arise in a disaster and teams were created that were tasked with addressing a specific problem. The projects ranged from designing a dam that would control the flow of water, creating a gasoline capture system to be deployed if a submerged fuel tank was compromised, reviewing safety procedures at the sewage treatment facility, designing a pontoon bridge, and establishing a municipal evacuation route that bypassed flooded roadways. In each of these projects, students learned some physics as well as parts of architecture, municipal planning, environmental risk assessments, 3D printing, economic restraints, networking with external agencies, and interpersonal problem solving.

The following conversation took place after students presented their projects and gave Ian and me feedback on the Saxby project.

Ian: How do we think that went?

Chris: I think it went well. I think we could have cut it back a bit in terms of time spent but the students got something different out of the project than just more physics equations, and I think that is what we were going for. You?

Ian: Yeah. The different groups definitely did some interesting work that I would have never been able to teach them. A lot of their comments had to do with learning how to work with other people on a big project and creating their own deadlines.

Chris: Yeah, they are not used to managing big projects like this that take coordination. Did you have any interesting conversations about the science they learned? I know I had a few.

Ian: The dam group spent a lot of time learning about topography and river systems in order to design the dam and then they made a scale model that is about five feet long. When they were talking to the civil engineer they kind of realized how much more the engineer needs to know about things like types of soil and concrete, water pressures and saline levels, and so many things that they would not have considered. It was an eye-opener for some of them that they would study that stuff in engineering.

Chris: I overheard one of the groups making a scale model say something like, "I really like this. I wish I could do this as a job..." and I stopped and said, "You can, you know." I told them about how architecture and engineering firms hire people to make models of products all the time.

Ian: See. When else do they have a chance to act like an architect? When do they get to take a small chunk of time, related to content they have already signed up for, and try something to see if they like it? They don't. I think that is something that these big projects can do for us.

Chris: Allow them to experiment without it costing them a year of university?

Ian: Yeah. And not have to take a full high school course to just try it out. Is there anything that we would change if we did something this big again?

Chris: Uh, it was too long. The group working on the evacuation route were treading water near the end.

Ian: OK. So did they come up with a solution?

Chris: Yes. They spend a lot of time researching the terrain and learning about the economics of building a rudimentary road. They felt like they were done

before the deadline and some of them started working on extensions work. They did come up with a solution based on their research and put together a plan that will be included in the final emergency preparedness report to the town.

Ian: And there were some groups that could have used more time. I wonder if we need to find a way to make sure that there is enough flexibility in the project so that individuals can step away to work on curriculum topics.

Chris: It is finding that balance. I think we want them to engage in large projects that blend engineering and other topics but we need to keep that focus on curriculum too.

Ian: I am happy that they have spent time learning lots of physics beyond a list of equations. This was our first real attempt at trying to break down the silos between the disciplines. I think we need to find ways to do more of this; we need to keep breaking down barriers so students can see that people in the “real world” rarely just work in one discipline.

Chris: I think, too, that it was important for them to have the opportunity to work in something more challenging than a set of word problems. Some students made comments that they learned more about themselves. Some of them said that they need to take more charge of their learning or that they actually want to learn when it is something that they think someone might use.

Engineering Brightness.

In the spring of 2013, Ian traveled to Fort Collins, Colorado, USA to attend and present at Preston Middle school’s annual STEM (Science, Technology, Engineering,

Math) Educator Symposium. From 2013 to 2016 there have been numerous exchanges and collaborations between Riverview High and Preston. One of the most significant collaborations has been the creation of a philanthropic engineering project called Engineering Brightness. The premise of the project is to have students around the world collaborate on the design, fabrication, and distribution of solar charging LED lanterns. Initially, students at Riverview High and Preston Middle designed and manufactured lights that could be sent to students in light-poor areas such as Uganda or the Dominican Republic. This has since expanded into a global network of students and teachers. Following is a representation of my conversation with Ian about how this project found its way into our physics course and subsequent developments.

Chris: How was Colorado?

Ian: It was good. I think we might have made an interesting partner.

Chris: Oh? How so?

Ian: They have some flexibility as a middle school that we seem to not have as a high school and they have started producing these lights. They are solar rechargeable lights that they have designed and are assembling. The idea comes from some students they know in the Dominican that can't study after dark and won't be able to go to university.

Chris: So what do they want our help with?

Ian: We got to talking and they have a design they like and are producing some lanterns but they want to ramp up their production and are interested in RHS students making some new designs. The idea is that we can create a global

network where schools in wealthier nations can help out students who do not have access to consistent light.

Chris: What do we need to do to create these lights?

Ian: They are using 3D printers to create the cases and are buying and building the circuits, lights, and solar cells with parts they are buying.

Chris: We could do that. We have a 3D printer and we could get some parts, I am sure. Most of that stuff is really cheap. We can definitely produce lanterns but I am interested in the design aspect too.

Ian: I agree. I think we could have different levels of engagement. Some students will want to learn how to use software to 3D print. Others will want to just learn to solder and build lanterns. Others will want to take over the process by designing a lantern, building the circuit, and printing a case.

Chris: When do we want students to do this? Physics 12 is the only place where we teach any electricity. Do you think everyone should build a light?

Ian: I think it could be a project in Physics 11 or 12.

Chris: All right. We have said that so long it is physics, it is OK. We can take some time on non-essential days to teach them how to solder on small circuits.

Ian: And they can come in any time during DSB or OSB to learn how to use the 3D printer.

Chris: So we will let students know next semester that they can start working on these lanterns at whatever level they want?

Ian: Yeah. So long as students are completing their essentials, they should be able to work on them through the semester. I don't want to force everyone to work on one but I think that it is a good idea to expose anyone who is interested.

Over the next few years we allowed students to take on the lanterns as a final project in Physics 11 and Physics 12.

Both of these examples show that teachers understanding the purpose of their curriculum can use this model to extend opportunities for students. Whether engaging with local experts or making a difference for students in other countries, curriculums can be used as a spring board for encouraging students to make a difference. It cannot be overstated that establishing essential skills and knowledge for a course does not limit what is taught from the curriculum, but provides focus for additional student support. It also provides the flexibility for teachers and students to engage in greater personalized learning.

Moving beyond a physics class.

As SPR of Assessment and Evaluation at Riverview High, I have the opportunity to work with teachers across the school at improving their assessment practices. I often find myself working with curriculum teams in OSB to plan assessments and, gradually, working with them to implement a version of the essentials and extensions assessment model that meets the needs of their course. Many of our math and science teams have implemented versions of this model that closely resembles what we do in Physics 11. I also teach Philosophy 120 and Economics 120 that have embraced much of the research on assessment to improve student engagement. Lastly I have had the pleasure of working

with Armand Doucet in developing an assessment system for his social studies classes that invite student passions to drive learning. I include these snapshots here to highlight that these ideas about learning communities and assessment can be applied to a variety of academic disciplines.

Math and science.

Many math and science courses have adopted similar assessment and evaluation models at Riverview High. Each system is slightly different depending on whether the course is a graduation requirement, what grade level is being taught, and the content of the curriculum. Even though there is variance some key features remain uniform through each course.

Teachers create sets of essential and extension skills and knowledge drawn from the curriculum document and referenced to the questions asked by DuFour (2006) and Reeves (2002) as described in Chapter Three. Teams of teachers meet during OSB to create these lists and the associated assessments and evaluations. The learning community structure is in place to support teacher conversations about best practices as well as support struggling students. Typically, students not successful on essential content are assigned to DSB to improve their understanding. Through each of these courses students come to understand that the essential skills and knowledge are a requirement to pass the course. While students tend to complain that they do not like the model (because it makes them work harder), teachers see that there is greater student engagement, more understanding of what they need to do to improve their understanding, and an increased rate of success. Most teachers who have adopted this model say they

would not go back to teaching in a more traditional model because this so clearly meets the needs of students that previous systems could not.

Philosophy and economics.

I am fortunate to be the only teacher who teaches Philosophy 120 and Economics 120 at Riverview High. In conjunction with the independence that comes with being the lone teacher to teach a course, Philosophy 120 is a locally developed course written by myself, and the Economics 120 curriculum has not been updated since the early 1990s (there is no date on the document itself). This gives me a fair amount of flexibility to build current assessment research into these two courses.

Building off of the success of the Saxby Gale project and our collaboration with the Town of Riverview, we have been contributing with the town's goal to be designated a sustainable community (Town of Riverview, 2015). A central tenant to the town growing its sustainability practices has been community engagement and the development of an annual think-tank called Sustaina-palooza. This has provided my Economics 120 course a rich opportunity to engage in real-world problem solving. Each year students investigate how to implement policies or create businesses that will improve the economic sustainability of our town or the province. Students are invited to collaborate with town staff and present their ideas in a public forum. Students have looked at topics as divergent as harnessing local tidal power, identifying healthcare policies to support an aging population, regulating the sale of recreational cannabis, and developing an industrial park based on pillars of sustainability. Groups of students select their research projects and, since I have identified the essential skills and knowledge, I

can guide them through their project with informal assessment and mini lessons when and where they need it.

Philosophy 120 was created out of my desire to give more options to students looking to take an academic arts course before university. In Ryan (2014), I describe an assessment system for this course that highly personalizes student ownership and learning based on the same assessment principles articulated throughout this thesis. It is the only other course that I have been exposed to that also employs a “no marks till the end” approach to evaluation. I have been overwhelmed by the consistency of student feedback on how the assessment and evaluation system affects their learning. By only giving specific feedback, with no associated mark, on all assignments and evaluating students through an end of year portfolio and conversation, students have vocalized that they see incredible progress on their learning goals. By collaboratively setting personalized learning targets based on three well-defined outcomes (improving academic writing with argumentation, increasing understanding of citizenship, and improving abilities to read between texts), students can focus on learning rather than getting lost in the noise and minutia of marks.

History and word issues.

In the fall of 2015 Armand Doucet transferred to Riverview High and started teaching Modern History 11. This course is a graduation requirement for a New Brunswick High School Diploma meaning every student needs to take the course. Armand approached me before the semester started in August for help with integrating current assessment practices and ideas of essentials into the social studies courses. He

was particularly interested in bringing together historical thinking skills outlined by the curriculum, student passions, ten skills attributed to the communication revolution from the World Economic Forum (WEF) found in Gray (2016), and flexibility of learning time. Our initial conversation mapped out a semester-long project and assessment plan that incorporated many of the same philosophies that we adopted in the Physics 11 and 12 courses.

The final system he developed is showcased by Armand at <https://www.lifelessonlearning.com/>, and later became a contributing document to his recognition as a Top 50 Finalist from the Varkey Foundation (2017) for their Global Teacher Prize. This assessment system builds on the fact that the essential skills for social studies are identifiable in our social studies curriculum and, largely linked to skills and content themes. Students are tasked with investigating a topic of interest to them and linking it to the content found in class by using identifiable skills. Examples include bridging passions in mathematics and women's rights to learn how warring states have encoded/decoded messages using mathematics or using historical footage of aviation battles to understand authentic Tie Fighter scenes in Star Wars. By bridging the skills from the WEF and curriculum, students conducted research, collaborated in creating knowledge, wrote academic papers, and produced a creative piece that reinforced their social studies learning. By leveraging transferrable skills that link to students' passions, we have seen true growth for all levels of students in our integrated system. By thinking creatively about deadlines and structures that teachers control in a classroom we have given freedom for students to learn without being hindered by arbitrary deadlines or

invalid evaluations. Armand continues to bring this philosophy of systems thinking about assessment and passion to each new course he teaches.

While these results are beyond what Ian and I anticipated would happen when we started learning about assessment, I feel it is important to reiterate that our students are average high school students attending a public high school. I believe that this story can show teachers and administrators how assessment research and implementation can lead to innovation in many traditional settings. While the stated purpose of this thesis is not to propose that this research is generalizable to all other courses or locations, this would be an interesting item for future research.

Overarching Questions and Answers

This section revisits the ten questions presented in Chapter One. Each of these questions needed to be addressed as we created the assessment model. Often these questions were answered in clusters after reading some assessment literature or a set of conversations. Although the answers came after conversations, they were not included as part of the above episodes because we did not come across them in a linear fashion. Often one answer would influence another question or come from multiple sources. I include all of the questions and answers so the reader can easily identify the overlap. These each represent specific questions that many teachers struggle with when attempting to implement changes to an assessment system. Even though the answers seem general enough that they can be applied to many subjects, teachers wishing to make assessment changes need to do so with their particular system constraints and expectations in mind. Teachers looking to implement all or part of this system should use our answers to these

questions as a guideline and not as a standard to follow. While I have helped other teachers, teams, and schools adapt this model to their needs, they have each had to go through the process of identifying the purpose of their courses and their essential skills and knowledge. All conversations about purpose must also happen within the context of the restraints and expectations placed on the learning community team by their school community. Only then can a coherent assessment model be created and, through that process, our answers to these questions may be used as a guide.

1. Should teachers generate marks using the best example of student work, the most recent, the top five scores, or some combination?

Teachers should use the most valid and reliable source of data to determine a mark.

We feel it is important that an assessment system gives students enough time to learn content and then assess them when they are ready. When students do not meet a predetermined standard we give them time to re-learn and re-assess until they have demonstrated the skill or knowledge. We use our final exam to ensure retention and believe the same principle of using the most valid and reliable data should apply. This is why the exam is divided into essential and extension components.

2. If an outcome can only be assessed naturally at one point in a semester, how can teachers allow for more assessment opportunities with limited disruption?

We needed broader support from our administration to create intervention time.

Struggling students need more time to master skills and content and be re-assessed.

With well-crafted essential skills and knowledge we were able to identify specific skills or content that students need to work on. The learning and assessing of

essentials may take many rounds and this can rarely happen during class time.

Weekly interventions supported by teams of teachers across common curricular areas seems to work best. In our model, this is supported by the use of study block systems.

3. What should teachers do if half of the class shows competence on an outcome or unit and the other half does not?

We believe we have well-defined essentials and extensions in a given unit allowing the teacher to simultaneously provide interventions for students who struggle while allowing successful students time to work on extensions material. Building assessments into the unit plan can provide teachers the flexibility needed to address divergent needs in a classroom. We found that defining the extensions topics or project associated with the given unit ensures that students successful with the essentials always have a task. If students are not successful on an extensions topic, the onus of responsibility shifts to the students to remedy their learning. While we still use some whole-class instruction, this model lends itself to flexible small-group learning. We can use stations, flipped classrooms, small-group discovery/near transfer learning, or online learning resources to personalize learning for specific needs.

4. If students are allowed multiple attempts to demonstrate proficiency, is there a limit for top end students as many of them would take a test until they scored 100% and should that same limit still exist for students who are just trying to earn a credit to graduate?

When we use this essentials and extensions model, essentials assessments can and must be re-written until students achieve a mastery level of proficiency. Extensions assessments are written once with no chance of a re-write. This ensures that all students can meet a minimum level of proficiency and earn a credit while allowing a healthy amount of stress to push students to meet deadlines. Philosophically students should be able to learn, assess, re-learn, re-assess, and repeat until they achieve their intended learning target. We found that this becomes an issue of logistics unless we adapt to a model in which the process is built into the assessment system.

5. How can teachers guard against simple memorization while promoting long-term retention and higher order thinking?

Some content is critical for immediate progress in a field and memorization is useful for easing that progress. In other cases memorized content is only useful for future, specialized careers in a given field. This means that memorized content may be essential in some cases and extension in other cases. We use the idea of essentials and extensions to create assessments and evaluations that force students to understand the content at a deeper level than basic memorization. Some learning tasks require memorization as part of the learning process but may not be required on an assessment. We build complex problem solving tasks into our courses forcing students to use content with the hope that this content-specific task will aid in them retaining the content. Additionally, allowing for multiple modes of assessment, such as discussions or presentations, allows us to push students to higher order thinking and not simple memorization.

6. How do teachers incorporate high quality Universal Design into an assessment system?

Universal design for learning is fundamentally about pre-planning instruction and assessment. We created an assessment and evaluation system that establishes essential skills and knowledge, extension content, and multiple means for students to access both sets of content. Any exceptionality or personal interest can be built into such a course. Because the essentials model clearly identifies what needs to be accomplished in a course, the remainder of the course can be tailored to the needs of students with exceptionalities, who miss significant time, or to advanced learners.

7. How can teachers allow more flexible learning environments and problem-based learning when there is a large amount of prescribed curriculum to deliver?

The first step for us was to identify essential skills and knowledge in a course or unit of study. We do not deliver all curriculum in the same format. Extension topics can be learned through online means, explorations, or small group projects. We spend time focusing on explicit, universal skills (writing, scientific inquiry, mathematical modeling) in parallel with content delivery. This allows our students to seek out problem- or project-based learning tasks based on their interests and abilities.

8. How do teachers balance individualization of student learning with maintaining an agreed upon standard of proficiency and content coverage?

Our first step is to identify essential skills and knowledge in a course or unit of study. These established essentials are non-negotiable standards and content that each student needs to master in the course. We individualize with the skills and content that are extension. The same structure can be applied to time in the classroom where students are free to pursue individual interests when they have mastered the essential.

9. How do teachers provide support for struggling students while increasing the standards of performance for all students?

Teachers who are confident that their essential skills and knowledge establish a solid foundation for learning at the next level are able to increase the level of challenge and raise their standards as they are not worried about leaving struggling students behind. I have observed that, when students have well defined targets for their essential learning and reassurance that they have met a basic mark, they are more willing to take risks and rise to a challenge.

10. How do teachers allow students to take more time for learning in a system that has fixed reporting periods?

There needs to be support from administration and communication to parents that progress reports or midterm reports are snap shots of how a student is doing in that instant. We worked with our administration to ensure that they understood our system and expectations. This led to the creation of a letter that is sent home to parents that outlines our philosophy, how students receive feedback, and the assessment system. In our courses, the final mark is what will appear in a transcript. If the final mark is,

at least in part, made from assessments and evaluations that are independent of specific dates, then students will be able to demonstrate their learning throughout the semester and have that reflected on the final mark. Yes, we have concrete deadlines that need to be respected and this is made clear to students and parents. We also build in reasonable flexibility for exceptional circumstances. In our semester system, the first three weeks of DSB in the second semester, students are allowed a final chance to demonstrate essential mastery and earn a course credit for courses that are offered in first semester.

I expect this story of assessment reform and innovation to continue for the duration of my education career. Helping other teachers improve their assessment and evaluation systems has become part of my daily work. This entire story of developing the essential model and the results of its implementation is used in working with teachers and administrators to improve their assessment practices. My experience is that this gives teachers enough perspective to be able to answer the challenging questions that exist in their own environment.

Chapter Seven: Final Reflections and Results

This final chapter provides an answer to the initial research question, “How can classroom teachers work in learning communities to build an assessment and evaluation system at the high school level that incorporates current assessment research and addresses many challenges that teachers face?” To answer this question I present four sections in this chapter that, taken together, describe what I have learned in exploring my story about building our assessment model. The first section details what I have learned about effective learning communities and suggests that, when used effectively, the learning community model can provide supports and structure for teachers looking to improve their practice. The second section discusses how Ian and I leveraged learning communities to build an assessment and evaluation model by incorporating theoretical assessment literature at the classroom level within our classrooms and by taking on an experimental approach with our teaching practices. The third section outlines areas of further research that arise from my learning. I end this chapter with my closing thoughts on expanding this model to other disciplines or jurisdictions.

Effective Learning Communities

In this section I summarize what I have learned about learning communities and how that operating system contributed to the creation of the assessment model. There are specific internal dynamics within PLCs that contribute to forming an effective learning community. These dynamics need to be supported and encouraged by administrative leadership in order for teachers to make changes to instruction. For Ian and I, this supportive climate allowed us to take risks and use an action research approach to making

improvements to our courses. I do not believe we would have been able to create this assessment and evaluation model without this system and its supports in place.

When examining the learning community dynamics that were most influential in building an assessment system, it is clear that having a trusting, collaborative team supported by our administration had the most significant influence. This is consistent with what is presented by Edwards (2012), Prytula (2012), Tidwell, Wymore, Garza, Estrada, and Smith (2011), Melville and Wallace (2007), and Lomos et. al (2011). Discussions about the purpose of teaching and being open to taking risks could not have happened without the professional trust we had established early in our teamwork. The administrative support of creating time in our weekly schedule to collaborate was also key. Having consistent collaboration time fostered our conversations that led to creating this assessment model. If it had not been for structured time in the day to collaborate and work with struggling students, we would not have had the same success in implementing and spreading this model. The success of our model also hinges on time built into the weekly schedule to work with struggling students outside of normal instructional time. The use of systematic interventions within the entire school provided a culture shift that supports this model.

It should also be noted that there is still exploration needed on the effectiveness of learning communities. While Ian and I have found significant success, there are examples in the literature of learning communities (or communities of practice) not meeting their expected goals. First, Storberg-Walker (2008) identifies that the original theory presented by Wenger (1998) does not hold up hold up to theory building scrutiny and may be partially invalid. Some articles, such as Abigail (2016) and Bolam et. al (2005), explicitly

ask whether or not learning communities or communities of practice work. These articles generally reply that they can work so long as conditions such as staff buy-in and adequate resource allocation are in place. The last type of article on this topic outlines potential reasons that learning communities fail as exemplified by Provini (2013). These include insufficient access to data, lack of teacher meeting time, lack of teacher ownership of the process, and a non-collaborative culture. Fortunately, Ian and I were able to establish a collaborative, trusting environment supported by our administration.

Another pivotal reason that I would identify for our success is that we have had internal stability in our curriculum-based team. We have been the only two physics teachers at Riverview High for the past ten years and have both reached a permanent contract status. This has given us the control over what elements of our courses we want to experiment with and the professional autonomy to take measured risks with the goal of improving our practice. I do not believe we would have sustained this success if we were not certain of our job security or the membership of our team was consistently fluctuating. In addition, even though three of our four administrators changed while we were going through this process, they each supported our work to improve our assessment practices and personalize student learning.

Over the course of creating this assessment model, I had the opportunity to work on a formal action research project called the Saxby Gale (Dealy, Ryan, Fowler, and Flinn, 2017), as mentioned above, and have come to regard the action research process as a powerful tool for professionals to improve their practice. This project involved devising a means to increase the use of Universal Design for Learning at the classroom level and publishing these results. The content focus for the project was to investigate what would

happen if a significant rain and flooding event occurred in our community. The goal was for students to engage in a school wide activity where different disciplines would investigate the event from a number of perspectives. An action research framework was used to create the project and collect data. This was my first formal use of action research as described by McNiff (2016).

Reflecting on the conversations that Ian and I had as part of our learning community, it is apparent to me that we were using an action research approach to bring our Physics 11 and 12 courses in line with current assessment and evaluation research. We identified an area for improvement, postulated a solution, implemented the solution, gathered data, reflected on the effectiveness of the solution on the area of improvement, devised a new solution based on our reflections and continued the process. This was an effective tool for our learning community because we trusted each other to take risks in expressing our ideas and in working through solutions in our classrooms.

When I put what I have learned through this research into practice as a teacher-leader in my school, it is to motivate more learning community teams to use action research. I have worked with teams that struggle to operate as a mandated learning community and I would be interested to see if this approach would help them take ownership of their professional development. I wonder if learning communities that take an action research approach would see more teacher ownership through implementing changes based on academic research such as creating an assessment model.

Building an Assessment System

We found that the bridge between learning communities and assessment were DuFour's (2006) four questions about what we teach and Reeves' (2002) three questions that determine criteria for essentials. The idea of essentials became central to our model as this idea helped us to overcome many of the challenges we faced in changing our assessment practices. When examining the answers to the ten challenging questions, it is clear that seven of the answers directly require the identification of essential and extension skills and content. This idea has become foundational to every aspect of our practice and is a major driver in changing the way we interact with students on a daily basis.

I have learned that students can direct their own learning and find their passions in our classrooms when the appropriate dynamics are in place. As we developed these dynamics it became evident to us that it is possible to provide focus for struggling students and liberate students who want to stretch the bounds of the curriculum. I do not have any data to support this but feel that because New Brunswick has a policy of inclusion, it seemed natural that we should be building one bifurcated assessment system (essentials and extensions) that can support all learners regardless of ability or interest. It seems as though all of the unique opportunities we have been able to accomplish with students driving their own work hinges on this concept that all students can learn physics and they each need to take from our class what they need to be successful on their given career or life path.

The last thing that struck me in examining how we implemented the new assessment model was our students' ability to take risks with us and their parents'

willingness to listen to our rationale. If it were not for our students' willingness to adopt a model that changes the focus from lecturing to inquiry this new model would have ground to a halt. Similarly, parents were willing to forgo immediate access to student grades when they were presented a system that would support all student's learning irrespective of ability level or length of time to master the content. Building on the culture of inquiry and collaboration in our learning community we purposefully promoted this atmosphere with students. This culture encourages teachers and students to expand their learning and to take part in opportunities like Engineering Brightness or working on transferable skills like those from the World Economic Forum. The emerging challenge of teaching students skills to collaborate and be creative will need to be incorporated into future assessment models with students at the center.

Further Research

Beyond the above stated need for research on effective learning communities and to understanding how successful communities are fostered, there are two broad ideas that stand out to me in terms of further research directions suggested by this thesis. This is an assessment model that was developed within one high school and is gradually being adapted for use in other disciplines and schools. Is this a model that has broader generalizability beyond the New Brunswick curriculum or beyond exceptional circumstances? I also believe that further research needs to be done on the effects of the assessment model on students. Many students express that they like the model while others do not. I am more interested on learning what the long term effects of using this model are on students' lives beyond high school.

I have had experience working with many teachers across New Brunswick to work through their versions of this model in their classrooms. There are key features from the learning community work that are foundational to this model's success, such as establishing essentials and creating devoted intervention time in the day, but it would be interesting to broaden the scope of systems that this could be applied to. Are there general characteristics that all education systems contain that either constrain changes assessment systems or other characteristics that could be leveraged to advance teaching practices? Versions of this assessment model have been used in many science and math courses at the grade eleven and twelve level. What adaptations would need to be made in other subject areas or grade levels to achieve similar results in student achievement and individual learning? And, recognizing that there are other teachers working to improve their assessment practices, how can this model continue to adapt in order to better meet the needs of students and continue to incorporate ongoing improvements in assessment theory? By answering these questions, we might be able to develop a more refined understanding of assessment and evaluation that could be used to create a more robust model. I hope that these answers would build upon our list of ten questions from Chapter One and the associated answers in Chapter Six. I expect that more questions and answers would be generated that contribute to this list.

The long term effects of using this model are unknown. Ian and I have heard anecdotal feedback from a number of students that support our use of the model. Students report that they have success at the post-secondary level, have found passion in their lives, and have become active citizens in their community. We also received this feedback before implementing this model of assessment. With our limited resources, we

do not have the means to measure the effect of the model once students graduate. This would require a longitudinal study controlling for, at least, socio-economic status, post-secondary attendance, achievement levels in high school, and extra- and co-curricular involvement in high school. A control group would also need to be established at another high school as all students at Riverview High now experience this model in all biology, chemistry, economics, electronics, math, and physics courses. I would recommend that one of the driving questions in a longitudinal study of this nature should be around student maturity and achievement. Students often complain that this model requires them to do more work and then support the model when it gives them flexibility in taking ownership of their learning. Teachers often comment that students do much more focused work and are learning content at a deeper level than in previously used models. This seems to raise questions such as: When do students understand the effort needed in their own learning? How can teachers determine if instruction has a long-term impact on their students? How can we foster student interests across curricular areas that carry forward into adulthood? Ian, I, and other colleagues often ask these questions but have no way of determining the answers.

Final Considerations

My stated goal for writing this thesis was to explore the thought process and systems that contributed to our success in creating an assessment system. This arose from my concern that, while I was reading ample literature on assessment, I found little discussing how teachers and school leaders are to implement these ideas at the classroom level. My experience in working with classroom teachers is that new assessment

literature can rub up against constraints teachers come across from various policies and expectations with little explanation in the literature of the ‘how’ of assessment change. My hope is that I have interwoven narratives about my own experiences with the literature on assessment and learning communities in a way that demonstrates that teachers can incorporate suggestions from the literature to overcome the constraints they encounter. Many of these dynamics come from effective learning communities.

While this thesis is not intended to be used as a guidebook for implementing assessment change, there are things that others can learn from my process. In my opinion, the key aspects to create this system are establishing essential skills and knowledge, building a collaborative environment, understanding the purpose of the course curriculum, and encouraging students to pursue their own interests. Teachers looking to create an assessment model that uses an essentials and extensions format that can deliver similar results need to accept that the first versions of answers to Dufour and Reeves’ questions need to be fluid. The answers will change. In this way teachers will be able to adapt to their particular system restraints. I have seen this model applied to many content areas by emphasizing skills and content that are appropriate to a particular situation. I expect that if teachers take the time to understand the challenges that are specific to their locality while adopting a culture of inquiry and exploration, they will develop a model that meets their needs and achieves unanticipated results, as we have.

Bibliography

- Abigail, L. K. M. (December 01, 2016). Do communities of practice enhance faculty Development?. *Health Professions Education*, 2, 2, 61-74.
- Barrett, P. (February 01, 1986). The Learning Community. *Industrial and Commercial Training*, 18, 2, 12- 16.
- Baumeister, R.F., & Newman, L.S. (1994). How Stories Make Sense of Personal Experiences: Motives that Shape Autobiographical Narratives. *Personality and Social Psychology Bulletin*, 20, 674-690.
- Bennis, W. G., & Biederman, P. W. (2007). *Organizing genius: The secrets of creative collaboration*. Reading, MA: Basic Books.
- Black, P., & Wiliam, D. (1998). Inside the Black Box. *Phi Delta Kappan*, 80,2. 139-148.
- Black, P., Harrison, C., Hodgen, J., Marshall, B., & Serret, N. (May 01, 2010). Validity in Teachers' Summative Assessments. *Assessment in Education: Principles, Policy & Practice*, 17, 2, 215-232.
- Bloom, B.S. (1984). The 2 sigma problem: The search for methods of group instruction as effective as one-to-one tutoring. *Educational Researcher* 13, no. 6: 4–16.
- Bolam, Ray, McMahon, Agnes, Stoll, Louise, Thomas, Sally, & Wallace, M. (2005). *Creating and Sustaining Effective Professional Learning Communities*. (Bolam, Ray and McMahon, Agnes and Stoll, Louise and Thomas, Sally and Wallace, M. (2005) *Creating and Sustaining Effective Professional Learning Communities*. Department for Education and Skills. ISBN 1 84478 460 6.) Dept. for Education and Skills.

- Boston, C., & ERIC Clearinghouse on Assessment and Evaluation. (2002). *The concept of formative assessment*. College Park, MD: ERIC Clearinghouse on Assessment and Evaluation.
- Boud, D., & Molloy, E. (September 01, 2013). Rethinking models of feedback for learning: the challenge of design. *Assessment & Evaluation in Higher Education*, 38, 6, 698-712.
- Brewer, J. D. (2000). *Ethnography*. Buckingham: Open University Press.
- Buffum, A., Mattos, M., & Weber, C. (2009) *Pyramid Response to Intervention: RTI, Professional Learning Communities, and How to Respond When Kids Don't Learn*. Bloomington: Solution Tree.
- Burgstahler, S. (2010). Equal Access: Universal Design of Instruction A Checklist for Inclusive Teaching University of Washington, College of Engineering UW Information Technology College of Education
- Burke, K. (2010). *Balanced Assessment: From Formative to Summative*. Bloomington: Solution Tree.
- Butz, D., & Besio, K. (September 01, 2009). Autoethnography. *Geography Compass*, 3, 5, 1660-1674.
- Champy, J. (2006). *Reengineering management: The mandate for new leadership*. Pymble, NSW: HarperCollins e-books.
- Chappuis, S., Stiggins, R, Arter, J and Chappuis, J. (2006). *Assessment for Learning: An Action Guide for School Leaders*. Portland: ETS Assessment Training Institute.
- Christie, M., Grainger, P., Dahlgren, R., Call, K., Heck, D., & Simon, S. E. (2015).

- Improving the quality of assessment grading tools in master of education courses: A comparative case study in the scholarship of teaching and learning. *Journal of the Scholarship of Learning and Teaching*, 15, 22–35.
- Clandinin, D., Pushor, D., & Orr, A. (January 01, 2007). Navigating Sites for Narrative Inquiry. *Journal of Teacher Education*, 58, 1, 21-35.
- Connelly, M.F., & Clandinin, J. D. (1990). Stories of Experience and Narrative Inquiry. *Educational Researcher*, 19(5), 2-14.
- Creswell, J. W. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, CA: Sage.
- Davies, A., Herbst, S., & Reynolds, B. P. (2008) *Leading the Way to Marking Classroom Assessment Work*. Courtenay, BC: Connections Pub.
- Davies, A. (April, 2011). Assessment workshop for District 2. Moncton NB.
- Davies, A., Herbst, S., & Busick, K., (2013). *Quality Assessment in High Schools: Accounts From Teachers*. Canada: Connect2Learning.
- Davies, A., Busick, K., Herbst, S., & Sherman, A. (2014). System Leaders Using Assessment for Learning as Both the Change and the Change Process: Developing Theory from Practice. *Curriculum Journal*, 25, 4, 567-592.
- De Lissovoy, N., Campos, E., and Alarcon, J., (2013) Challenging Epistemological Authority in Qualitative Research An Emancipatory Approach. In T. M. Kress, C. Malott, and B. Porfilio (Eds.), *Challenging Status Quo Retrenchment: New Direction in Critical Research* (29-51). Charlotte, NC: Information Age Publishing, Inc.

- Deal, T. E., & Peterson, K. D. (1999). *Shaping school culture: The heart of leadership*. San Francisco: Jossey-Bass Publishers.
- Dealy, D., Ryan, C., Fowler, P., and Flinn, M. (2017). Hosting the Saxby Gale at Riverview High: Using Disaster Day to Teach Universal Design, Increase Student Engagement, and So Much More. In Sherman, A. (Ed.), *Universal Design for Learning Action Research*, New Brunswick Department of Education and Early Childhood Development: Fredericton, NB. January 2017.
- Denzin, N. (1997) *Interpretive Ethnography: Ethnographic Practices for the 21st Century*. Thousand Oaks, CA: Sage Publications.
- Doucet, A. (2016, June 18). Life Lesson Learning. Retrieved from <https://www.lifelessonlearning.com/home>
- DuFour, R. (2006). *Learning by doing: A handbook for professional learning communities at work*. Bloomington, Ind: Solution Tree.
- DuFour, R., & DuFour, B. (September, 2007) NBTA/District 2 Presentation. Moncton NB.
- Edwards, F. (2012). Learning Communities for Curriculum Change: Key Factors in an Educational Change Process in New Zealand. *Professional Development in Education*, 38, 1, 25-47.
- Gardner, J. W. (1988). *Leadership, an overview*. Washington, D.C. (1828 L St., N.W., Washington 20036: Leadership Studies Program, Independent Sector.
- Gezie, A., Khaja, K., Chang, V. N., Adamek, M. E., & Johnsen, M. B. (2012). Rubrics as a tool for learning and assessment: What do baccalaureate students think? *Journal of Teaching in Social Work*, 32, 421–437.

- Grainger, P., & Weir, K. (2016). An alternative grading tool for enhancing assessment practice and quality assurance in higher education. *Innovations in Education and Teaching International*, 53, 73–83.
- Gray, A. (2016, January 19). *The 10 skills you need to thrive in the Fourth Industrial Revolution*. Retrieved from <https://www.weforum.org/agenda/2016/01/the-10-skills-you-need-to-thrive-in-the-fourth-industrial-revolution/>
- Gudmundsdottir, S. (2001). Narrative research on school practice. In V. Richardson (Ed.), *Fourth handbook for research on teaching* (pp. 226-240). New York: MacMillan.
- Guskey, T. R., & Bailey, J. M. (2001). *Developing grading and reporting systems for student learning*. Thousand Oaks, Calif: Corwin Press.
- Guskey, T. (2009). *The teacher as assessment leader*. Bloomington: Solution Tree.
- Hackmann, D. G., Walker, J. M., & Wanat, C. L. (2006). A Professional Learning Community at Work: Developing a Standards-Based Principal Preparation Program. *Journal of Cases in Educational Leadership*, 9, 3, 39-53.
- Hamilton, M. L., Smith, L., & Worthington, K. (January 01, 2008). Fitting the Methodology with the Research: An exploration of narrative, self-study and auto-ethnography. *Studying Teacher Education*, 4, 1, 17-28.
- Hammer, D. (1995). Student Inquiry in a Physics Class Discussion. *Cognition and Instruction*, 13, 3, 401-30.
- Hammersley, M. (1990). *Reading ethnographic research: A critical guide*. London: Longman.
- Hammersley, M. (2001). On Michael Bassey's Concept of Fuzzy Generalisation. *Oxford*

Review of Education, 27, 2, 219 – 225.

Hattie, J. (2012). *Visible learning for teachers: Maximizing impact on learning*.

London: Routledge.

Heflebower, T. (2009). Proficiency: More Than a Grade. In T. R. Guskey (Ed.), *The Teacher as Assessment Leader* (pp. 111-133). Bloomington, IN: Solution Tree.

Heikkinen, H. L. T. (2002). Whatever is narrative research? In R. Huttunen, H. L. T.

Heikkinen, & L. Syrjälä (Eds.), *Narrative research: Voices from teachers and philosophers* (pp. 13-25). Jyväskylä, Finland: SoPhi.

Heikkinen, H. L. T., Huttunen, R., & Syrjala, L. (January 01, 2007). Action research as narrative: five principles for validation. *Educational Action Research*, 15, 1, 5-19.

Hord, S. M., & Educational Resources Information Center (U.S.). (1997). *Professional learning communities: Communities of continuous inquiry and improvement*.

Austin, Tex: Southwest Educational Development Laboratory.

Kouzes, J. M., & Posner, B. Z. (1999). *Encouraging the Heart: A Leader's Guide to Rewarding and Recognizing Others*. The Jossey-Bass Business & Management Series. Jossey-Bass Inc. Kouzes, J. M., & Posner, B. Z. (2012). *The Leadership Challenge: How to Make*

Extraordinary Things Happen in Organizations. Hoboken: Wiley.

Kyrtziz, A, & Green, J. (1997). Jointly Constructed Narratives in Classrooms: Co-construction of Friendship and Community Through Language. *Teaching and Teacher Education*, 13(1), 17-37.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*.

Cambridge England: Cambridge University Press.

- Leithwood, K., Harris, A., & Hopkins, D. (2008). Seven strong claims about successful school leadership. *School Leadership and Management*, 28, 27–42.
- Lomos, C., Hofman, R. H., & Bosker, R. J. (2011). Professional Communities and Student Achievement-A Meta-Analysis. *School Effectiveness and School Improvement*, 22, 2, 121-148.
- Louis, K. S., Kruse, S. D., Bryk, A. S., & Educational Resources Information Center (U.S.). (1994). *Professionalism and community: Perspectives on reforming urban schools*. Washington, DC: U.S. Dept. of Education, Office of Educational Research and Improvement, Educational Resources Information Center.
- McNiff, J. (2016). Action research for professional development: Concise advice for new action researchers. Retrieved from <http://www.jeanmcniff.com/ar-booklet.asp>
- Marzano, R. (2010). *Formative Assessment & Standards-Based Grading: Classroom Strategies that Work*. Bloomington: Solution Tree.
- Meisels, S.J., S. Atkins-Burnett, Y. Xue, D.D. Bickel, and S. Son. (2003). Creating a system of accountability: The impact of instructional assessment on elementary children's achievement test scores. *Education Policy Analysis Archives*, 11, no. 9.
- Melville, W., & Wallace, J. (2007). Metaphorical duality: High school subject departments as both communities and organizations. *Teaching and Teacher Education*, 23, 1193–1205.
- Moen, T. December (2006). Reflections on the Narrative Research Approach. *International Journal of Qualitative Methods*, 5, 4.
- Moen, T., Gudmundsdottir, S., & Flem, A. (2003). Inclusive Practice: A Biographical

- Approach. *Teaching and Teacher Education*, 19, 359-370.
- Muhammad, A. (September, 2009) NBTA/District 2 Presentation. Moncton NB.
- Murray, M. (1997). A Narrative Approach to Health Psychology. *Journal of Health Psychology*, 2, 1, 9-20.
- Nanus, B. (1995). *Visionary leadership: Creating a compelling sense of direction for your organization*. San Francisco: Jossey-Bass.
- Nyquist, J.B. (2003). The benefits of reconstructing feedback as a larger system of formative assessment: A meta-analysis. Master's thesis, Vanderbilt University, Nashville, TN.
- O'Connor, K. (2007). *A Repair Kit for Grading: 15 Fixes for Broken Grades*. Boston: Pearson Assessment Training Institute.
- Pole, C., & Morrison, M. (2003). *Ethnography for education*. Buckingham: Open University Press.
- Polkinghorne, D. E. (1995) Narrative configuration in qualitative analysis. In J. A. Hatch & R. Wisniewski (Eds.), *Life history and narrative* (pp. 5-24). London: Falmer Press.
- Provini, C. (2013). Why Don't Professional Learning Communities Work? *Education World*. Retrieved from http://www.educationworld.com/a_admin/professional-learning-community-pitfalls-best-practices.shtml
- Prytula, M. P. (2012). Teacher metacognition within the professional learning community. *International Education Studies*, 5, 4, 112-121.
- Reeves, D. B. (2002). *The leader's guide to standards: A blueprint for educational equity and excellence*. San Francisco: Jossey-Bass.

- Reeves, D. B. (2004). The Case against the Zero. *Phi Delta Kappan*, 86,4, 324-325.
- Reaves, D. (August, 2010). NBTA/District 2 Presentation. Moncton NB.
- Reeves, D. (2011). *Elements of Grading: A Guide to Effective Practice*. Bloomington: Solution Tree.
- Rodriguez, M.C. (2004). The role of classroom assessment in student performance on TIMSS. *Applied Measurement in Education* 17, no. 1: 1–24.
- Ryan, C. (January 01, 2014). Changing the philosophy of education with an education in philosophy. *Antistasis*, 4, 2, 38-42.
- Sadler, D. R. (June 01, 1989). Formative assessment and the design of instructional systems. *Instructional Science: an International Journal of Learning and Cognition*, 18,2, 119-144.
- Savin-Baden, M., & Van, N. L. (2007). Narrative Inquiry: Theory and Practice. *Journal of Geography in Higher Education*, 31, 3.
- Senge, P. M. (1990). *The fifth discipline: The art and practice of the learning organization*. New York: Doubleday/Currency.
- Slavin, R.E. (1987). Mastery learning reconsidered. *Review of Educational Research* 57, no. 2:175–213.
- Stiggins, R. (2005). From Formative Assessment to Assessment FOR Learning: A Path to Success in Standards-Based Schools. *Phi Delta Kappan*, 87, 4, 324-328.
- Stiggins, R. (May 01, 2007). Assessment through the Student's Eyes. *Educational Leadership*, 64, 8, 22-26.
- Stiggins, R. J., Arter, J. A., Chappuis, J., & Chappuis, S. (2007). *Classroom assessment*

for student learning: Doing it right -- using it well. Upper Saddle River, N.J:
Pearson Education, Inc.

Storberg-Walker, J. (August 01, 2008). Wenger's Communities of Practice Revisited: A
(Failed?) Exercise in Applied Communities of Practice Theory-Building
Research. *Advances in Developing Human Resources*, 10, 4, 555.

Talbert, J. E. (2002). Professionalism and politics in high school teaching reform.
Journal of Educational Change, 3, 339–363.

Tidwell, D. L., Wymore, L., Garza, A., Estrada, M., & Smith, H. L. (2011). Creating a
Professional Learning Community through Self-Study. *Studying Teacher
Education*, 7, 3, 315-330.

Town of Riverview (2015). Integrated community sustainability plan. Retrieved
from [http://www.townofriverview.ca/en/ourcommunity/IntegratedCommunity-
Sustainability-Plan.asp](http://www.townofriverview.ca/en/ourcommunity/IntegratedCommunity-Sustainability-Plan.asp)

Varkey Fondation (2016, December 13). Congratulations to our top 50 finalists.
[Blog]. Retrieved from [http://www.globalteacherprize.org/top-50-shortlist-
announced-us-1million-global-teacher-prize-2017/](http://www.globalteacherprize.org/top-50-shortlist-announced-us-1million-global-teacher-prize-2017/)

Wheatley, M. J. (2006). *Leadership and the new science: Discovering order in a chaotic
world.* San Francisco, Calif: Berrett-Koehler.

Wiliam, D. (2011). *Embedded formative assessment.* Bloomington: Solution Tree.

Winey, T., & Howe, J. (2012). The Neighborhood STEM School: Creating a Better
World. Retrieved from [https://www.amle.org/BrowsebyTopic/WhatsNew/
WNDet/TabId/270/ArtMID/888/ArticleID/15/.The-Neighborhood-STEM-School-
Creating-a-Better-World.aspx](https://www.amle.org/BrowsebyTopic/WhatsNew/WNDet/TabId/270/ArtMID/888/ArticleID/15/.The-Neighborhood-STEM-School-Creating-a-Better-World.aspx)

Winter, R. (2001). Truth or Fiction: problems of validity and authenticity in narratives of action research. *Educational Action Research*, 10, 143-154.

Appendix A: Complete Assessment and Evaluation Model

Presented here is a description of our complete assessment model. It is stripped away from our philosophy of teaching and the supporting literature to give the reader a clear picture of how all of the classroom pieces fit together. This represents the culmination of our assessment work and is here so teachers can incorporate aspects of this model into their own practice. I cannot emphasize enough that teachers will have greater success implementing this model only after they go through the hard work of identifying their essential skills and knowledge from their curriculum and enlist administrative support for changes to their practice.

This complete assessment system was first presented and published at the Global Learn Conference with the Association for the Advancement of Computing in Education (Ryan, 2016). Each assessment component has an important role in addressing teacher concerns, providing student feedback, and allowing for personalized learning through the course. It is the strength of implementing these pieces together that allow the system to work in addressing the constraints that teachers face in fully applying assessment research on a course wide or school wide scale.

The components are unit tests, lab experiments, a final exam, and an engineering project. Portions of tests, exam, and labs are designated as essential. Students are required to achieve complete mastery of essentials content and skills and doing so earns them a passing mark, 60%, in the course. Portions of tests, and exams are considered extension. In addition to these pen and paper extension assessments, extension labs and an engineering project create the remainder of student grades. The extensions portion is, thus, worth 40% of a student's mark.

Unit tests are administered over a two or three day block of time. The essential portion of a test is given to all students at the same time. Questions consist of word problems and short answer responses that are aligned with the core concepts found in the unit of study. Since the test is short, students complete it, hand it in to be marked, and receive their marked test back within one period. While students are waiting, they work on extensions questions for the coming extensions test. Students who respond correctly to each question continue to work on extensions material. Students who respond incorrectly to one or more questions correct their work. At this point they are encouraged to access their class notes, a textbook, or work with a peer. Students then conference with their teacher on corrected questions where they are asked a follow-up question to ensure they have a deep understanding of the skill or concept. Students unable to answer the question are required to continue this process of reading, learning, and discussing until they prove their understanding of every question. This continues until they have answered every question correctly. This may take several conferences for more challenging fundamental concepts and this often takes place during Designated Study Block.

Extensions tests are scheduled two days after essentials tests. This allows time for students to conference and work on extensions questions as needed. This gap day allows students to gain confidence heading into more challenging or novel questions, gives teachers time to address any major concerns that arose during the essentials test, and gives more time for struggling students to demonstrate understanding of fundamental concepts. Completing the essential test may take longer than this period of time for some students. There are no time constraints for when this understanding of foundational

knowledge can be demonstrated, as specified by Davies, Herbst & Reynolds (2008), O'Connor (2007), and Stiggins (2005).

The extensions test is written by all students in one class period and evaluated soon after. Extensions tests consists of a variety of questions. Some are more challenging, some combine multiple concepts, and others are novel questions that build from the examples done in class. This is the primary opportunity for students to practice solving challenging and novel problems in preparation for the extensions exam.

For purposes of mark generation at a given period of time, an essentials test is weighted at 60% and the extensions test at 40%. The mark generated by this combined test is recorded but does not count for the final course mark. It is used as an administrative tool to communicate to students, parents, or other education professionals a student's progress. It does not factor into marks that students receive on their transcripts. This is a formative tool that teachers use to give feedback to students on how to improve. As this is identified by Burke (2010), Chappuis, Stiggins, Arter, & Chappuis (2006) and Hattie (2012) as a consistently effective method of increasing student achievement, it is critical that this formative assessment not be attached to the evaluative component of a mark. Students and parents are made well aware of this shift in philosophy in the first days of the course, while understanding that a mark can be generated, if needed, for things like post-secondary schools or scholarships.

In an effort to cover more content, labs are often squeezed out of the traditional physics class or turned into demonstrations. To accommodate this, students engage in essentials and extensions labs teaching essential skills and extensions content. All students complete four essentials labs and submit a group lab report. These labs are

designed to encourage students to focus on the essentials of acting like a scientist. The focus of the feedback from the teacher is on how students can improve on the essentials skills of designing a lab, gathering data, interpreting data, and technical writing. There is no mark given for these labs as students are expected to perfect these skills through the course.

There are between eight and ten extensions labs available to work on throughout the course. The purpose of these labs are for students to be exposed to small packets of content through a variety of learning styles. Students complete these labs in less than one half hour and are typically done over a DSB, OSB, or noon hour. Students complete these as individuals or in small groups and are evaluated through a short discussion. Students are given a pro-rated mark based on completion so that if students completed seven of eight they earn an 8.75 out of ten as their extension lab mark.

The final exam consists of two essential components and one extensions component. Essential components take one week to conduct and consist of all essential content from the essential unit tests and the essential skills from the essential lab experiments. The extensions component consists of a series of questions similar to the extensions unit tests and is scheduled during the normal exam writing period. This three part exam is administered over the last four weeks of the course as seen in Figure 1.

Final Weeks – Evaluation Period			
	Essentials week	Flexible weeks	Exam week
Priority one		Complete essentials	
Priority two		Design, build, and present an engineering project	
Priority three		Extension exam preparation.	
Timeframe	One class period for the essentials word problems and each of the lab components.	Flexible time for students	Standard exam

Figure 1: Evaluation timeframe

The first week is devoted to having students complete the essential portion of the exam. On the first day students write their first attempt of the essentials exam, which is similar to the essentials unit tests. These are assessed and returned to the students in the same manner as the essentials unit test. The following three days are used to assess students' abilities in the essentials lab skills. Individual students demonstrate lab skills of interpreting a graph, collecting data, and writing a portion of a report. Students waiting for lab equipment have the opportunity to conference with the teacher on essential exam questions, practice extensions questions for the extensions exam, or work on their engineering project.

The second and third week of this block is student directed and devoted to extensions work. This includes teachers lecturing curricular topics deemed extensions that have not yet been covered. Students have class time to practice extensions questions for the exam or work on their engineering project. Often, students alternate between these options along with completing essentials exam questions. Since a student cannot pass the

course without earning a 100% on all portions of the essentials exam, every student is given class time to conference to demonstrate proficiency.

The engineering project is designed as a unique opportunity for students to pursue a personal interest. The purpose of this project is for students to act like an engineer by defining a problem and then researching, designing, and building a solution. As this is an extension component, not all students are required to complete a project. Students often start this project earlier in the semester as more involved projects will take longer than two weeks to complete.

The extensions exam is written by all students during the regular exam period. This is an exam similar to the extensions tests. The questions are a mix of challenging, multi-concept, and novel problems. The exam is marked as a traditional exam with scores incorporated in transcript marks.

All components of students' exams are used in determining transcript marks. Students have had the entire semester to receive feedback and make improvements as per Davies, Herbst and Reynolds (2008). Teachers are confident that there is long term retention of the essentials skills and knowledge. In this model a final mark is calculated by having the essentials portion of the exam worth 60% (a pass), the extensions portion of the exam worth 20%, extensions labs worth 10%, and an engineering project worth 10%. Because students have multiple opportunities to demonstrate their understanding of the fundamental concepts struggling students have a means to focus their time and effort on fundamental skills and knowledge to earn a credit. Stronger students, meanwhile, have abundant opportunity to extend their learning through individual interests or advanced content.

Appendix B: Timeline of Events in Creating the Assessment Model

This timeline is intended as a guide to the reader to understand how events unfolded in creating the assessment and evaluation model presented in this thesis.

Fall of 2007: District 2 teachers build on Richard DuFour and Douglas Reeves work.

All teachers gathered together to establish a list of essential learnings in each grade and course.

Winter of 2008: District teachers revisit essential learnings.

All teachers were invited back to Moncton high to refine their lists of essentials.

Spring of 2008: Introducing Rollercoasters

Ian and Chris discussed how to engage students taking Physics 11 in an engineering capacity. Students were tasked with building and testing small rollercoasters. Students started building rollercoasters in the next semester, Fall of 2008.

Winter of 2008: The purpose of teaching and learning Physics.

Ian and Chris have a series of conversations about the purpose of students taking Physics.

This results in a deep understanding that there are some fundamental concepts and skills that students should learn regardless of their life path.

Summer of 2009: First attempt at teacher collaboration time.

School based administration created a schedule to have all teachers meet weekly to work in curricular teams.

Winter of 2009: Discussing Rube Goldberg Machines.

Ian and Chris discussed how to build on the success from the rollercoaster project and settled on students designing and building Rube Goldberg machines to showcase their understanding of Physics. Students built them for the first time in Spring of 2009.

May 2009: Disruption #1 changes the way we view problem solving.

Students using Smart Boards forces Ian and Chris to change how we think about problem solving as a teaching tool.

Fall of 2010: Second attempt at collaborative time.

School based administration created a schedule to have dedicated teacher collaboration time as well as devoted Tier Two intervention time. Students could be Directed to a Study Block to receive interventions.

Academic year of 2010 – '11: Disruption #2 brings assessment literature into physics.

Reading 2010-2011 Davies (2008), Burke (2010), Guskey (2001, 2009), O'Connor (2007), Reeves (2002, 2004), and Stiggins (2005, 2007), and attending a workshop by Davies (2011) helped to spawn a new thinking of essentials.

February of 2011: Essentials mean a sixty percent

Through conversations with other teachers and building on the assessment literature reframes the thinking that earning a credit in a course should mean mastering the essentials.

Spring of 2011: Global Essentials from ELA to physics

Ian and Chris had a conversation about how ELA is different than physics which sparked an epiphany that global essentials could be established in Physics 11.

April of 2011: Students can personalize their learning with engineering.

Ian and Chris discuss the prospect of students having to define and solve their own engineering problem in place of the Rollercoaster and Rube Goldberg projects. This idea is incorporated into the courses in September of 2011.

May of 2011: No Marks till the end.

Faced with uncertainty of how to implement the assessment changes they seek, Ian and Chris broach the final topic of the final exam and transcript marks. Deciding that the final exam will be composed of essential and extension components is the final piece that fits all of the changes together. The plan is implemented September of 2011 with Ian and Chris team teaching all Physics 11 courses that semester.

Academic year 2013 – '14: Disruption #3 brings UDL and thinking bigger.

The Saxby Gale project is launched school wide and the Physics classes can engage because they are using the essentials model of assessment.

Academic year 2013 – ‘14: Engineering Brightness.

Ian and Chris partner with Preston Middle School in Fort Collins, CO to build Engineering brightness. This has led to a global collaboration increasing personalization of learning embedded in the Physics courses at RHS.

Curriculum Vitae

Christopher Ryan

Universities attended: University of New Brunswick (2005, B. Philosophy in Interdisciplinary Leadership), Saint Thomas University (2006, B. Education)

Publications:

Dealy, D., Ryan, C., Fowler, P., and Flinn, M. (2017). Hosting the Saxby Gale at Riverview High: Using Disaster Day to Teach Universal Design, Increase Student Engagement, and So Much More. In Sherman, A. (Ed.), *Universal Design for Learning Action Research*, New Brunswick Department of Education and Early Childhood Development: Fredericton, NB. January 2017.

Ryan, C. (January 01, 2014). Changing the philosophy of education with an education in philosophy. *Antistasis*, 4, 2, 38-42.

Ryan, C. (2016). Filling an Assessment Literature Gap: A Systemic Example of Formative Assessment in a High School Physics Course. In *Proceedings of Global Learn 2016* (pp. 52-64). Association for the Advancement of Computing in Education (AACE).

Fogarty, I. & Ryan, C. (2017). Bringing Assessment Research to Practice Using an Essentials Model. In J. Cummings, & M. Blatherwick (Eds.), *Creative Dimensions of Teaching and Learning in the 21st Century*. Boston. Sense Publishers.

Conference Presentations:

Creative Connections Conference at University of New Brunswick, November 2017.

Association for the Advancement of Computing in Education Global Learn Conference,

April 2016.

Riverivew High BrainSTEM Symposium, April 2017.

Preston Middle School's STEM Educator Symposium in Fort Collins, Colorado, USA,

April 2015.

University of New Brunswick/Rothesay Netherwood Learn2Learn conference in

Rothesay, NB, July 2013 and July 2014.

New Brunswick Teacher's Association Subject Council Day, 2011, 2012, 2013, 2015