CONSTRUCTIVIST ASSESSMENT & EVALUATION IN SECONDARY SCIENCE

How do Ontario Secondary School Science teachers who have demonstrated leadership and expertise in the area of constructivist learning theory enact assessment and evaluation?

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Abstract

Numerous articles discuss and subsequently decide whether constructivism is good or bad pedagogy. My question is which is it? In the literature review, one brings out the principles as well as multiples misuses, misapplications and misconceptions with regards to what practically constitutes constructivist learning. Following, and the objective of this particular research paper, is a shift focusing on constructivist assessments and evaluations. The purpose of this study then is to explore how Ontario Secondary School Science teachers demonstrating leadership and/or expertise in constructivism enact this framework when assessing and evaluating students. In this qualitative research, two participants were interviewed using semi-structured interviews and the data was analyzed using Bloom’s revised taxonomy as a conceptual framework, existing literature including constructivist principles, and the recent Ontario Growing Success assessment document. Findings showed that constructivist assessments allow students to develop higher-order thinking and become independent autonomous learners, but can also be fickle and challenging to implement without the presence of particular factors. These factors result in the implications and recommendations provided to diverse educational actors at the end of this paper.

Key Words: Constructivist principles, Science assessment, Secondary school, Revised Bloom's taxonomy, Growing Success assessment for/as/of learning.
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Chapter 1: Introduction

1.0 Research context:

Conventional transmissive teaching has many disadvantages. Even if students (taught in the traditional way) score well on standardized tests, they are often unable to use memorized facts and formulae in real-life applications outside school (Boaler, 1998; Yager, 1991). They are unaware where school knowledge is applicable to the real world (Saunders, 1992) and forget their rote learning over time (Yager, 1991). Hence, to avoid what Freire (1994) refers to as banking education model, the educational shift has been more towards constructivist learning where students are active participants in constructing their own knowledge and hence they become their own independent learners by which they learn how to analyze, question, critically think, inquire, collaborate, and research. Constructivist learning theory mainly then focuses on teaching students ‘how to learn’ skills to become autonomous learners (Gray, 1997).

Literature on the concept of constructivism in learning though has been fragmented and unclear, so much that teachers and educators may find it hard to define ‘effective’ constructivist teaching, let alone assess and evaluate it (Baviskar, Hartle, & Whitney, 2009). The gap may result from either neglecting the use of constructivist learning theory or misusing it. The former implies going back to only using what Freire (1994) refers to as banking education model where students are seen as passive blank slates by which teachers transmit information to be stored or memorized (Gordon, 2009). The latter misuse implies using solely pure unguided constructivist teaching where accommodating students takes over challenging them, reaching standards and covering content in depth (Nykiel-Herbet, 2004).

1.1 Research focus and problem:

The focus in this paper is on how teachers assess and evaluate their students in ways that align with constructivist learning theory. The reason the focus is on assessments per se is there is a lot of research talking about constructivism when it comes to pedagogy, so adding onto this line of research will not benefit as much. Also, in real life, people continuously go through assessments and evaluations by for example submitting resumes, writing cover letters, answering application skills questions, going through diverse interviews, giving presentations, going through standardized testing (ex: MCAT, CFA), and continuously proving themselves and their capabilities. People professionally develop and construct knowledge and skills, hence showing Kincheloe’s (2000) point that knowledge about the world does not simply exist out there waiting
to be discovered, but is rather continuously constructed by people in their interaction with the world. Hence constructivist experiences should provide opportunities for students to demonstrate their comprehension and skills in diverse ways (Windschit, 1999). So by looking at teachers’ assessments and evaluations tools and techniques, the study can reveal how constructivism can help students develop skills and knowledge needed when they are similarly assessed later on in real life. Implementing these various assessments may prepare students for these real world evaluations, but they need to be in a meaningful context that is relevant to students and they need to go beyond initial information levels by elaborating using in-depth research and analysis (Brooks 1999).

From this study’s focus, the research problem is teachers having a limited understanding of constructivism to begin with and/or when they implement assessment, they may not be doing it in ways that align with constructivist theory. While teachers are knowledgeable in the discourse surrounding constructivism, research suggests that their understanding and practices do not necessarily follow suit. This may be due to the briefly aforementioned misuse or misconceptions towards this learning approach (Nykiel-Herbet, 2004), need for professional training (Alesandrini & Larson, 2002), the notion that constructivism may seem counterintuitive to summative assessments, and/or other reasons shown in the research review (discussed in Chapter 2: literature review). Subsequently teachers may feel a tension. In this context, the purpose of my research is to learn how a sample of teacher-leaders in the area of constructivist learning theory are enacting assessment within constructivist models of teaching and learning.

1.2 Purpose of Study:

Murnane and Frank (1996) reveal that skills taught by schools today are not sufficient for high school graduates in an increasingly changing, challenging workplace. Surveys consistently show that many high school graduates still do not meet standards in a variety of academic areas, as well as in employability skills such as attendance, teamwork and collaboration, and work habits. (Peter D. Hart Research Associates, 2008; Dion & Maldonado, 2013). Students have mastered the basics and can be understood but often seem unable to move beyond this functional level (higher-cognitive skills). The purpose of this study then is to show whether and/or how assessments and evaluations that follow the constructivist learning framework can help students become self-directed higher-order thinkers and prepare them for their subsequent educational stages.
Assessing and evaluating using constructivist learning approach reveals though that teachers should first value and apply constructivism when teaching. According to Bandura (1986), an individual’s decisions throughout his/her life are strongly influenced by his/her beliefs. Hence teacher beliefs play a major role in teacher decision-making about curriculum and instructional tasks (Nespor 1987; Pajare, 1992). In addition, relating this to assessments, Cresswell (1996) and Broadfoot (1996) state:

Any analysis of different national assessment systems will quickly reveal a wide variety of assessment techniques and approaches. All of these systems have their strengths and weaknesses in relation to technical, resource and time considerations and in their impact on the associated education system. Even if it were possible, in a given context, to start completely afresh in devising an assessment system, there is no universal best technical practice that could be adopted. Instead, the choices made in devising assessment systems inevitably reflect the values and priorities of the broader social context in which they are made (IBO, 2004, p. 4).

1.3 Research Questions:

The main question guiding this research inquiry is how a sample of Ontarian Secondary school Science teachers who have demonstrated leadership and expertise in the area of constructivist learning theory enact assessment and evaluation in their teaching?

Subsidiary questions include:
- What does constructivist-learning theory mean to these teachers in theory and practice?
- How do these teachers conceptualize the meaning and role of assessment and evaluation within constructivist learning theory?
- What instructional strategies, approaches, and practices do these teachers enact to assess students’ work following constructivist framework? What supports and challenges do they encounter and how do they respond to these?
- What experiences and factors informed these teachers’ development of confidence and competence in this area?
- What outcomes do these teachers observe for their students as a result of these approaches?

In addition, I used Bloom’s revised taxonomy as a conceptual framework in this research.
1.4 Researcher background (reflexive positioning statement):

My interest in this topic is due to some personal experience. I am Egyptian in origin and I went to three different schools in Cairo. I started by going to a national school in Egypt where the Ministry controls the curriculum and evaluation. I remember my teachers taught me in a very passive teacher-centered way and I remember I had to memorize in order to get the best grades in my exams. I do not recall assessment for or as learning much. Every other year there would be Ministerial exams where external examiners come in and give out exams. We would take these exams more seriously and the teachers would teach to it. The other years in between were exams set by the schools themselves and the examiners were our own schoolteachers (but not our own class teacher). The class teacher would come in once if we have questions to ask. Examinations were the only evaluation tool in the school (no assessment for or as learning). The way to rank was to get the full marks and the way to get those was by who can memorize more. I do not remember relevance, objective communication, or inquiry-based learning on the purpose behind learning specific lessons or unit. Though the structure focused on mere memorization, this system taught me other good habits in dealing with pressure and challenges by studying a more bulky curriculum (ex: perseverance, self-regulation, automaticity, structure). Hence it still developed good working habits/attitudes I am grateful for.

By around ninth grade, I switched schools and went to an American division in another school. At this point my parents started thinking about university outside of Egypt. They were told switching to a school with American division and doing the SAT exam would help. In addition to exams set by the teachers themselves, this system focused on more constructivist evaluation approaches like artistic projects and essay writing. However I did not feel like I was learning any material or I struggled to learn through assessments in order to prepare for evaluations. I do not remember rubrics or checklists shared. There was emphasis on projects but I felt I was at a disadvantage for not being as artistic as my peers. It felt like there were constructivist evaluation tools, but it lacked context sometimes or relevance (so maybe not constructivist after all) and it did not usually follow guided constructivist teaching to begin with. I felt we spend too much time on projects to the point we did not cover much content by the end of the term. Also I felt that the system lacked eliciting prior knowledge (ex: result of switching schools and switching systems), differentiating instruction, or guided constructivist teaching to train myself to critically
think. It also increased focus on process over product that seems like a good track, however I felt that the pace in covering course material was very slow. As a result, the purpose of constructivist evaluation seemed useless and confusing.

By eleventh grade, I again switched to another school where I did the International Baccalaureate diploma (IB). Until this day I am thankful for such a program in that, I perceive, it implemented constructivism through guidance. I remember it was very demanding but it prepared me well when I entered my first year in McGill University. I remember teachers figuring out my strengths and weaknesses, clearly communicating those with my parents and myself, and focusing on working on my weaknesses through accommodation and guidance. I remember feeling ‘opened up’ during these two years and being surprised at the diverse skills and ways I can show my work. There were numerous constructivist assessment opportunities and constructivist evaluation tools. Tasks were relevant and authentic, objectives were communicated, and guidance was provided. For example, in Business course, we had two exam papers and a project due. The first paper focused on a seen case study (i.e. discussed previously in class), the second focused on new analytical questions and case studies, and the research project taught us to get in touch with a real organization and write a report on it. Hence the program had a good mix of tests with diverse types of questions (Bloom’s revised taxonomy which will be discussed in Chapter 2 literature review), performance tasks and authentic assessment pieces. The IB program evaluated us in two ways: internal and external assessments. The external were the two/three exam papers at the end of the two-year IB program, and internal were other performance-based tasks. Both evaluations took place in the second year, giving teachers some time to formatively assess and continuously guide students to improve to the demanded task standards (assessment of and as learning). So we had a clear goal to reach in two years for each subject group and for each task in each subject. I find this system integrated differentiating instruction while applying constructivist formative assessment to monitor progress to prepare in time for these summative external and internal evaluations. It was not preparing to merely a standardized close-ended test as the exams themselves had analytical questions, so I remember memorization was not the way to go (unlike in my former national system). Hence though it was a struggle to start building skills from 11th grade, I found that time was my chance to basically catch up as well as teachers’ guidance differentiating to my need and parental support.
Having these three experiences, plus my education in universities and my practicum experiences throughout, I can see through diverse lens. My last practicum was a high school placement teaching 11th grade university Chemistry and 12th grade university Biology. I am thankful that by interviewing teachers for this research study and comparing what they mentioned to what I pursued when teaching high school students, I can relate to their views including the benefits and challenges they brought up. I found that constructivist assessment, especially as a beginner teacher, can be overwhelming, but structuring one step at a time can help. Hence through my experiences as a student, researcher, teacher candidate, and my life in Egypt and Canada, my interest in exploring constructivist assessment is growing. It is perceived as one of the biggest difficulties new teachers deal with when entering the job, and misapplication or challenges in applying it may be one of the reasons behind low student preparation for post secondary education. Multiple factors need to be considered with the most important being the role of teachers and the obstacles realistically faced. That is why I seek to explore this further with Ontarian Secondary school Science teachers who demonstrated expertise or leadership in applying constructivist framework in their assessment and evaluation.

1.5 Preview of Whole:

To respond to the research question and sub questions, I conducted a qualitative research study using convenience sampling by interviewing two Ontario secondary school Science teachers. I investigated how they understood constructivist learning, and how they assessed and evaluated in ways that align with this framework. In addition, I used Bloom’s revised taxonomy as a conceptual framework by which I analyzed findings.

In chapter 2, I reviewed the literature on constructivist learning theory with its principles, pedagogical implications, teachers’ understandings and practices, challenges, misconceptions, and outcomes for students. Then I shifted focus specifically on assessment and evaluation looking at assessment structures including constructivist assessments and Bloom’s revised taxonomy, assessment modes including formative and summative, Growing Success document’s assessment for/as/of learning, students’ culture, and assessment tools such as standardized tests, performance assessment, authentic assessment, and portfolios. I also looked at assessment challenges including accountability, policy versus practice, criterion-based assessments, nature of subject, the relation between process and product, and assessment pros and cons.
In chapter 3, I elaborated on the research design. In chapter 4, I reported my research findings developing themes I interpreted through the process of data analysis while using Bloom’s revised taxonomy as conceptual framework. Finally in chapter 5, I discussed the findings and their significance in relation to the literature, and shared implications for other educational actors and for my own practice as a beginning teacher, an educational researcher, and an aspired future educational reformer. I ended by providing some recommendations and suggesting areas for further studies.
Chapter 2: Literature Review

2.0 Introduction:

This literature review consists of two parts. The first shows constructivism from a learning theory to a pedagogical practice. This section includes different theorists, existing misconceptions, teachers’ role in applying this learning framework, constructivist principles in teaching, benefits and challenges teachers face, and constructivist insights and students outcomes.

The second part examines the main aspect behind the research question focusing on assessment and evaluation. So the focus is on assessment modes and tools, constructivist aspects in assessment, and assessment challenges.

Part 1 – Constructivist Learning & Pedagogy

2.1 Theory of Constructivism:

Constructivism is a theory of knowledge in which humans actively engage in making meaning and building knowledge by manipulating, creating, and exploring the new information to fit their belief systems and prior experiences (Cooperstein & Weidinger, 2004). Knowledge is not passively received but is actively constructed by the learner (Savasci & Berlin, 2012, Wheatley, 1991). With a practical lens, students do not come to class as blank slates waiting to be filled with information but rather with diverse knowledge impacted by their environment, culture, and surroundings (Kincheleoe, 2000).

2.1.1 Constructivist learning theories:

There are multiple forms of constructivism including personal, social, behavioral, cultural, radical and others. These revolve around the concept that the learner is active in constructing his/her own knowledge (Piaget, Vygotsky, Dewey, Maria Montessori).

John Dewey stressed the idea that the child’s own experience must be acknowledged as the heart of both the content and the process of education (Ultanir, 2012). He rejected the notion that schools should focus on repetitive rote memorization and emphasized that education needs to be grounded in real experience by which students can only learn through directed living. Hence students need to engage in real-world authentic workshops to be provided with opportunities to think for themselves and creatively construct knowledge (Ultanir, 2012). On a similar note, Maria Montessori states that a student chooses what he wants to be involved with as well as how long and with whom. The freedom of decision spheres students within the discipline
inherent within themselves, encourages problem-solving skills, and teaches independence (Lopata, Wallace, & Finn, 2005).

Furthermore, Piaget (1970) also found that learning occurs through construction of meaning rather than passive transmission and that learning takes place around an activity that is relevant and engaging. He believed that learning is based on cognitive schemes or mental structures by which people organize their perceptions of their environment (Derry, 1996). Learners organize concepts and ideas into schemes, and construct these schemata by testing new information against their prior knowledge. They then apply the information to a new situation followed by integration of the new knowledge (Ultanir, 2012). Two key adaptation concepts that created the individual’s construction of new knowledge are assimilation (interpreting events in terms of the person’s existing cognitive structure), and accommodation (changing/reframing the cognitive structure to make sense of the environment) (Fosnot & Perry, 1996). Piaget emphasized constructivist aspects with a focus on students discovering relationships and ideas through autonomous activities (Piaget, 1970; Ultanir, 2012). Here children are in control of the knowledge provided to them and construct their own learning by exploring.

However, where Piaget emphasized learning as an internal process through personal constructivism, Lev Vygotsky stressed environmental, social, and cultural influences through social constructivism. Though they both emphasize learners are active participants in their own learning, Vygotsky’s social development theory is based on the ideas that human learning is dependent on interactions between a learner and an expert within the learners’ zone of proximal development; a zone where learners can almost, but not quite, complete a task alone (Vygotsky, 1980). This expert can either be a teacher, an adult, or a more knowledgeable peer. In addition, Bruner extends Vygotsky’s social constructivism concept by the term ‘scaffolding’ which is the temporary support that a more knowledgeable other gives a learner to construct and extend his skills (Jonassen, 1999). As the learner gains competence, the support is gradually removed.

2.1.2 From Theorists Views to Teachers Roles:

As briefly mentioned, literature on constructivism has been fragmented and unclear, so much that teachers and educators may find it hard to define ‘effective’ constructivist teaching, let alone assess and evaluate it (Baviskar, Hartle, & Whitney, 2009). Cooperstein and Weidinger (2004) even mentioned; “While theorists like Dewey, Piaget, Bruner, Vygotsky, Kolb, Maria Montessori are often cited as the foundation of active lessons, a careful study of the concepts
proposed by these educational theorists reveals that these theorists meant much more by active learning than providing hands-on activity, encouraging class participation, or having students move around the room. Active learning as prescribed by these theorists, and more appropriately called constructivist or discovery learning, moves from experience to learning and not the other way around. Constructivist learning is inductive and it dictates that the concept follows the action rather than precede it” (p. 141).

Since constructivism is a theory of learning, not a theory of teaching, constructivist pedagogy is referred to as the creation of class environments, activities, and methods that are grounded in a constructivist theory of learning, with goals that focus on individual students developing deep understandings in the subject and habits of mind that aid in future learning (Richardson, 2003; Yilmaz, 2008). Though there is a great body of information with regards to constructivism, the features of effective constructivist teaching are not really known (Yilmaz, 2008). Subsequently constructivist teaching, built on constructivist learning theory, is a set of prescriptions that challenge the transmission or banking education models. Experiential learning, self-directed learning, discovery learning, inquiry training, problem-based learning, and reflective practice are examples of constructivist learning models (Gillani 2003; McLeod 2003; Slavin 2000). This enhances understanding subject matter and, along with exposure to multiple sources of information, provides opportunities for students to show their knowledge and skills in varied ways (Windschit, 1999).

As a result, constructivist teachers are facilitators rather than lecturers. They become one of many resources that the student may learn from and not the primary source of information, engage students in experiences that challenge previous conceptions of their existing knowledge, allow students some thinking time after posing questions, encourage the spirit of questioning by asking thoughtful open-ended questions, encourage thoughtful discussion among students, use Bloom’s taxonomy cognitive terminology (ex: ‘classify’, ‘analyze’, ‘create’) when framing tasks, and extend learning beyond the classroom (Gordon, 2009). Pondering students’ concepts, misconceptions, modes of thinking, and responses, these teachers appropriately shift their teaching methods or content when needed.

In addition, constructivist teachers inquire about students' understanding of concepts before sharing their own understandings, provide time for students to construct relationships, encourage thoughtful discussion among students, and encourage and accept student autonomy
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and initiative. They are also willing to let go of classroom control, promote student leadership and taking actions as a result of the learning process, and encourage students to suggest causes for events and to predict consequences (Brooks & Brooks, 1993). Through authenticity, they extend learning beyond the classroom, do not separate knowing from the process of finding out, and insist on clear expression from students because when students can communicate their understanding then they have truly learned. Constructivist teachers nurture students’ natural curiosity through frequent use of the learning cycle model that consists of discovery, concept introduction, and concept application (Brooks & Brooks, 1993). Hence this type of pedagogy involves a new way of thinking that takes time, effort and commitment. More importantly the success of the learner depends on teacher’s knowledge, beliefs, and actions when pursuing this type of pedagogy (Brooks & Brooks, 1993).

2.2 Constructivism Misconceptions:

2.2.1 Teachers Misunderstandings:

The truncated literature on the effectiveness of constructivist approaches may be due to misunderstanding or misapplication in integrating important aspects of different constructivist theorists and applying them in practice. By isolating some theorists’ viewpoints and focusing solely on the concept of one over the other (ex: social over personal constructivism), it may lead to different student outcomes and generalize the impact of constructivism in class. Misapplication in practice may be due to a similar reason. By using only one or two constructivist teaching aspects without integrating the others, this may lead to different student outcomes and generalize effects. That may be why scholars and teachers have a whole pile of literature with some proving constructivist effectiveness in practice and others proving ineffectiveness.

Some misunderstandings include the erroneous notion that constructivist learning is a kind of ‘anything goes’ approach, that it stands for one type of pedagogy (either child-centered or pure discovery, or hands-on learning), that the process is prioritized over the end-product (or the skills over the knowledge), that teachers no longer need to have expertise in a particular body of knowledge, and that teachers’ experiences and knowledge are not legitimate resources that can be used to evaluate constructivist pedagogy (Gordon, 2009). Constructivist theories have been mainly descriptive rather than prescriptive by dictating teachers what not to do rather than what
to do. There is an emerging fallacy that constructivist learning theory in which the learner is cognitively active translates into one in which the learner is merely behaviorally active (Gordon, 2009). Other fallacies include since constructivism is assumed as pure student-centered approach then it must be on the opposite side of subject-centered or teacher-centered instruction (Baines & Stanley, 2000), and knowledge is seen as only relative in which students do not need to be held to rigorous academic standards anymore. As a result, constructivist lesson plans do not have to have all the stages or principles required by this approach (Baviskar et al., 2009).

In addition, misuse results from educators tending to confuse constructivism as a theory of knowing with a theory of teaching. For example, teachers confuse the need of the child to construct his/her own knowledge with a form of pedagogy that sees it as the child’s responsibility to achieve that (Rowe, 2006). Educators focus on the action of the student in the construction rather than the action of the teacher in engaging with the child’s misconceptions and structuring experiences to challenge those misconceptions (Rowe, 2006). Constructivism actually requires the teacher is to intervene vigorously and systematically which is done on the basis of his/her excellent knowledge of a domain, of knowledge of student conceptions and misconceptions in that domain, and use of high quality formative assessments. That way the teacher still ensures that the child’s construction of knowledge leads him/her to a more correct understanding of the domain (Rowe, 2006).

Furthermore, another misunderstanding may be due to treating constructivism and explicit teaching as mutually exclusive teaching strategies: at the same time constructivist approaches have been promoted, direct teaching methods have been criticized and dismissed as inappropriate, with the suggestion that they simply do not work and are dull and boring for learners (Westwood, 1999). The message that most teachers appear to have absorbed is that all direct teaching is old-fashioned and should be abandoned in favor of student-centered inquiry and activity-based learning. The problem arises more when constructivist-learning activities precede explicit teaching, or replace it, with the assumption that students have adequate knowledge and skills to efficiently engage with constructivist learning activities designed to generate new learning (Westwood, 1999).

2.2.2 Guided versus Unguided Constructivism:

Though Kirchner et al. (2006) mention that constructivist learning description is accurate, the instructional consequences suggested by constructivists do not necessarily follow. Instructors
often design unguided instruction that relies on the learner to discover or construct essential information for themselves (Kirchner et al., 2006,). However, a constructivist class should have balance between teacher-directed and student-directed learning, requiring teachers to take a very active role in the learning process, including formal teaching (Gordon, 2009). Dewey reveals that in education extremes are dangerous and that teachers and educators should avoid approaches that either marginalize students’ needs and experiences or focus entirely on these factors. In constructivist classes, the ‘authority’ of knowledge still rests heavily on teachers’ own knowledge and experiences, and this pedagogical approach raises the bar for students by demanding far more from them than teacher-centered models (Gordon, 2009). Kincheloe (2001) further argues that teachers and students should not disregard information generated by others, but that schools should place less emphasis on the simple acquisition of predigested facts and more on the ability to interpret and make sense of ideas and experiences students encounter.

Furthermore, with teacher-centered pedagogy, teachers are referred to as authority figures transmitting knowledge, yet in discovery child-centered models, teachers are facilitators. However in a study where teachers in South Africa received a manual to be constructivist and applied it, following these teachers’ actions in being constructivist, Nykiel-Herbet (2004) eloquently revealed that in pure unguided discovery constructivist teaching, teachers are actually ‘baby-sitters’ allowing students to do whatever they want (ex: talk to peers, explore and discuss). She summarizes ineffectiveness through the following points; “the attitude of learners constructing their own knowledge encourages the uncritical acceptance of what they know as inherently right and valid; the belief that all pupils can learn, while undoubtedly true, is meaningless without spelling out learning standards and expectations; the primacy of hands-on learning can severely undermine the importance of reasoning especially in higher grades; the idea of social learning in practice turns too easily into socializing; and catering to each individual student’s interests, needs and preferences comes dangerously close to abandoning the standards of performance for all, and renders the idea of accountability essentially useless” (p.262). Subsequently many constructivist lesson plans are transformed into ‘un-constructivist’ lessons. The result of Nykiel-Herbert’s study is teachers returned to the old traditional banking education teaching method since their perceived constructivist approaches (i.e. unguided discovery) did not lead to increased student outcomes (in fact student outcomes worsened). This also reveals an aforementioned point not to treat direct instruction and constructivist learning as mutually
exclusive; in fact constructivism has been questioned as an effective approach in differentiating instruction since some students need direct instruction and cannot be left to discover with no guidance.

2.2.3 Our Brain and Guided constructivism:

Relating our own brain architecture with the effective way of being constructivist, Kirschner et al. (2006) mention that a pure-discovery approach requires the learner to search or solve a problem, but that actually puts heavy demands on the working memory to the point that it is not available to ‘learn’ by switching this knowledge and skills to the long-term memory. This leads to minimal impacts on long-term memory and student learning. The goal of instruction is rarely simply to search for or discover information, but to give learners specific guidance about how to cognitively manipulate information in ways that are consistent with a learning goal, and to store the result in long-term memory (Kirschner et al., 2006). In fact, if constructivism is merely pure discovery, then learning is idiosyncratic and a common instructional strategy is ineffective. In fact unguided constructivism may have negative results when students acquire misconceptions or incomplete knowledge (Nykiel-Herbet, 2004).

In addition, another constructivist assumption is the prioritization of process (skills) over product (knowledge), and resembling formative assessment over summative assessment. Yet, Kirschner et al. (2006) find this view led to unguided practical work and the rejection of instruction based on facts, laws, and theories that make up a discipline’s content. The emphasis on practical application of what is being learned seems very positive, but it is an error to assume that pedagogic content is identical to methods/processes of the discipline being studied and a mistake to assume that instruction should exclusively focus on application (Hodson, 1988). Pure discovery may confuse the teaching of a discipline as inquiry with teaching by inquiry, and the fallacy is there is no distinction between for example behaviors/methods of an expert practicing a profession and those students who are novices to the discipline (Kirschner et al., 2006).

Moreover, novice learners do not have enough knowledge in their long-term memory to prevent unproductive problem-solving search. They need extensive guidance that can only be relaxed with increased expertise, which is when knowledge in long-term memory takes over from external guidance (Kalyuga, 2003). This may relate to the varying degree of student scaffolding, gradually teacher’s external guidance will be replaced with the student’s own long-term memory.
2.3 Constructivist Four Teaching Principles in Practice:

Although there are differences in definition and understanding that lead to some of the aforementioned misuses, there are four main pedagogical principles in constructivism that more or less are agreed upon and that follow from the aforementioned theorists’ views on constructivism: learners construct their own meaning, new learning builds on prior knowledge, learning is enhanced by social interaction, and meaningful learning develops through ‘authentic’ tasks (Cooperstein & Weidinger, 2004). Practically then, there are four critical constructivist stages that must be addressed in the activities, structure, content and context of a lesson (Baviskar et al., 2009).

First is eliciting prior knowledge; if the educator or teacher does not have a mechanism for eliciting students’ prior knowledge, the new information cannot be gainfully presented in a way that can be incorporated within the students’ constructs. In addition, if the student’s attention is not drawn to his/her prior knowledge, then the learner will either ignore the new knowledge or incorrectly incorporate it (Baviskar et al., 2009). This may follow Dewey’s and Montessori’s point that the student’s own experience must be acknowledged as the heart of both the content and the process of education.

Furthermore, the second criterion is creating cognitive dissonance in which the learner needs to be made aware of a difference between his/her prior knowledge and the incoming new knowledge (Inch, 2002; Sewell, 2002). Cognitive dissonance is the mental discomfort experienced by an individual who holds two or more contradictory beliefs at the same time or the individual is confronted by new information that conflicts with existing ideas. Constructivist theory states that knowledge possessed by an individual is connected in a comprehensive construct of facts, concepts, experiences, emotions, values, and their relationships with each other, yet if this construct is insufficient or incorrect when compared with ‘new’ information the individual is gathering from the environment, the individual will experience cognitive dissonance (Lorsbach & Tobin, 1993). This motivates the individual to eliminate dissonance by either rejecting the new information or incorporating it into his construct (Sewell, 2002). This may relate to Piaget’s cognitive schemata in that learners adapt their constructions through assimilation or accommodation.

In order to make changes to the knowledge construct permanent, the learner must apply the changed construct to novel situations, receive feedback about the validity of the construct
from other sources, and establish further connections to other elements in the construct (Baviskar et al., 2009). This introduces the third criterion application of the knowledge with feedback in that misinterpretation or rejection of new knowledge is likely if the student does not interpret and modify prior knowledge within the contexts of new knowledge (Windschitl, 2002; Yager, 1991). In addition, feedback is an important instructional tool and motivational factor which is logical because if students are to function as self-regulated learners, they need opportunities to assess their progress in understanding content or mastering skills (Good and Brophy, 1994). The application of knowledge may reveal some of Dewey’s and Montessori’s points about the value of authentic tasks, and feedback may relate to Vygotsky’s and Brunner’s scaffolding and the value behind social interaction.

The last fourth criterion is reflection on learning in that once the student has acquired new knowledge and verified it, the student needs to be made aware of the learning that has taken place (Windschitl, 2002; Yager, 1991). Thus he/she needs to be provided with an opportunity to express what he/she learned. This relates to an earlier point that the concept follows the action. Cooperstein & Weidinger (2004) further mention that to capitalize on principles of constructivist learning, students need time to reflect on what they have discovered. Logically, learning involves moving information from the short-term memory, where it can stay for only a few minutes, to the long-term memory, where it will stay forever. Transferring information to the long-term memory requires attention, organization, and repetition (Kirschner, Sweller, & Clark, 2006). Reflection stage in constructivist classes emphasizes this by reviewing key concepts at the end of the session (rather than beginning) to fix information in the long-term memory and cut forgetting curve. Thus the end of the session may be a better time when abstract terms can be attached to concrete activities through a PowerPoint (Cooperstein & Weidinger, 2004).

2.4 Teacher Studies:

2.4.1 Student outcomes:

As mentioned in the previous chapter, conventional transmissive teaching has many disadvantages. Even if students (taught in the traditional way) score well on standardized tests, they are often unable to use memorized facts and formulae in real-life applications outside school (Boaler, 1998; Yager, 1991). They are unaware where school knowledge is applicable to the real world (Saunders, 1992) and forget their rote-learning over time (Yager, 1991). Boaler (1998)
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presented a study on high school students in Math classes at two different schools, one grounded in constructivism and the other in traditional pedagogy. Students in constructivist class did not know more math than those in the traditional class. However they were more willing to learn, able to interpret different situations, develop meaning, gain a deeper understanding of procedures and when to use them in real life. Hence constructivism orients students towards values like student growth, interest, and agency. However this view differs between studies. For example, in a second study, there is evidence that exclusive emphasis on constructivist approaches to teaching are neither initially nor subsequently in the best interests of any group of students, and that explicit teaching needs to precede constructivism to ensure students have basic knowledge and skills before engagement in constructivist learning activities (Rowe, 2006).

Furthermore in a third study, though theoretically it seems ideal that students build a growth mindset and inquiry skills as teachers use constructivist learning framework in their practice, results show that students respond otherwise. In a study by Savasci & Berlin (2012), four high school Science teachers (who were participants in the study) revealed that the most widespread factor influencing their practice was student behavior and ability. For example, one teacher shared that students wanted to do worksheets so that they could be easily and quickly completed rather than do inquiry activities that would require more time and a higher level of thinking. Another teacher, on a similar route to having direct teaching precede constructivist inquiry, believed that inquiry-type lessons associated with constructivism were more appropriate for high-level students and that students need lectures and notes to better understand the content and guide their inquiry in the right path. Other two teachers elaborated saying that even though they assigned open-ended projects, students were used to being spoon-fed everything and seeking quick solutions. So students look for the easiest way to get the easiest answer so they do not have to work with it anymore. Hence they would do the minimum to answer the question and be done with it. Subsequently according to teachers’ views in this study (middle and high school science teachers), generally their students did not want to get challenged but sought quick answers requiring little thought or effort. Hence students did not appreciate teachers’ constructivist learning practices.

2.4.2 Teacher challenges or influential factors:

Though many teachers are in favor of adopting constructivist instructional approaches, they are unsure of where to begin (Gilakjani, Leong, & Ismail; 2013). The learning that is
captured within a constructivist environment is pictured as more student-centered, collaborative, minds-on, authentic and experiential. For some teachers, this rings with the magic of beanstalk growth, while others will be dissatisfied with a perceived lesser role of coach or facilitator (Gilakjani et al., 2013). In a constructivist environment the best hope for the educator is in the possibility of intervening in the learning that is occurring, rather than being in charge (Petraglia, 1998). This may be a cause for anxiety for teachers and uncertainty develops (Gilakjani et al., 2013). Another challenge is the assumption that constructivist teachers are viewed as the “anything goes” type, that using constructivism is equated with low structure, and that permissiveness may interfere with students' construction of meaning. Hence to help students become creative, some kind of discipline and structure must be provided (Wilson, 1997). So as the teacher relinquishes control over content, pacing, and specific activities, students need corresponding increases in decision and performance support. However poorly planned learning environments are vulnerable to failure due to lack of support, leaving students feeling stranded and faced with unreasonable performance expectations (Gilakjani et al., 2013). This problem is complicated by the fact that learners differ dramatically in their need for guidance. Hence dealing with these constant new situations increases tension and anxiety on the teacher’s part.

Furthermore, relating to an aforementioned point about students’ response towards teachers’ usage of constructivist approaches, teachers revealed that students prefer the easy way and/or be told the right answer. Hence an influential factor was student behavior and ability that, along with teachers relinquishing control over content and pace, may lead to class management issues and poor student outcomes. In addition, other challenges or influential factors are school type and grade level. Savasci & Berlin (2012) reveal that teachers in lower grades may use more constructivist-like, student-centered activities such as concrete, hands-on activities to reflect the developmental level of their students. In contrast, high school teachers tended to use more teacher-centered activities such as lectures, worksheets, and videos/demonstrations with their high school students. This is due to the belief that middle school teachers should understand the developmental uniqueness of young adolescents and should be as knowledgeable about their students as they are about their subject. In contrast, teachers in high schools may employ a more content-focused, teacher-centered approach reflective of their goals and beliefs in transmission, efficiency, rigor, and examination preparation (Tobin & McRobbie, 1996; Savasci & Berlin, 2012).
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2012). This may further correlate with how teacher beliefs impact their practice (Bandura, 1986; Savasci & Berlin, 2012).

Moreover, school type such as public or private was another influential factor on teachers’ use of constructivist approach (Savasci & Berlin, 2012). All teachers mentioned the influence of the district curriculum based on mandated content standards and standardized testing. However public school teachers were more vocal about its impact on their constructivist practice than private school teachers (Savasci & Berlin, 2012). The private school teachers had more autonomy to modify their curriculum and instruction as needed. However private school teachers still reported more parental influence on their curriculum and instruction since teachers there tended to be more responsive to parental interests and concerns (Savasci & Berlin, 2012).

In addition to curriculum flexibility and parental involvement, teacher practice either in a public or in a private school may depend on some other factors including school resources and facilities, the nature of students, and class size. Teachers in private schools may have more resources and facilities, more motivated students with interests, educated parents, and small class sizes (Savasci & Berlin, 2012). As a result, it may be more challenging for public school teachers to implement constructivism in their classrooms compared to private school teachers.

Lastly how teachers are trained to be constructivist is another key challenge. Teachers are trained verbally through courses without much emphasis on the practical experience or realistic contexts they face (Nykiel-Herbet, 2004). Trainings basically consist of introducing the new constructivist terminology and explaining the design and structure of the curriculum framework itself. The change in the curriculum (making it more inquiry-oriented using constructivist wording) will not get translated into effective practice unless and until the teachers get a better grasp of the content knowledge, become fluent in instructional procedures suited to teaching particular areas of content and specific skills (Nykiel-Herbet, 2004). If that does not take place, teaching using constructivist learning framework becomes present using ideological rather than pragmatic grounds. For example, returning to Nykiel-Herbet’s (2004) study on South African teachers shows the government introducing a new curriculum that is constructivist in nature. Subsequently, to implement it, teachers set up their class environment to suit a constructivist learning framework. However the intended recipe for educational success turned into a new variety of educational malpractice, producing another generation of illiterate, innumerate South Africans (Nykiel-Herbet, 2004). The reason is teachers were trained on the
new constructivist curriculum through crash courses and they were left to come up with their own materials in class. Hence teachers faced many of the aforementioned challenges (ex: student misbehavior) and misused some of constructivist principles (ex: students prior knowledge was seen as always right and the main knowledge). The result was even lower student outcomes than when they used the chalk and talk method (i.e. the traditional method of teaching), and subsequently many teachers decided to return to using the banking educational model.

2.4.3 Constructivism and Motivation:

Ryan and Deci (2000) distinguish between extrinsic and intrinsic motivation. Extrinsic means performing an activity in order to gain a separate outcome (ex: physical reward). Intrinsic motivation is doing an activity for internal satisfaction. The latter is crucial in constructivist learning as it is not the teacher but the learner who is his own motivator (Palmer, 2005). In this case, students take the responsibility of their own learning by relying on their intrinsic motivation through features like curiosity, deep-level thinking, exploration behavior, and self-regulation (Ryan & Deci, 2000). Hence learner’s perception is crucial as the question is not if a task is authentic or engaging, but whether it is perceived as such by students.

Part 2 – Assessment & Evaluation:

2.5 Assessment structures:

A main feature of some schooling structures such as the Ontario Secondary School Diploma (OSSD) and the International Baccalaureate Diploma (IB) programs is the emphasis on criterion-based performance assessment. Student evaluations are not based on comparisons with other students, but learning is measured in relation to established, published standards that apply equally to each student (IBO, 2004, p. 7; Growing Success, 2010, p. 19). IB standards are consistent worldwide, and OSSD standards are consistent across Ontario. There are, however, some fundamental differences in the way the courses are evaluated in each and how final grades are awarded.

According to the Ontario Ministry of Education website, to earn the OSSD, secondary students must earn 18 credits from specified compulsory courses and 12 credits from optional courses, pass the Ontario Secondary School Literacy Test (OSSLT), and complete a minimum of 40 hours of community involvement shown through completion documentation. The individual
courses are completed in one year and students sit examinations at the end of each course. For Grades 9 -12, a final grade (percentage mark) is recorded for every course and these credits are accumulated over the four years. Class teachers evaluate OSSD courses and assess students on the basis of projects, labs, assignments, and tests set throughout the course. 70% of the final OSSD grade for each course should reflect the student’s most consistent level of achievement throughout the course, although special consideration can be given to most recent evidence of achievements (Ontario Growing Success, 2010, p.93). The remaining 30% of the grade will be based on a final evaluation administered at or towards the end of the course (p.93). This evaluation is based on evidence from one or a combination of the following forms: exam, performance, essay or other method of evaluation suitable to the subject content.

2.5.1 Constructivism in Assessment Structure:

Bednar et al (1992) highlight two ways in which constructivist learning can be evaluated. First is how well students are able to function within a content domain, whether they can use the tools and understandings of the domain to solve problems, and if involved in an authentic task, then assessing whether the student successfully completed that task. The second method is students reflecting on the processes whereby they came to their conclusions and document this construction process. These methods relate to the four stages in applying constructivist teaching: 1) eliciting prior knowledge, 2) creating cognitive dissonance, 3) authenticity and applying to new contexts with feedback, and 4) reflecting on learning. In terms of eliciting prior knowledge, teachers can use formal pre-tests, asking informal questions, having formal interviews with students, or setting up activities such as concept-mapping (Baviskar et al., 2009). Eliciting and organizing the information in the form of a map that resembles the student’s own cognitive construct allows the student and teacher to assess any misconceptions and target the implementation of the lesson plan accordingly. Second is creating cognitive dissonance that should act as a motivator to students as they think how the contradicting beliefs or new knowledge fit with their own constructs. Teachers can select tasks that have a high chance of being problematic for students (ex: case study problem) and so encourage students to think deeply to resolve the conflicting or ‘missing’ ideas (Wheatley, 1991).

Furthermore, the third stage is application of knowledge with feedback (Vermette et al., 2001; Windschitl, 2002). This can be in the form of quizzes, presentations, group discussions, projects, portfolios, or other activities where students compare their individual constructs with
their cohorts’ or new situations (Baviskar et al., 2009). In addition to checking their construct validity, application allows students to define the interconnectedness of the new knowledge to a variety of contexts. Through task authenticity, this new knowledge is integrated permanently.

Finally is reflection on learning where students have the opportunity to express what they learned (Baviskar et al., 2009). This can be through presentations, papers, or examinations with questions fostering reflection on the learning process (Saunders, 1992). Reflection can also be through activities that are more meta-cognitive in nature like a reflexive paper, a return to the dissonance creating activity, or having the student explain a concept to a fellow student (Lord, 1994). Constructivist assessment can also motivate students to form their own checklists, co-construct rubrics, and aid learning through self and peer-assessment tools.

2.5.2 Bloom’s Taxonomy:

Though it is often stated that we (general public) live in a knowledge society, this does not mean that retention of factual information is the key (IBO, 2004, p. 16). In fact the key valuable skill in today’s society is learning how to learn. This includes skills like accessing, ordering, sifting, synthesizing, evaluating, creating, and constructing knowledge. Bloom’s Taxonomy models a framework for teachers to use to focus on higher order thinking. It consists of a hierarchy of levels that can assist teachers in designing performance tasks, crafting questions for conferencing with students, and providing feedback on student work (Krathwohl, 2002).

Bloom’s original taxonomy was divided into six levels: knowledge, comprehension, application, analysis, synthesis, and evaluation (Krathwohl, 2002). Except for ‘Application’, each of the categories was further broken down into more specific subcategories (presented in Appendix C). The categories were organized from simple to complex and from concrete to abstract. The original taxonomy was assumed to represent a cumulative hierarchy in that mastery of each simpler category was a prerequisite to the next more complex one. One of the most fundamental uses of Bloom’s Taxonomy is classifying curricular objectives and subsequently learning goals.

Using Bloom’s taxonomy, the learning objectives are framed using two aspects: 1) some subject matter content, and 2) a description of what is to be done with that content. Consequently the objective statements comprise a noun (or noun phrase) and a verb (or verb phrase). The noun presents the subject matter content, while the verb represents the cognitive process involved. For example, one can look at an objective stating ‘the student shall be able to
learn the different parts of a cell’. The ‘student shall be able to’ is common to all objectives because it generally defines what students are expected to learn. Hence in objectives, these statements are often removed to simplify and specify. So the unique part is ‘remember the different parts of a cell’. In this example, the noun phrase showing the actual content is ‘the different parts of a cell’ and the verb, showing what is to be done with the content, is ‘remember’.

In the original Taxonomy, the ‘Knowledge’ category embodied both the noun and verb phrases where the noun was specified in its subcategories, and the verb was included in the actual definition (i.e. in this case the student was expected to recall or recognize knowledge). Subsequently one of the criticisms towards Bloom’s Taxonomy was its one-dimensional model. The ‘Knowledge’ category was seen as two-fold and hence different from the other categories. In response, the Taxonomy was reviewed where this irregularity was removed. The revised Bloom’s taxonomy (now called Taxonomy Table) had the same two aspects (noun and verb) but forming separate dimensions or two axes (Krathwohl, 2002). The noun provided the basis for a Knowledge dimension, while the verb formed the basis for what is referred to as Cognitive Process dimension (Appendix D). Hence combining the noun and verb from both domains lead to forming an objective (which is one of the Taxonomy table’s cells).

2.5.3 The Taxonomy Table - Bloom’s Revised taxonomy:

The first dimension of the Taxonomy Table, Knowledge dimension, contains four instead of three main categories found in the original taxonomy. The three are basically the gist of the subcategories of Knowledge in the original taxonomy, but reorganized to use relevant recent terminology. To break it down, the first category in the revised taxonomy table on the ‘knowledge domain’ axis is factual knowledge that focuses on basic elements students must know to be acquainted with a discipline (ex: terminology, specific details or elements). Second is conceptual knowledge, which focuses on the interrelationships among the basic elements within a larger structure that enable them to function together (ex: knowledge of classifications, categories, principles, generalization, theories, models and structures). The third is procedural knowledge, which focuses on how to do something by looking at inquiry skills, methods, and criterion for using those skills/methods (ex: knowledge of subject-specific skills and algorithms, knowledge of subject-specific techniques and methods, and knowledge of criteria for determining when to use appropriate procedures). The added fourth is metacognitive knowledge,
which focuses on knowledge of cognition in general and awareness of one’s own cognition (ex: strategic knowledge, knowledge about cognitive tasks such as proper contextual or conditional knowledge, and self-knowledge).

The second dimension of the Taxonomy Table, Cognitive Process domain, contains the same six categories as the original taxonomy but with some modification. Three categories were renamed, the order of the two highest were interchanged, and category names were changed into verb form to fit the way they are used in stating objectives. Hence the six categories from simplest to most complex are: remember, understand, apply, analyze, evaluate and create (Appendix D).

One of the criteria in selecting subcategory labels was using terms that teachers use in talking about work. So, in the revised Taxonomy, major emphasis is given to 19 specific cognitive processes subcategories within the six categories. Hence ‘Remember’ has recognizing and recalling as subcategories. The second category ‘Understand’ has interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining. The third category ‘Apply’ has executing and implementing. The fourth category ‘Analyze’ has differentiating, organizing, and attributing. The fifth ‘Evaluate’ has checking and critiquing. The last highest category ‘Create’ has generating, planning, and producing. Overall these are the 19 subcategories for the 6 categories in the Cognitive Process dimension that teachers may use as verbs when setting objectives.

Like the original, the revision is a hierarchy where the six categories in Cognitive Process dimension differ in complexity, with ‘remember’ being least complex and ‘create’ being most complex. However because the revision gives greater weight to teacher use, the requirement of a rigid hierarchy has been relaxed to allow categories to overlap one another (Krathwohl, 2002).

To visualize, in the revised taxonomy, any objective is represented in two dimensions. A two-dimensional table is used with Knowledge dimension forming the vertical axis, and Cognitive Process forming the horizontal. The intersections would form the cells (Appendix D). Hence any objective can be classified in the Taxonomy Table in one or more cells that correspond with the intersection of the column proper for categorizing the verb (hence cognitive process) and row proper for categorizing the noun (hence knowledge category). So going back to the example ‘remember the different parts of the cell’, the verb ‘remember’ shows the first category in the Cognitive Process dimension, and the noun phrase ‘different parts of the cell’
shows factual knowledge in the Knowledge dimension.

2.5.4 Assessment & Table Taxonomy:

Relating back to assessments, the Taxonomy Table can be used to classify instructional and learning activities used to achieve learning objectives, as well as the assessments employed to determine how well the objectives were mastered. The two dimensions guiding the process of stating objectives and planning instructions lead to sharper, more clearly defined assessments with a stronger connection to both objectives and instruction. The power of assessments, regardless of the form they take, resides in this triad connection that the Taxonomy Table facilitate in developing.

Different types of objectives require different types of assessment. One of the challenges teachers face is validly assessing higher-order cognitive processes. There may be some disagreement about the nature of Bloom’s taxonomy, but it still provides a useful framework to express diverse skills required. Student skills of analysis, synthesis and evaluation can only be properly assessed by requiring them to analyze, synthesize and evaluate at some length. Performance assessment is the only realistic means of assessing student achievement in these areas, and because the outcomes of such activity cannot be tightly prescribed, such assessments must be comparatively unstructured and open ended (IBO, 2004, p.17). Hence this is where teachers find higher-order cognitive processes challenging to reliably assess and evaluate. In addition demands of these higher order skills cannot be ignored (especially after finishing secondary school).

In response to this challenge, the information obtained during assessment process is greatly impacted by what preceded it during instruction, specifically as both instruction and assessment should align with the objective. Thus by setting Bloom’s diverse higher order skills within the subject objectives, they now form a significant part of the construct to be assessed. So when speaking of evaluation following constructivist learning framework, teachers actively engage in the assessment process from the start when they specify objectives and write rubrics to score results of constructivist activities (Alesandrini & Larson, 2002). Only when this three-way alignment takes place, assessment reliability and validity becomes doable.

Moreover, since specific objectives can be interpreted differently to begin with (hence impacting reliable assessments), the Taxonomy table is a useful tool to avoid misinterpretation by recommending using the listed 19 cognitive process subcategories (or alternative the 6 main
process categories) as verbs when stating objectives. Ambiguous verbs including state, list or demonstrate should be used with care because such terms are more applicable to assessment than to learning. For example, at one end, students can demonstrate that they remembered a specific concept. However at the other end, students can demonstrate the results of a creative process. In between, they can further demonstrate their ability to understand, apply, and analyze and evaluate (Krathwohl, 2002). Hence this and other similar verbs need to be used with care to avoid confusion.

Furthermore, another benefit from Taxonomy table is focusing on linking assessment methods with specific types of objectives. If the objectives are all examples of one category, then the appropriate assessment task will be similar. For example, if the learning objectives are students remembering addition facts, or recalling definitions of social studies terms, or recalling parts of a cell, the proper assessment task will be similar because they all revolve around ‘remembering factual knowledge’. So the task can be to ‘list’ the fact. Similarly if conceptual knowledge includes categorizing different species or categorizing different food, students can do so using similar assessment task by ‘classifying’ (which lies under ‘Understand’ category).

Practically, teachers can place objectives, instructional activities, and appropriate assessment tasks/methods in the Taxonomy Table. For example, a teacher can use questioning and informal observation to assess student mastery of remembering parts of a cell. He/she can also use a quiz to assess mastery of explaining the Charter of Rights and Freedom. In addition, a performance assessment can be integrated to assess mastery of choosing a character and writing a persuasive essay. As a result, the Taxonomy Table should show strong alignment between assessment, objectives and instructions (Krathwohl, 2002).

Lastly, another benefit using Taxonomy Table, in addition to its use in class instruction and assessment, is using it to analyze results of statewide assessments in terms of their impact on curriculum and instruction. Teachers and students are confronted with statewide high-stakes assessment. Using the Taxonomy Table to increase alignment of school wide curriculum and instruction with state standards assessments will enable teachers to focus on the standards without the backwash effect by which teachers teach to the test. Krathwohl (2002) concludes in that because the Taxonomy Table focuses on student learning rather than performance, it accentuates this need to focus on the two dimensions (cognitive process and types of knowledge) required to achieve the standards rather than the specific or general types of items included on
statewide assessments. This knowledge of relevant two dimensions can be used to make adjustment in curriculum and instruction, hence improving effectiveness of the whole system.

Peterson (2003) mentions that what matters is not the absorption and regurgitation of facts, but the development of powers of the mind or ways of thinking which can be applied to new situations and new presentations of facts as they arise. Such considerations must have a major influence on assessment then if it is to retain validity. If the skills expected of today’s students are changing, or expanding to include a greater diversity, then assessment instruments should do likewise (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956; IBO, 2004, p.17). The two-dimensional Taxonomy Table categories and subcategories can be appropriately applied to each of the four aforementioned stages of constructivist learning. For example, with creating cognitive dissonance, teachers can inquire students through level 4 ‘analyze’ type of questions along with the proper knowledge domain. However it is important to remember that the point of Taxonomy table and Bloom’s hierarchy in general is to show that still some skills are needed to be developed before others (ex: remembering before analyzing).

2.5.5 Integration of Traditional assessment elements:

An example of teachers undergoing and evaluating using constructivist learning framework is during their activity task in building a bridge; they scored their own team’s bridge and participated in a gallery walk in which each team used both their own and the other teams’ rubrics to score bridges formed by the other teams (Alesandrini & Larson, 2002). Teachers then realized that their ‘excellent’ work would likely receive a poorer grade when held to a different standard/criteria. This experience helped teachers appreciate the limitations of traditional grading practices in a constructivist classroom and they subsequently learned that assessment is relative by which grades result from applying a rubric that relates to specific criteria or objectives, which can be constructivist learning objectives (Alesandrini & Larson, 2002).

This brings out an important point in that traditional and constructivist assessments are not totally different; they can both be through paper and pencil, hands-on experience, or even exchange questioning. Yet assessing the process of active knowledge construction along with the outcome are greater priorities to constructivist assessor than a traditional one (Jonassen, 1991). Hence a constructivist class emphasizes both learning process and product.

The other difference mainly lies in the support of standardized testing where, in traditional teaching, it is higher resulting in educational decisions from scores. Yet
constructivists have a more negative view, as they prefer assessments with more of a genuine thinking and 'real-life' application such as authentic, performance, or portfolio assessment (Reeves & Okey, 2004). Plus the variety of assessment techniques helps to reduce the potential for inequity in assessment (Brown, 2002).

2.6 Assessment Modes

2.6.1 Formative and Summative:

Assessment is used to mean a set of actions undertaken by teacher and student to gather information about student learning. There are two different types of assessment: formative and summative. For formative, the purpose is to provide detailed feedback to teachers and their students on the nature of students’ strengths and weaknesses, and to help develop students’ capabilities (Garrison & Ehringhaus, 2007). An example is the direct student-teacher interaction where, following Vygotsky, the teacher is a supporter rather than a director of learning. He/she should make use of assessment tasks/tools that help the student work in their zone of proximal development. It is more vital that formative assessment correctly identifies the knowledge and skills that students should develop, rather than accurately measure each student’s level of achievement (Black & William, 1998).

Thus the teacher sets formative assessments that are at just the right level of challenge for the student, and keeps adjusting that level as the student progresses. Hence, as IBO states, reliability is a much lower consideration for formative assessment than validity (p.4).

On the other hand, summative assessment is used for quite different purposes: the provision of information about student achievement, certification and selection of students, an accountability mechanism to evaluate teachers and schools, and a driving force for reform of curriculum (IBO, 2004, p.4). Although the primary role is achieving certification for university or college admission, summative assessment is also a major tool for reinforcing and reflecting teaching curricular goals. It contributes to knowing the diploma’s impact on students’ education by providing differentiated information about student achievement and teacher effectiveness to inform teacher professional development (IBO, 2004 p.4).

Recently with the Growing Success document, the terms ‘diagnostic’, ‘formative’, and ‘summative’ assessments are used interchangeably with ‘assessment for learning’, ‘assessment as learning’, and ‘assessment of learning’. It is important to note though that the terms
assessment for, as, of learning refer to the purpose of class assessment, while the terms diagnostic, formative and summative refer to the nature of assessment taking place to reach the specified purpose. Practically then, diagnostic assessment is used as assessment for learning before instruction, formative assessment can used as both assessment for learning and assessment as learning during instruction, and summative is used as assessment of learning after instruction where the goal is evaluation.

2.6.2 – Assessment for, as, and of learning:

a) Assessment for learning and as learning:

According to Ontario Growing Success (2010), assessment for learning is the process of seeking and interpreting proof for use by learners and their teachers to decide where the learners are in their learning, where they need to go, and how best to get there. Hence assessment for learning takes place when teachers do diagnostic assessment, which is assessment before instruction takes place. This is when teachers know where students’ initial points are in a particular topic before introducing it, so they check for students’ readiness to learn new knowledge and skills while simultaneously obtain information about their interests and learning preferences (Growing Success, 2010 p. 31). Assessment for learning also takes place when teachers undergo formative assessment, which is an ongoing assessment during instruction while students are gradually building knowledge and skills (Growing Success, 2010 p. 31). This is when teachers provide timely and specific descriptive feedback to students throughout as well as scaffold and differentiate instruction or assessment as needed.

Furthermore, assessment as learning is another type of formative assessment where in this case students are encouraged to be their own and their peers’ assessors (rather than merely the teacher). So students in this case provide feedback to others (peer assessment), monitor their own progress towards learning goals (self-assessment) and constantly make adjustments, reflect on their learning, and set individual goals (Growing Success, 2010 p. 31). It also occurs in an ongoing manner during instruction and with support, modeling and guidance from the teacher.

In terms of tools, teachers will obtain assessment information through a variety of means, which may include formal and informal observations, discussions, learning conversations, questioning, conferences, homework, tasks done in groups, demonstrations, projects, portfolios, developmental continua, performances, peer and self-assessments, self-reflections, essays, and tests (Growing Success, 2010, p. 28). These assessments should have the goal of developing
students as autonomous independent learners while incorporating work habits by which students’ interests and belief they can learn are critical to their success. By following assessment for and as learning to increase student engagement and commitment to learning, teachers can share learning goals and success criteria with students, provide timely feedback in relation to goals, and develop students’ ability to self-assess (Growing Success, 2010, p. 29). Teachers should also continuously gather information about students using assessment to inform instruction, guide next steps, and monitor student progress.

**b) Assessment of learning:**

Finally assessment of learning is basically summative assessment or evaluation. This occurs near or at the end of a period of learning, and is used by the teachers to summarize students learning at a given point in time. It is used to make judgments about quality of student learning on the basis of specific criteria, to assign a value that represent that quality, and to support communication about achievement to students, parent, teachers, and others (Growing Success, 2010 p. 31). In this case, the point is no longer to assess progress. It is important to note thought that assessment of learning shows evidence of student achievement collected over time from multiple sources: observations, conversations, and student products. This increases reliability when evaluating. In addition, student products can be in the form of tests, exams or assignments. The assignments can be performance tasks, demonstrations, projects and essays (Growing Success, 2010, p. 39).

Furthermore, ensuring equity, evaluation assignments are to be completed in class under teacher supervision. They should not include ongoing homework. In addition, if involving group work, each student’s work in the group project is to be evaluated independently and assigned an individual mark, as opposed to a common group mark. This evaluation or assessment of learning is solely the teacher’s responsibility; hence it should not include student or peers’ judgments (Growing Success, 2010, p. 39).

Harlen (2006) explains that using formative and summative terms give the impressions that they are different kinds of assessment or are linked to different methods of gathering evidence (Growing Success, 2010, p. 30). In fact, what actually matters is how the information is used. Hence the terms assessment for, as, and of learning are preferred: “the essential distinction is that assessment for learning is used in making decisions that affect teaching and learning in the short term future, whereas assessment of learning is used to record and report what has been
learned in the past” (Harleen, 2006, p. 104; Growing Success, p. 30). Hence what the information is to be used for determines the nature of the assessment.

2.6.3 Assessment and Student Culture:

The use of assessment to improve student learning and to help students become independent learners requires teachers and students to enact a shift in how they perceive their roles in the learning process (Growing Success, 2010, p. 30). In traditional assessment, the teacher is perceived as the active agent in the process, determining goals and criteria for successful achievement, delivering instruction, and evaluating student achievement at the end of learning. However the use of assessment, with the aim of improving learning and helping students become independent learners, requires a culture in which student and teacher learn together in a collaborative relationship. The teacher’s role then is being a “lead learner” where he/she provides support while gradually releasing more and more responsibility to the student, (Growing Success, 2010, p.30). Gradually, the student develops the knowledge/skills needed to become an independent learner.

2.6.4 Assessment Tools:

a) Standardized testing:

Standardized (or psychometric) testing uses carefully developed short questions (usually multiple choice) to measure student’s ability in a specific area. These tests are taken under strictly controlled conditions and every test question is required to assess the same skill. The items that discriminate most effectively between different students are retained for use in tests while other items that may not discriminate, regardless of the educational value of question content, are discarded (IBO, 2004, p.5). Thus, relative student performance on each question is used to reflect and measure ability. Plus since tests are automatically marked, unfairness or inequity is not introduced by different standards of grading. The main intent is to measure student capability regardless of social or educational background, or ethnicity (IBO, 2004, p. 5).

The idea that tests can or should measure a single quality has been open to question. However standardized testing has some realistic advantages like cost effectiveness, time efficiency when used on a large scale, and high degree of outcome reliability (IBO, 2005, p. 5). Apart from narrow standardization and the atomized disconnected view of learning, the realistic notion is standardized tests are used more to measure student achievement against desired curricular goals. It has become a very high-stakes operation in some countries, linked to school
and teacher accountability, with the outcome having a significant impact on students’ life chances (Hoffmann, 1962; Resnick & Resnick, 1992). Hence, this limited nature of testing will have a major impact on how teachers teach in class (“backwash” effect). This negative effect of teaching to the test is a key disadvantage of standardized objective testing (Resnick & Resnick, 1992).

b) Performance assessment:

Performance assessment/evaluation includes various forms where students carry out tasks that directly reflect the range of knowledge and skills learned. These forms include problem solving, essays, project work and examinations. The need for various tasks, response construction and skill performance makes this approach timely and costly (Stecher, 2010, p.26). For example, ensuring that assessment tasks are designed to reflect the desired skills and knowledge requires professional judgment of a marker or considerably increased assessment workload from the teacher. This leads to increased costs and/or decreases assessment reliability due to inevitable opinion differences between markers (IBO, 2004, p. 6). However, the benefit of this approach is it relates to curricular goals and supports constructivist class teaching (Wiggins, 1989). Performance assessments must have criteria defining the behavior or attributes of a product expected, as well as a well-defined scoring system (allowing the teacher, students, and others to evaluate a performance or product as objectively as possible). Stiggins (1991) notes if a teacher fails to have a clear sense of the full dimensions of performance, he/she will not be able to teach students to perform at the highest levels or help students evaluate their own performance.

c) Authentic assessment:

Performance assessment further incorporates authentic assessment. Meyer (1992) reveals that both are not the same though; a performance is “authentic” to the extent it is based on challenging and engaging tasks that resemble the context in which adults do their work. Practically, an authentic task/assessment allows students sufficient time to plan, complete the work, self-assess, revise, and consult with others. Meyer also contends that authentic assessments must be judged by the same kinds of criteria/standards used to judge adult performance on similar tasks.

Moreover, Wiggins (1990) revealed three factors to determine assessment authenticity: task, context and evaluation criteria. The task requires students use knowledge or skills to
produce a product or complete a performance. Hence, memorizing a formula would not be an authentic task, but using the formula to solve a practical problem would be. Second the context needs to have as much realism as is possible. The setting, including time given for task completion, should mimic the context faced by professionals, citizens, and consumers (Wiggins, 1990). An examination in which the student has almost no prior knowledge of what will be asked, little time to complete the activity, and no opportunity to reflect or consult appropriate resources would not be authentic. Third, an authentic assessment should be judged using criteria similar to those used to judge adults who perform/produce in real life (Wiggins, 1990). For example, authentic criteria used to evaluate a written paper would give primary consideration to the paper’s organization and ideas, and then to mechanical errors (ex: grammar and spelling).

Furthermore, five standards to evaluate authenticity include employing higher-order thinking skills (ex: Bloom’s taxonomy levels), depth of knowledge, and connections to the world beyond the class (ex: problems/topics that occur in the larger society). Others are substantive conversations (ex: meaningful teacher-student conversations), and social support for achievement (Newmann, King, & Carmichael, 2007, p.35). These standards illustrate though authentic assessment is normally seen as part of formative assessment, it can also form part of a summative assessment model (IBO, 2004, p.6).

**d) Portfolio:**

Consistently, performance assessment incorporates use of portfolios. A portfolio is more than a folder stuffed with student papers, videos, progress reports, or related materials. It must be a purposeful collection of student work that tells the story of a student’s efforts, progress, or achievement in a given area over a period of time (Paulson, Paulson, & Meyer, 1991). If it is to be useful, specific design criteria also must be used to create and maintain a portfolio system. Frazier and Paulson (1992) argue that portfolios allow students the opportunity to evaluate their work, and offer students a way to take charge of their learning through ownership, pride, and high self-esteem. As more teachers incorporate portfolio assessment process in their daily instruction, they are seeing directly how beneficial portfolios can be when used to strategically address students’ individual needs (particularly with students in inclusive environments or with disabilities) (Tierney, Carter, & Desai, 1991; Walther-Thomas & Brownell, 2001). Portfolios can specifically recount constructivist element reflection of learning while integrating authenticity.
2.7 Assessment Challenges:

2.7.1 Accountability:

There is a controversy when using summative assessment as an accountability mechanism, with goals of raising standards and providing information on identifying good schools and teachers (Stobart & Gipps, 1997). The difficulty lies in making fair comparisons between teachers and schools that may have students from different backgrounds and teaching in different contexts. Plus, it is difficult to interpret apparent rises in performance standards as they may reflect either real improvements to teaching or concentrated efforts at teaching to the test leading to increased neglect of other educational aspects (IBO, 2004, p.4).

The IBO (2004, p.4) mentions that assessment has no formal role being an accountability mechanism by which school performance is judged. A five-year program evaluation of authorized IB schools is conducted, but only rarely is student performance on assessment a major consideration in evaluating school status (except with recurrent maladministration or improper conduct). Hence instead of using national standardized tests, this evaluation program can be a model approach to determine school effectiveness, and to show if teachers are teaching to the test or genuinely for students’ learning.

2.7.2 Program Policy to Practice:

There is a conflict in assessment design between techniques that can give the most reliable measures of specific aspects of student achievement, and techniques that measure and encourage the most desirable educational student achievements. Alec Peterson, the first Director General of the IB (1971), revealed this dilemma;

“What is needed is a process of assessment which is as valid as possible, in the sense that it really assesses the whole endowment of the pupil in relation to the next stage of his life, but at the same time is sufficiently reliable to assure pupils, parents and teachers, and receiving institutions that justice is being done. Yet such a process must not, by its backwash effect, distort good teaching, nor be too slow, nor absorb too much of our scarce educational resources.” (IBO, 2004, p.12).

If the aim is developing students to be active lifelong learners, then this should be reflected in the assessment system. The goals, objectives, and aspirations need to be supported by the assessment system as it is an inevitable fact that what is not assessed is not so highly valued and may even be overlooked (IBO, 2004, p.13).
The following shows an example with the Science course objectives from both the IB Diploma Programme Assessment Principles and Practice document (2004), and the Ontario Science Curriculum (2008). In both courses, though ordered or worded a bit differently, most of the curricular objectives are similar and revolve around constructivist concepts. For example, in the IB Science courses (IBO, 2001b, p.7), the objectives are: 1) Demonstrate an understanding of scientific facts, concepts, methods and techniques, terminology, and methods of presenting scientific information; 2) Apply them; 3) Construct, analyze and evaluate; 4) Demonstrate personal skills appropriate for effective scientific investigation; and 5) Demonstrate the manipulative skills necessary. Similarly by looking at the Achievement Chart of the Ontario Science curriculum, there are four main categories: 1) Knowledge and Understanding; 2) Thinking and Investigation through initiating/planning skills, processing skills, manipulating, and critical/creative thinking; 3) Communication through expression or ideas, and use of proper terminology; and 4) Application through making connections or transferring knowledge. Both programs emphasize constructivist objectives, and the structure closely follows Bloom’s taxonomy (Bloom et al, 1956).

On the other hand, both programs may differ in the modes, formats, and degree of autonomy when assessing these constructivist objectives. In worldwide IB schools, all science subjects are assessed through four components: three examination papers marked externally, and practical laboratory work marked internally by the class teacher. The first exam paper is a multiple-choice test, designed to give broad coverage of course content, assessing IB objectives 1 and 2. The second exam paper consists of a data-analysis question, some short-answer questions and one extended-response question (two if higher level) based on the core course content. Paper 3 consists of short-answer questions on the particular option students have chosen to study. In both papers 2 and 3, questions are designed to give equal weighting to objectives 1 and 2, and to objective 3. The practical work includes assessment of all five objectives. For IB Science subjects, the structure of the exam papers ensures balanced and appropriate coverage of course content (IBO, 2004, p. 19). Hence the assessment structure set by worldwide IB illustrates which assessment tool is used to emphasize particular subject objectives.

On the other hand, the Ontario curriculum states; “teachers will ensure that student work is assessed and/or evaluated in a balanced manner with respect to the four categories (mentioned above), and that achievement of particular expectations is considered within the appropriate
categories” (Ontario Science Curriculum, 2008, p. 25). Ontario teachers are responsible for developing appropriate instructional strategies to help students achieve curriculum expectations, as well as appropriate methods for assessing and evaluating student learning (Ontario Science Curriculum, 2008, p. 8). This is where the degree or amount of internal assessment (i.e. evaluation by school teachers) differs between both programs. The point behind this study is to understand how the teachers feel about their existing practice in assessment/evaluation, and their ability to integrate constructivist aspects depending on the policies and school/program structure.

2.7.3 Criterion-based assessments:

It has been argued that the current trend of making assessment criteria more explicit may actually have a deleterious effect on student learning (Norton 2004). Sadler (2005) and Woolf (2004) mention that there is a wide range of difficulties in using criterion-referenced assessment. They highlight that the term ‘criterion’ means different things in different contexts; in some cases criteria refer to the desirable qualities, but in other cases they refer to standards of achievement. There is also the problem that assessment criteria often do not indicate weighting as in the comparative importance of one in relation to others. Subsequently the formulation of the ‘criteria’ suggests a relativity that may make judgment difficult. This may be one of the challenges teachers face when assessing and evaluating their students. Woolf (2004) actually gives an example of an assessment criterion formulated as ‘students are to synthesize an appropriate range of material’ but what determines ‘appropriate’? There are no benchmarks for securing what appropriate might mean (Shay, 2008). Hence reliability may be impacted.

2.7.4 Nature of Subject:

The degree to which objectives are linked to prescribed course content will vary between subjects (ex: low direct linkage in language A1 and high linkage in science/math), and this influences the format of assessment components and tasks that make them up (IBO, 2004, p. 19). The complexity of the skills being assessed denies the possibility of analytical marking (dividing available marks between different criteria, with weightings according to their relative importance). There are some subject areas (ex: Math/Science) where analytical marking approaches seem like general rule (probably due to belief of more objective content in these subjects), but even in those it is not possible to prescribe exactly what students’ produced responses are (IBO, 2004, p. 19). Markers (external or internal) must be constantly aware of the need to give credit for alternative valid responses. This may show how constructivist learning is
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contingent on the way it is approached and valued, and practically on how it is assessed.

2.7.5 Mutual exclusion – Process & Product:

Jonassen (1991) mentions that it is the process of knowledge acquisition that should be evaluated, not any product or observing behavior. Evaluating how learners go about constructing knowledge is more important than the resulting product, suggesting that evaluation must become part of the instructional process. Similarly, since formative assessment is more directly linked to how students learn and is referred to assessment for learning while summative assessment is referred to as assessment of learning, this misleading distinction underestimates the major impact of summative assessment on what is actually learned in class. It is not just an activity conducted after learning occurred, but should be designed to have an integrated role in the teaching/learning of a subject (IBO, 2004, p. 6). Educational objectives, learning outcomes, and assessment design should be cyclical (Frith & Macintosh, 1984). As a result, though a distinction is made between summative and formative in terms of their functions, the same assessment instruments can be used for either purpose. The difference just lies in the way outcomes are interpreted (Wiliam and Black, 1998). Thus, Biggs (1998) expressed it is not helpful to regard formative and summative as mutually exclusive, but both should interact and be mutually supportive.

2.7.6 Internal assessment pros and cons:

Internal assessment (i.e. evaluation set and recorded by teachers) can provide individual students with the opportunity to select their own topic, giving them greater control over their learning (IBO, 2004, p. 24). This flexibility makes internal assessment valuable as it differentiates learning to students’ interests, thereby improving the validity of the assessment process and student’s authentic learning experience. In addition, it allows schools to place learning in a local cultural context, or to draw closer links between the class and the world immediately outside. Brown (2002) points out the value of internal assessment in allowing for cultural diversity within assessment; it encourages broader perspectives of internationalism by allowing a multiplicity of cultural approaches and giving students opportunities to experience a range of cultural values.

On the other hand, a challenge with internal assessments is reliability. There are fears of whether the work is the student’s own, so the usual decision is either excluding them completely or carrying them out under supervised conditions. Another concern is workload, particularly for teachers and students. Internal or school-based assessment increases teachers’ workload and
burden, and exerts excessive pressure on students through a large number of assessment activities (Yip & Cheung, 2005). They are usually substantial and require significant time commitment. Hence though it is important that teachers spend time preparing students in skills and processes required for internal assessment, a risk is insufficient time left for teaching the rest of the course or other topics (IBO, 2004, p.25). This may be why IB focuses more on external assessment; teachers facilitate constructivist higher-order learning by covering topics in depth and breadth.

Black (1993) expresses that internal assessment carried out by some teachers can be as reliable as external assessment. A number of national and state education systems use only internal assessment for end of secondary school or university entrance level assessment (subject to varying degrees of external regulation). This reflects the high value often attached to this approach of assessment (ex: comparing OSSD and IB).

2.8 Conclusion:

This literature review focused on explaining constructivism from a theoretical lens to practice then focused mainly on assessment/evaluation. It explained the different assessment tools, modes, formats, and challenges. It highlighted the degree in which teachers may feel supported or hindered by specific constructivist assessment approaches and their degree of autonomy. The point is looking at which main factors led to such support or hindrance.

The research showed views from higher institutions, employers, policy-makers, and educational researchers, but what is not known is how teachers themselves realistically view and apply this constructivist approach when assessing and evaluating students within the confines of the their school structure. By conducting interviews with teachers, my research will contribute to this existing body of work by reporting teacher understandings and practices pertaining to assessment and evaluation aligned with constructivist learning theories in their voices based on their lived experiences.
Chapter 3: Research Methodology

3.0 Introduction:

In this chapter I describe the research methodology. I begin by reviewing the general approach, procedures, and data collection instruments before elaborating more specifically on participant sampling and recruitment. I explain data analysis procedures and review the ethical considerations related to my study. I identify a range of methodological limitations but I also speak to the strengths of the methodology. Finally I conclude the chapter with a brief summary of key methodological decisions and my rationale for these decisions given the research purpose and questions.

3.1 Research approach and procedures:

This research study has been conducted using a qualitative research approach involving the literature review and semi-structured interviews with teachers. The qualitative approach to research acknowledges that social reality is constructed differently by different individuals (Gall, Borg, & Gall; 1996). It focused more on how individuals (ex: interview participants) perceive their world (Krathwohl, 1998), and subsequently it could be viewed as a set of interpretive practices where no single practice had privilege over any other (Denzin and Lincoln, 1994).

Unlike quantitative approaches, the goal was not collecting more facts of human behavior to verify a theory (Bogdan & Biklen, 1998). Instead it was to better understand human behavior and experience by grasping the complex processes by which participants constructed meaning and described what those meanings were (Bogdan & Biklen, 1998). The goal was to develop deeper understandings and rationales (Maxwell, 1996; Bogdan & Biklen, 1998), describe multiple realities, generate insights (Gall et al., 1996), and give voice and empowerment to different groups in society (Cherryholmes, 1993).

The purpose of this study was to learn how teachers enact assessment and evaluation within a constructivist-learning framework, and the aim was not to prove whether or not they do so or to prove the strengths of this approach. Instead, the aim was to allow participants to share their subjective stories by revealing actual practices, challenges and student outcomes they individually faced and observed. A further aim was to learn what meaning participants make from their practices and experiences, which could not be easily measured using surveys or quantitative approaches. Neither could the meaning that teachers made of their practice be generalized to broader populations of teachers, given the specific contextual circumstances they
individually worked within. This qualitative approach created opportunity to access a more complex detailed understanding of the issue which could only be established when talking directly to people and allowing them to share their stories without being hindered by what researchers expected to find.

3.2 Instruments of data collection:

The primary instrument for data collection used in this study was the semi-structured interview protocol. Semi-structured interviews have a more flexible and fluid structure than surveys and structured interviews especially with such a small-scale research (Drever, 1995). In this study, I underwent one-on-one interviews with two participants, and hence having semi-structured interviews seemed more appropriate. With this instrument, the interviewer still has a clear list of issues to be addressed and questions to be answered, hence maintaining the organization aspect and ensuring addressing the aforementioned research sub-questions. However, flexibility stemmed from the interview questions themselves being more open-ended and revolving around themes or topics to be covered from the research questions and sub-questions. This allowed the interviewed participants to deeply develop ideas and speak their minds more widely on the complex issues raised and stories shared. Subsequently, the responses were open-ended in that there was more emphasis on the interviewee elaborating their points and ideas throughout (Denscombe, 2007). This flexibility further allowed for the discovery of rich original information that was important to participants but might not have been previously thought of by the researcher (Silverman, 2000). Thus, from this interviewing style, themes emerged which helped with the later thematic analysis of the qualitative data. (Alvarez & Urła, 2002).

3.3 Participants:

Here I reviewed the sampling criteria I established for participant recruitment and I reviewed a range of possible avenues for teacher recruitment. I have also included a section where I introduced each of the participants.

3.3.1 Sampling Criteria:

Participants interviewed are *high school teachers teaching 11th or 12th grade*. The reason I chose high school teachers was due to Savasci & Berlin’s (2012) study revealing that grade level is a factor that influences teacher implementation of classroom practices related to constructivism. They found that teachers in lower grades tend to use more constructivist-like
student-centered activities that reflect the developmental level, interests, and needs of that age group, while high school teachers tend to use more content-focused teacher-centered activities (ex: lectures, worksheets, and videos/demonstrations) reflective of their goals and beliefs in transmission, efficiency, rigor, and examination preparation (Tobin and McRobbie 1996; Savasci & Berlin, 2012). As a result, I wanted to interview secondary teachers because the use of constructivist learning framework might have been an area where they might be less comfortable or efficient in implementing. So it is crucial to learn to better prepare and support high school teachers in this area given what is known about the potential learning outcomes for students.

Secondly the interviewees selected are teaching Science (in this case Biology). The reason I chose this subject was the dual belief that constructivism might or might not work with a scientific discipline. Yilmaz (2008) explained that, in contrast to the objectivist notion of objective truth and meaning inherent in objects, constructivism postulates that truth is not absolute and that knowledge is not discovered but rather constructed based on experiences. Thus constructivism replaces the conception of truth with the concept of viability, meaning that descriptions of events of the world are relative to the observer. Consequently a constructivist-learning framework may not correlate well with Science as a discipline that is historically aligned with notions of scientifically proven facts and objective truths/discoveries. On the other hand, there has been a teacher study where Science teachers indeed implemented pedagogical constructivist approaches in their science classes through integrating aspects like personal relevance, critical voice, shared negotiation, and sometimes shared control (Savasci & Berlin’s, 2012). Thus looking at the two aforementioned sides, by interviewing Science teachers in this study, more information was elicited with regards to how teachers integrated this learning framework in their science classes with the specifically focused lens of assessment and evaluation.

Furthermore, since the focus is on how teachers use constructivist theory when assessing and evaluating students, the selected participants had to believe in the value of constructivist learning to begin with and to demonstrate expertise or leadership in applying this learning framework in their modes of assessment and evaluation in practice. Hence the teachers selected demonstrated expertise in this area by providing or pursuing professional development (ex: registered in a graduate program emphasizing this learning framework, authored support materials towards this end, attended conferences emphasizing this framework or different kinds
of assessment approaches, or have been selected to mentor others). According to Nespor (1987) and Pajares (1992), teacher beliefs play a major role in teacher decision-making about curriculum and instructional tasks. A number of studies have looked at the relation between teacher beliefs and practices in applying constructivism, and some have found consistency while others have not. However though there was no absolute consensus about the relation and even if not the only factor influencing class practices, teacher beliefs still appeared to be a strong influential factor. Subsequently participants were required to show belief and pedagogical application of this learning theory (especially since it is foundational to how they subsequently apply his framework when assessing and evaluating).

Moreover, selected teachers needed to be using constructivist approaches when assessing and evaluating their students. These teachers might have used a mix of authentic assessments, performance assessments, critical thinking tests, Bloom’s taxonomy class of questions, and product outcomes for both formative and summative assessments. As highlighted in the literature review, though a distinction is made between summative and formative in terms of their functions, the same assessment instruments can be used for either purpose. The difference often lies in the way outcomes are interpreted (Wiliam and Black, 1998). Biggs (1998) argues that it is not helpful to regard formative and summative as mutually exclusive because both interact and can be mutually supportive. For example, though authentic assessment is normally seen as part of formative, it can also form part of a summative assessment model (IBO, 2004, p.6).

3.3.2 Sampling Procedures/Recruitment:

To recruit, I relied on convenience sampling. It is a type of nonprobability sampling in which people are sampled simply because they are accessible sources of data for researchers (Marshall, 1996). There are some drawbacks from convenience sampling like quality control and maybe bias. However it is the least costly in terms of money and time (Marshall, 1996) and, given the parameters and timeframe of the MTRP in the MT program, this concern is particularly relevant. Hence for the scope of this study, convenience sampling was appropriate and accessible. In my graduate program department, I am immersed in a community of pre-service teacher colleagues, teachers who returned to pursue Masters and/or Doctoral studies, mentor teachers, educational instructors with previous teaching professional experiences, and administrators and directors who are in constant contact with diverse schools. Hence, I relied on networks and contacts, who mostly underwent their own research studies or who worked
with/within high schools, to recruit participants by sharing my sampling criteria and consent form (Appendix A).

To ensure that teachers are volunteering to participate rather than feeling pressured or obligated to participate, I provided my information to the graduate program contacts rather than asked them to give me the teachers’ contact information. After receiving approval, my contacts forwarded me the teachers’ e-mails to directly reach them.

3.3.3 Participant Bios:

I interviewed two participants, one working within a public Secondary school and the other working in a private secondary school. Protecting privacy and following research ethics, I used pseudonyms for my participants.

Nancy:

Nancy teaches grade 11 and 12 University Biology. She has been teaching these grades on and off for around 18 years. She started teaching in 1997 and has been working in her public Secondary school since 2001. There was a brief period in which Nancy was not working in this school but at the board where she was centrally assigned. Then she went to graduate program for around three years.

When describing the school, Nancy mentioned that it is broad ranged where there is a large special education department for students with special needs. The school also runs a special education LD class that includes Science, English, Geography, Math and History. The school also has a gifted program, and a deaf and hard of hearing program. Hence the students are fairly diverse in terms of learning. However they are more uniform in terms of cultural background as in the school is not as diverse as some other schools in the same board.

Mark:

Mark teaches Science and is the department head of Science. He has taught every single course from grade 7 to 12. Mostly he teaches grade 11 and 12 Biology as well as grade 9 and 10 Science. He has also taught grade 11 Physics, grade 11 Chemistry, and 7/8 Science. Mark has been teaching for around 13 years; he started teaching in 2002 and he started teaching in his current private secondary school since 2004.

When describing the school, Mark mentions that it is a private school and so it markets itself as a school of high achieving students. Mark thinks however in over the last 10 years, as the price of tuition increases (to about 22,000 dollars now), the high achieving student population
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has actually declined. He mentions that the school still has kids coming from two parent families where there is a great deal of family focus around the child’s education, and that this is really what keeps this school’s kids successful. However, when looking at the bound of students’ ability and the skill levels, Mark mentions that the lower bound has actually increased so that the school is getting more diverse kids with more different learning styles or without necessarily the kind of high achieving kids they used to get in the past. So he had to really change his teaching in the last 10 years and he can clearly tell there has been a total shift in thinking. For example, when giving a student a problem, the teacher would ask whether the student would like to try solving it or would like the teacher to do so. Before, the students would want to try it first and then seek guidance if they needed it, however now the students say that the problem is hard and ask the teacher to walk through it step by step. So though that is fine, Mark sees it as a total shift of thinking.

3.4 Data Analysis:

The significance of data analysis is to summarize data so that it can be easily understood and to provide the answers to the original research questions (Wright, 2003). If this section is rushed, then important aspects are missed and inaccurate interpretations can be developed, leading to misleading results and conclusions (Kelley, Clark, Brown, & Sitzia; 2003).

Before analyzing the data, I transcribed each interview. Then I began coding my transcripts by closely observing the data, and looking for common themes and differences in the data that relate to my main research questions. Hence I started first coding by looking at each transcript individually and identifying themes in the data. This is an important first step as the familiarity with data and attention to what is actually there rather than what is expected can facilitate realizations or ideas that emerge during analysis (Pope, Ziebland, & Mays, 2000).

After first coding, I did second and third class coding where I integrated themes that are part of the interview questions and categories from my five main research sub-questions. Subsequently I looked at the two transcripts, and read the codes and themes beside each other to start synthesizing major themes within categories (used as headings in chapter 4) where appropriate. The final five categories formed are: teachers’ development in constructivism, Science teachers’ constructivist beliefs and practices, constructivist learning assessment and Bloom’s taxonomy, supports and challenges in constructivist assessments, and student responses and outcomes. Each category has a few themes that emerged from the data and that is discussed
in relation to the literature review. So by synthesizing, as part of the actual analysis, I spoke to what teachers identified and what mattered about the themes given what has been found in existing literature. I also acknowledged some null data as in what participants did not identify or speak to and why that also mattered.

3.5 Ethical Review Procedures:

Any research that includes people requires an awareness of the ethical issues that may be derived from such interactions, as the protection of human subjects or participants in any research study is imperative (Orb, Eisenhauer, & Wynaden; 2001). Ethical issues are present in any kind of research because the research process creates tension between the aims of research to make generalizations for the good of others, and the rights of participants to maintain privacy (Orb, et al., 2001). Research ethics pertains to avoiding harm by applying appropriate ethical principles. In addition, by being transparent about participants’ rights and study expectations, there may be a lower chance of researchers facing ethical dilemmas. As Field & Morse (1992) mention, once access to the field has been granted and the first steps of data collection are taken, researchers may experience ethical dilemmas that may not have been anticipated in the research plan. Hence when preparing research protocols, researchers should consider the potential ethical issues that can be anticipated in the study such as informed consent, confidentiality, data generation and analysis, researcher/participant relationships, and reporting of final outcomes. Subsequently a balanced research relationship will encourage disclosure, trust, and awareness of potential ethical issues (Orb, et al., 2001).

Taking the aforementioned points in this study, once recruitment started, participating interviewees knew their rights and study expectations. First they were sent a consent form (Appendix A) that they reviewed and were asked to sign on the day of interview. This consent letter provided an overview of the study, addressed ethical implications, shared specific expectations of participation, and provided contact information if there were any questions or concerns. It included the project description, purpose of interview, description of activities or participation expectations, and confidentiality points.

On the day of the interview, before starting, participants were reminded that their interviews were audio recorded, were asked to sign a consent letter giving their consent to the interview as well as the audio recording, and were asked if they had any questions they would like to share first.
Throughout the interview, participants were further reminded of their rights to withdraw at any time in the study and/or to decline answering specific question(s) during the interview. In addition, by assigning pseudonyms, I informed participants that their identities would remain confidential as well as any identifying markers relating to their schools or their students. Participants were also told that there was no known harm associated with participation in the interview. In addition, all data brought out during this study from the interviews and subsequent transcription was stored on my password-protected laptop and will be destroyed after 5 years.

3.6 Methodological limitations and strengths:

**Strengths:**

The use of interviews allows the researcher to get material with more in-depth insights on the topic, drawing on information provided by fewer participants. Hence since two participants were interviewed for the scope of this research, the interviews allowed me to dig deeper by getting more detailed responses relating to the research questions. Some other advantages of pursuing interviews included valuable insights (Denscombe, 2003). It is beneficial in allowing participants the chance to freely expand their ideas, explain their views through personal stories, and identify what they regard as crucial factors (Denscombe, 2003). This method is also flexible in that the researcher can adjust lines of inquiry during the actual interview and can validate whether information received is accurate. In addition, since interviews are arranged for specific time and place, they usually result in a higher response rate (Denscombe, 2003). Finally, interviews can be therapeutic as it is a rewarding experience for participants themselves (they reflect as they respond). Compared with questionnaires, observation, and experiments, this method provides a more personal element where participants get to enjoy the rare chance to verbally share their ideas while others listen and note them down without being critical (Denscombe, 2003).

**Limitations:**

On the other hand, the study’s small scope can still be a limitation. Though one of the strengths is allowing for in-depth information, having a small/limited number of teachers to be interviewed will result in findings informing the topic but not generalizing participants’ experiences on a broader level. Though students and parents could have been valuable sources of information with regards to the research question, given the ethical parameters that I have approval for the MTRP, only teachers can be interviewed. Hence reliability can be a limitation.
in that the data collected is to an extent unique owing to the specific context and the specific individuals being interviewed (Denscombe, 2003). That means since teachers teach in different contexts (which can be quite diverse) and since only teachers are interviewed as participants for the study, reliability can be a limitation.

In addition, having one interview at one point in time may further negatively impact reliability. Unlike surveys, interviews can provide non-standard responses and data that are not pre-coded with a relatively open format (Denscombe, 2003). This open format may be a limitation though as it may impact how data is analyzed (can be subjective) and subsequently how reliable it is.

Moreover another limitation is, without observing participants teach, researchers are relying on the fact that what participants say they do is actually what is done in practice. In Savasci & Berlin’s (2012) study on science constructivist teachers, for example, interviews and observations were applied as methods of data collection, and there was inconsistency between how teachers believed they implemented constructivist approaches (via their interview responses) and what they actually did in their teaching practice (via observations). Denscombe (2003) refers to this limitation as interviewer effect where the data from interviews are based on what people say rather than what they do. Subsequently what people say they do or prefer cannot automatically be assumed to reflect the truth.

3.7 Conclusion:

In summary, this study’s purpose was to learn how a sample of teachers are implementing assessments and evaluations that follow the constructivist learning framework in their practice. It is to learn what those teachers believe about the extent by which these approaches can help students become self-directed higher-order thinkers and prepare them for their subsequent educational stages. Consequently the main research question is: how does a sample of teachers who are committed to constructivist learning theory and/or demonstrated leadership in its use enact assessment and evaluation in their teaching?

Given the purpose and question, for the scope of this research, this study is a qualitative study that uses semi-structured interviews with two high school Science teachers (11th and 12th grade levels) who believe in the constructivist-learning framework and apply it within their own pedagogical practice. These teachers need to show expertise in this field by showing they are professionally developing when it comes to applying this concept (ex: graduate program,
mentoring, conferences or others) and they are using multiple diverse modes of formative and summative assessments that are constructivist in nature. Due to the time span of this study, convenience sampling seemed feasible and reasonable. Using this sampling method by relying on networks in the OISE education department, potential participants were sent both the consent form and sampling criteria should they wish to participate. In the consent form and throughout the interview, teacher participants were reminded of ethical rights (ex: right to withdraw, right to skip a question, use of pseudonyms) and study expectations (ex: duration of interview). They were also asked before and after the interview whether they had any questions or concerns. Finally in chapter 4, I report the research findings based on the data collected from participants’ interviews and/or transcripts.
Chapter 4: Research Findings

4.0 Introduction:

As mentioned in the chapter 3, one participant (Nancy) works in a public school and the other (Mark) works in a private school. When talking to the two Secondary School Science participants (Nancy and Mark), a few themes emerged focusing on the use of constructivist learning framework when assessing and evaluating students.

Having the Revised Bloom’s Taxonomy (referred to in this chapter as Bloom’s taxonomy) or Taxonomy Table as a conceptual framework, each theme brought out from participants’ viewpoints is critiqued, elaborated on, or validated through this framework lens. The themes or categories emerging were: 1) Teacher Development in Constructivism and 2) Science Teachers’ Constructivist Beliefs and Practices. These two focus more on constructivist learning and teaching as they are crucial when later discussing assessments and evaluations. The subsequent three themes focusing more on assessments are: 3) Constructivist Learning Assessment & Bloom’s Taxonomy, 4) Supports & Challenges in constructive assessments, and 5) Student Responses and Outcomes.

4.1 Teacher Development in Constructivism:

4.1.1 Informal Use of Constructivism:

When it came to professional development on constructivist learning, both participants were unsure whether they learned about it yet they felt they informally used it. They did not receive professional development in constructivist learning per se but they pursued lots of professional development in other topics including assessments and evaluations. Though not necessarily with these participants, informal use of constructivism in instruction or assessment might lead to many misapplications brought out in research where some teachers merely use group work, or other teachers merely allow behavioral rather than cognitive activity, or others merely find it opposed to direct teaching in which students can do whatever they want and their opinions are always correct (Gordon, 2009). However with these two participants, Mark became more aware of constructivist learning when self-developing via attending conferences. Nancy, without necessarily consciously knowing it, brought out practices and meanings that correlate with how research defined it. So pragmatically constructivist learning has multiple terminology such as guided discovery (Kirchner et al., 2006), meaningful/deeper learning (McGee, 2003), and/or inquiry-based learning.
4.1.2 Becoming Constructivist and applying Bloom’s Taxonomy:

Both participants found that the key to developing competence and confidence in applying constructivist learning framework is through continuous work and commitment, comfort and belief in the use of the framework, and trial and error. There was no one way to idealistically apply constructivist techniques, but it was more teachers exploring. The key point emphasized by Mark when applying constructivist practice was having a clear framework and taking it slow so that students would not ‘buy out’. He further criticized how teacher education still teaches beginner teachers constructivist approaches through lecturing:

My worst class in teacher education was when someone lectured me about cooperative learning for 75 minutes and I was you want me to use cooperative learning but you can’t use cooperative learning yourself to teach me. That to me says you don’t value it. And I have serious problems sometimes when I’m asked to come in… and they’re like can you just come in and lecture about how well you work with constructivist.. … the whole point is to actually try it out and figure out what works and what doesn’t work.

This related to Nykiel-Herbert’s (2004) study when trainings consisted of verbal crash courses without emphasis on the practical experience or realistic contexts teachers faced. Hence training teachers about constructivist learning through rote-learning techniques seemed to contradict and devalue the purpose of executing it. Pragmatically, it increased teachers’ own discomfort in trying out different levels of Bloom’s Taxonomy as the constructivist learning perspective emphasized how learners cognitively process new knowledge. The cognitive processes domain comprised Bloom’s six different stages. Hence if teachers were not modeled or allowed to explore learning through constructivism, they also did not learn how to apply Bloom’s revised taxonomy effectively leading to the multiple misuses and misconceptions about constructivism, and further encouraging teachers to reuse the old traditional methods.

Valuing and persistently applying, Nancy brings out the advantage of this framework in bringing out critical thinking skills and active engagement:

For me I think that they’re developing critical thinking skills that are important.. that’s why I approach it… like even when students who are like ‘we’re not doing well in that class, I love coming to this class … this is my favorite class’, and I think it’s because I have them kind of doing and active most of the time. So I think the engagement is higher although they’re still teenagers and off-track but I think the engagement is higher..
development of critical thinking skills is definitely higher and more important…more prominent.

To summarize, to execute constructivist learning in classes, teachers need to value and explore it themselves via pre-service and in-service trainings. Some teachers might not have mastered higher-order cognitive processes or might not have practiced for a while. By allowing teachers to pursue Bloom’s revised taxonomy and constructivism on projects that align with objectives and curricular materials, they would have a sense of what their students go through.

Also having papers that allowed pre-service teachers to research, analyze and reflect a topic might show using different thinking levels from Bloom’s taxonomy. However the low curricular connection with the real topics students take in specific subjects showed that we might be applying the old original taxonomy rather than the revised one. The revised one has knowledge domain separately (factual, conceptual, procedural, and metacognitive), so teachers need to practice applying the different cognitive processes across each of the four knowledge domains in their specialized subject (i.e. with content from curricular documents).

4.2 Science Teachers’ Constructivist Beliefs and Practices:

Though my research question focuses on assessment and evaluation using a constructivist-learning framework, I perceive that assessment cannot be discussed without first talking about teachers’ objectives, instructional beliefs and pedagogical practices. Airasian & Miranda (2002) evoked that the information obtained during assessment process is impacted greatly by what has preceded during the instructional process, particularly as both processes (instruction and assessment) are aligned with the stated objected (using the revised Bloom’s taxonomy). Having two dimensions to guide the processes of stating objectives and guiding instruction leads to sharper, more clearly defined assessments. In fact the power of assessments, regardless of the form they take, resides in their close connection to objectives and instruction. The Taxonomy table (or revised Bloom’s taxonomy) is a useful tool to examine and enhance this three-way linkage. This linkage would further allow lots of opportunities where assessment for and assessment as learning can take place.

4.2.1 Constructivist versus Traditional:

Both participants similarly defined constructivist learning as students building knowledge and figuring out ways to explore, interpret, hypothesize, and test their ideas and explanations. It comprised an active collaborative exploring environment that was more inquiry-based problem
solving rather than teacher centered passive instruction where students were merely told the knowledge. So for example in Science class, Mark shared: “I might just say you know like here’s a piece of garlic and I want you to try and figure out what might be things that make it grow and when it’s growing, I want you to try and figure out is this because some cells are getting bigger or is it that they’re more cells. Like what do you think and where are you going to start from there”. This showed a practical example of Cooperstein & Wedinger’s (2004) point when bringing constructivist theorists’ viewpoints together whereby constructivist learning moves from experience to learning and not the other way around. It is inductive by which the concept follows the action rather than precede it. On the other hand, Nancy highlights the use of flipped class model:

It kinds of involves flipping lessons a little bit in my mind so I teach Science, and Biology in particular is particularly theory based so it’s finding ways to present students with situations where they explore and find things out. So getting away from the traditional kind of teacher-centered lecture and moving towards other things. So in glycolysis, they have to learn the stages of glycolysis, learn the chemical reactions involved in each stage of glycolysis and the I guess the traditional approach is that teachers to say from this stage to this stage, you do this, and to kind of flip it around and get the students to use what they know to come up with ideas.

Therefore, if the participant merely told the students the answer, the students might recall it but they might not be able to do more than that. Hence students might master the first level in Bloom’s cognitive processes. Nancy and Mark’s examples might further prove why the original one-dimensional Bloom’s taxonomy was revised. In this case, students might not have known anything about cells or glycolysis in order to start analyzing the question, so they still did not have the proper factual/conceptual knowledge. However by setting up this activity and active environment, the question was presented as a puzzle where students needed to realize they needed to recall their own background factual/conceptual knowledge (ex: knowledge about cells from eighth grade) to explain the concept and transfer it to new situations. Hence compared to traditional methods, students were asked to practice understanding and applying conceptual knowledge (first three stages in Bloom’s taxonomy) rather than merely recalling. Having the two axes then (knowledge domain and cognitive processes) in the revised Bloom’s taxonomy shows the realistic context and practices whereby students gradually develop higher-thinking skills.
4.2.2 Bloom-Constructivist Relation in Science:

Baviskar et al. (2009) mentioned four constructivist principles: eliciting prior knowledge, creating cognitive dissonance (or discomfort), authentic application with feedback, and reflection on learning. Relating those to Nancy’s previous glycolysis example, one major point brought out was students’ prior knowledge. An example from Nancy’s Science class:

I cut the molecules out and put them in an envelope and then, without ever having learned anything about process or anything, I ask the students to put them in order of what they think is the correct order just by looking at changes in molecular structure and they can actually put the stages of glycolysis together … the whole thing they can do it by just exploring what they already know about molecules and then after that they tell which reaction. So it’s taking them from what they know and showing them that they can now build their own knowledge based on that, so I think that’s a pretty good example of constructivist learning.

Similar to the garlic cell question, if students did not have any prior knowledge in the subject, the question/activity becomes decontextualized, as students cannot transfer knowledge that they did not originally have. This shows that within Bloom’s Taxonomy framework lie the four sequential constructivist-teaching principles. For example to understand, students need to recall, and to recall, students need their prior knowledge. So to recall and understand, students need to bring out their prior knowledge. In addition, Nancy emphasizes that bringing out prior knowledge is a great route where misconceptions are brought out for students to think through.

On a similar note, Mark used an example when prior knowledge was not primarily brought out and the resultant student feelings:

If the students have the right background, they love it. I think it’s when students feel they can’t actually contribute to the discussion because they are actually missing some key pieces of knowledge and they have gaps in their knowledge that are actually important to address the topic at hand, that’s when they’re like can you just tell us the answer because we feel like we are just making stuff up and we’re nowhere near the mark.

If one realizes, the teacher might have presented a problem (i.e. creating cognitive dissonance which is the second principle of constructivist learning). However this step was not applied in the proper time because the teacher did not bring out the prior knowledge first. So the
question became very decontextualized, leading either to Mark’s students irrelevant responses and Nancy’s students’ holding misconceptions.

To summarize, the main point is contextualizing and that is why Bloom’s Taxonomy started out as a framework to first identify objectives, and then plan instructional activities and assessments to target these objectives. Hence to visualize the relationship, I highlighted the places where the four constructivist principles are set within the Bloom’s revised Taxonomy below.

**Bloom-Constructivism Table:**

<table>
<thead>
<tr>
<th>Knowledge Domain</th>
<th>Cognitive Process Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factual Knowledge</td>
<td>Remember</td>
</tr>
<tr>
<td>Conceptual Knowledge</td>
<td>Understand</td>
</tr>
<tr>
<td>Procedural Knowledge</td>
<td>Apply</td>
</tr>
<tr>
<td>Metacognitive knowledge</td>
<td>Analyze</td>
</tr>
<tr>
<td><strong>Constructivist Teaching Principles</strong></td>
<td>Evaluate</td>
</tr>
<tr>
<td>Eliciting Prior knowledge</td>
<td>Create</td>
</tr>
<tr>
<td>Creating Cognitive dissonance</td>
<td></td>
</tr>
<tr>
<td>Applying with feedback</td>
<td>Reflecting on learning</td>
</tr>
</tbody>
</table>

Table shows the Relation between Bloom’s Taxonomy and Four principled Constructivist Learning Framework

The table, which I refer to as Bloom-Constructivism table, shows the relationship between constructivist teaching principles and Bloom’s taxonomy. This relationship presented shows that teaching is a continuum rather than a strict hierarchy, so it validates the revised Bloom’s taxonomy context where the revision gives greater weight to teacher use, and the requirement of a rigid hierarchy has been relaxed to allow categories to overlap one another (Krathwohl, 2002). So if one realizes and following the Bloom-Constructivism table, for students to elicit prior knowledge, they need to both remember and understand knowledge. Then if they are to create cognitive dissonance by solving a puzzle, they need to both understand and apply their understandings. Subsequently they apply through authentic tasks via Bloom’s ‘apply’ and ‘analyze’. Finally they reflect on their learning by evaluating different options and creating their own product.

Moreover, if only one of the constructivist principles was applied out of context (ex: creating cognitive dissonance by presenting a problem without first bringing out prior knowledge), that was when teachers assumed they used constructivism and Bloom’s taxonomy leading to ineffective results, while in fact they might have applied them improperly. In addition, relating to one of the aforementioned options in chapter 2, direct teaching is not necessarily the
opposite of constructivist teaching. Especially in Science, if students were not familiar at all with the topic glycolysis, that might be a time when the teacher might incorporate some direct teaching or, as participants brought out, a flipped class model. So similar to Nancy, Mark mentioned use of flipped model:

So what I do is record videos off all the lectures I’ve done. Over every lecture that I would’ve normally given, I recorded videos and gave them as background information. The kids read and then come to class, and then often when they come to class, what I give them is a puzzle or question that they work in groups and I walk around. And what it does is allows them to build on the lecture and question something deeply, so getting a sense of do I really understand what was asked I talked about lipids generally but now we’re talking about trans fat and applying. What parts are not.. it’s a way to test my knowledge.

This example of flipped class showed the appropriate sequencing of constructivist principles by first focusing on background knowledge (so if new topic, then presenting videos to give students some background information). Then Mark (and Nancy with her glycolysis question) created cognitive dissonance by giving students a puzzle or inquiry question in class asking why trans fat are bad. So by using their prior knowledge on saturated and cis fats (via remembering and understanding), the students could now solve cognitive dissonance and authentically apply their knowledge via Bloom’s Taxonomy higher-order stages ‘applying’ and ‘analyzing’ (ex: different fat types).

4.2.3 Teacher’s role during Constructivist Learning – Assessment for Learning:

Getting away from teacher-centered pedagogy where teachers talk and students listen, both participants accentuated that a constructivist learning class was one where there was active collaboration between students and between students and the teacher. Mark referred the teacher’s role to be an impartial judge just making sure everyone got a chance to speak and that students were deeply thinking through their responses and arguments. This showed an example of guidance, another crucial factor to effective constructivist implementation. It related to Gordon’s (2009) point that a constructivist class should have balance between teacher-directed and student-directed learning, and hence required teachers to take a very active role in the learning process (Gordon, 2009).
The ‘authority’ of knowledge still rests heavily on teachers’ own knowledge and experiences, and this pedagogical approach raises the bar for students by demanding far more from them (Gordon, 2009). So an example modeling guidance from Mark’s class was:

I’ll be like have you considered these ideas but usually what I do is try to sneak it in when I’m in the small group. I’m like oh but think about this particular thing… have you thought about it? Or you kind of dancing around this idea, can you work on this a little more… I think that might actually be valuable to you. So hints that I do.

It further contradicted Nykiel-Herbert’s example where constructivist learning was misapplied by having pure unguided activities/lessons where teachers were more ‘baby-sitters’ than facilitators, and by which students ended up either with misconceptions or no learning whatsoever.

Teacher consolidation and misconception corrections were particularly interesting in my analysis. Mark mentioned that if there were five minutes left, he would inform the students the true answer and what reasons they did not consider. He emphasized doing this only when class was almost over and he did not want his students leaving having solidified wrong information or misconceptions. This example showed that with pure unguided discovery, there was confusion between teaching of a discipline as inquiry and teaching it by inquiry. As Kirschner et al. (2006) mentioned, prioritization of process merely over product may lead to unguided practical work and the rejection of instruction based on facts, laws, and theories that make up a discipline’s content. So though emphasizing practical application is positive, it is an error to assume content as identical to processes and a mistake to assume that instruction should focus exclusively on the application.

Pondering that separation between process and content yet understanding their linkage without prioritizing one or the other, the aforementioned example further validated the importance of revising Bloom’s original one-dimensional taxonomy into its current two-dimensional axes (knowledge domain, and cognitive processes). The process focuses on the cognitive processes domain in Bloom, while the content focuses on the knowledge domain axis. Hence recalling verb and noun from chapter 2, when writing an objective, the verb brings out the level of cognitive process while the noun brings out the actual knowledge category. After writing this objective, teachers form instructional activities and different assessments with
guidance. Hence Bloom’s revised taxonomy may practically show Kirschner et al. (2006) point that teaching a discipline as inquiry is not the same as teaching it by inquiry.

In addition, still relating to teachers’ consolidation and misconception corrections, as Pintrich & Schunk (2002) revealed, teachers are not encouraged to provide students with positive but false feedback. Instead it is important for students to have accurate perceptions and judgments of one’s knowledge than to have inaccurate self-knowledge (Pintrich & Schunk, 2002). If students do not realize they do not know some aspect of factual or conceptual or procedural knowledge (i.e. content knowledge), it is not likely that they will make any effort to acquire/construct new knowledge. Hence, relating to metacognitive knowledge, teachers need to help students make accurate assessments of their self-knowledge, not merely inflate their self-esteem. Mark’s approach in correcting students’ responses and sharing that they did not consider particular reasons demonstrated his aid in allowing students to make accurate assessment of their self-knowledge rather than merely focusing on increasing their self-esteem. On the other hand, Nancy mentioned that she does not take her students’ first lab grade into the report card at end of year because this is the time where it is their first time and where she provides lots of feedback. By then allowing students to metacognitively reflect through what they did in their first lab and what is actually expected, she provides them with other chances where they can improve, and subsequently remove that first grade.

In addition, it might be that metacognitive knowledge could not occur without the prior three content knowledge domains, or that the metacognitive domain could be a tool to master the three prior domains through the fourth constructivist principle reflection on learning. Hence it seems like there is a slight hierarchy in Bloom’s knowledge domain itself as metacognition can not occur without having some factual or conceptual or procedural content to think around (i.e. thinking about the methods to cognitively process the content).

To summarize, there is a very close relation between constructivism and Bloom’s taxonomy (provided by the above Bloom-Constructivism table). Just as there is room for creativity and teachers’ professional judgment when selecting objectives and instructional activities matching a particular stage in Bloom’s hierarchy, the primary question teachers need to ask themselves is whether they targeted all prior constructivist principles needed to be able to work at that selected stage in the hierarchy. In addition, this relation provides the space where teachers undergo lots of assessment for and as learning. They become lead learners (Growing
Success, p. 30) where they guide students and slowly fade that guidance to ensure mastery of specific cognitive process before proceeding to the subsequent one and guide on another level (and the cycle continues). Below is the Bloom-Constructivism table with a model showing how teacher guides at each stage.

4.3 Constructivist Learning Assessment & Bloom’s Taxonomy:

4.3.1 Constructivist Assessment & Evaluation - Teacher’s Perceptions:

Nancy brought out that assessment or evaluation following a constructivist framework was fickle as it was not straightforward to figure out:

This is why evaluation is so fickle… I find it’s probably the biggest issue we have in education. Parents have issues with it, we have issues with it. And I haven’t quite figured out how assessment and evaluation should proceed … it’s still a big block for me, so I keep trying to explore different things.

The biggest challenge was bringing in assessment as a learning tool for high school students who have lots going on in their lives and would not bother doing something that does not count for grades. Nancy mentioned that it takes work and time, and that she actually had to train her 11th graders to understand that they need to work hard on assessment tasks even if they do not count towards their grade. They need to use assessment as a learning tool and as preparation for their summative. Hence she showed how executing this framework realistically requires continuous trials, persistence, and exploration.

One the other hand, presenting tests with thinking inquiry questions brought out one of Mark’s use of constructivist assessment. He presented questions in a gradual sequence starting from placing the knowledge using close-ended questions (which he saw as not very
constructivist) to applying it using open-ended questions. So he gradually integrated higher-order thinking questions/puzzles in his assessment techniques:

Now that I’ve brought them thinking about stuff, I’ve given them a new question here. This is a question they’ve never seen before. So I tell them what I’m looking for. I say that the main source of nitrogen oxides comes from road vehicles… and I’m telling them also A are plant like organisms that can vary in tolerance with levels of nitrogen oxide and some A can grow in very clean areas or low levels and others are nitrogen insensitive. So I give them the two nitrogen species… so this is the nitrogen sensitive and here is the insensitive one. And now I tell them how would you use this. So they have to come up with their own experiment, their own plan.

As seen, both participants brought out different experiences when inquired about constructivist assessments. Nancy’s perception of constructivist assessments being fickle due to the pre-requisite of training students to value these assessments may show a missing gap in Bloom’s taxonomy and constructivism effectiveness; students’ attitudes towards learning and work habits. This important point will be brought out and elaborated on later when discussing challenges. On the other hand, Mark’s perception via sharing his inquiry based test showed an example of the hierarchal application of the revised Bloom’s Taxonomy where it started with knowledge questioning (i.e. close-ended) and slowly testing the next level via open-ended questions (ex: nitrogen sensitivity factors). It further showed constructivist principles by using an authentic task as a context by which students applied their knowledge.

Furthermore, students’ creation could be the result of students’ different approaches to the questions. Hence, as both participants mentioned, though the question might be answered in the same way, students could come up with completely different methods. That is the essence of constructivist assessment (i.e. students’ individual constructions) and the shift away from the one answer in one-way regurgitation method. This actually may show, depending on the type of teacher, an example of a challenge or preference where the teacher has to understand and assess these individual students’ thinking to make sure they are on the right track through their different thinking routes. Hence when evaluating, views might be perceived differently, and hence what the teacher might find as the better method might not necessarily correlate with what the student viewed. In this case teachers need to be open-minded, patient, and real constructivist assessors.
Considering the fact that evaluations could be different by different people, in Science as a subject, the teacher might have a point in disagreeing with the student’s evaluation. Maybe the student did not consider vital factual knowledge or conceptual knowledge that was specific to the discipline (i.e. Science content which is not easily altered). That might show the validity behind having a revised two-dimensional taxonomy where objectives were set by looking at the cognitive process assessed and by the appropriate knowledge domain. If the student evaluated appropriately using a specific method, he might have done well with that cognitive process stage, but he might not have applied it well with the proper Science content (from knowledge domain) and therefore had not really targeted the whole objective. The lack of understanding this difference can model another example of constructivist teaching or assessment misapplication. It goes back to Gordon’s (2009) point in that there is an emerging fallacy that constructivist learning theory in which the learner is cognitively active translates into one in which the learner is merely behaviorally active. Hence is it not merely seeing how well students can execute at different cognitive stages but also on how they execute within the appropriate knowledge domain (especially in Science as a discipline that incorporates knowledge and facts).

Consequently, teachers and pre-service candidates need lots of practice when working with Bloom’s taxonomy on both axes (cognitive processes and knowledge domain). Merely analyzing or applying a concept is not enough because the concept may in itself be incomplete, faulty, or misconceived. That is also why sometimes when evaluating a student, he/she may show great thinking but the content may be irrelevant or off point, and then the teacher is set in a dilemma on how to give that student a grade (which shows the advantages though of assessment for learning as teachers guide and facilitate). By primarily remembering that the point of Bloom’s original work is setting objectives, and by using the taxonomy table to insert activities and assessments that target those objectives (both cognitive process and knowledge domain), the whole process becomes manageable. That also shows that constructivism does not merely mean the ‘anything goes’ approach (Gordon, 2009) by allowing students to critically think and construct whatever meaning they come up with and leave it at that because the meaning is in the eye of the beholder. It is to critically think in constructing meaning about different appropriate knowledge domains and use the diverse cognitive processes to critique, extend, or validate these meanings. Only when teachers comprehend and value this, they will apply constructivist assessment and evaluation effectively.
4.3.2 Bloom-Constructivist Assessment Relation:

When inquired about tools that make effective constructivist assessment/evaluation, both participants mentioned using a variety of assessments, thinking about different ways, and having the formative supporting the summative. Addressing the former, participants used a mix of summative techniques including tests, labs, performance assessments, and authentic assessments (ex: field trips). Integrating the latter, for whatever summative technique, there was a practice formative assessment in the same style and form, hence emphasizing the importance of having the assessment for and as learning (formative assessment) supporting the assessment of learning (summative) in any evaluation. For example, Mark was taking his students to a garden on a field trip that contained an evaluation piece (ex: maps, information, open-ended questioning). To prepare for it, he had a three-day assessment where he gave his students water samples from another garden to look at the effect of the city on the waterway and similar questions.

On a similar route, Nancy mentioned the idea that for whatever summative evaluation is given, students needed to practice it: “If you’re doing a presentation, they need a practice presentation before they actually do the presentation that’s going to be evaluated. So this idea of the assessment for and as learning again (formative) supporting the summative in any evaluation is important I think”. In addition, Nancy had a strategy by which she gave lab reports where usually the first one was of poor quality with lower student grades. She mentioned taking this first lab as an opportunity to scaffold, provide lots of specific feedback, and model exactly what is expected from students. Subsequently students knew what was expected and the lab reports became more substantial as the teacher now expected more. As the year progressed and students improved, Nancy mentioned removing the first lab report grade. This shows Nancy’s use of assessment for learning in helping students build for their assessment of learning piece: “so this step wise kind of increasing expectations so that they learn through what they’re handing in to me”. It also shows her implementation of an important note written in the Growing Success (2010) document by which a grade should reflect the student’s most consistent level of achievement, with special consideration given to more recent evidence’ (p. 39).

Nancy’s and Mark’s approaches revealed good examples of assessment for learning supporting/preparing assessment of learning, as well as use of diverse types of assignments that integrated Bloom’s taxonomy cognitive processes and procedural knowledge within the context of constructivist principles (authentic application with feedback).
In addition, though Mark mentioned that he would like to integrate more assessment as learning, Nancy highlights showing students how they can build knowledge by undergoing it: “so a lot of assessing for themselves…that is assessment as learning piece where they are to look at the piece and say ‘where were my… where do I need to study more? What do I need to review and how do I go about reviewing it’ so that’s a big part of it”. This assessment as learning piece really provides students with the opportunity to undergo specifically that last constructivist principle: reflection on learning. It further shows the importance of adding metacognition as part of the knowledge domain in the revised Bloom’s taxonomy.

Considering the purpose of this study on constructivist assessments and evaluations, following both participants as well as the goal of Ontario’s Growing Success (2010) assessment document, prior emphasis was on product to the point that we created a culture where only the product was valued. That might be why teachers continuously used traditional rote learning and lecturing because at the end, the product was evaluated without necessarily pondering the cognitive processes students went through. As a result, and one of Nancy’s reasons when referring to constructivist assessment as fickle, it was difficult to shift students’ attitudes to currently value both process and product. Therefore constructivist assessments and evaluations became difficult to implement without changing those attitudes. Students neither respond well to seeing evaluation as a learning tool or using assessment as learning opportunities. Hence realistically, students may not necessarily value assessment for/as learning.

Participants had a huge role in constructivist assessment environment. Through observing, conferencing, and questioning, teachers applied assessment for learning to push students to think outside their comfort zones and develop higher-order thinking skills (Bloom’s taxonomy cognitive processes). By setting an environment where students could fail and re-explore, students’ attitudes changed by which they felt more confident and motivated to try out (Ex: critiquing or failing a test). Mark shared with students that the first time they test themselves at the evaluation stage, they should not be surprised if they failed because they were meant to fail at those earlier points. He provided online tests so students had chances to practice for an evaluation piece. On another route, Nancy would repeat or eliminate previous evaluation pieces as students show improvement:

It is graded but then by the time you get to the second report card and we’ve repeated an evaluation from there to that, the first one I’ll often remove from the evaluation. So in
the end, at the end of evaluation, like the grade they get at the end doesn’t always include all the things that they also had at the beginning because they are improving over time.

Hence both participants brought up with their students the value of using assessment as learning tools for their evaluation. By answering Mark’s online tests and using Nancy’s elimination of the worst evaluation assignments via integrating multiple rounds of evaluation, students got practice and chances to build themselves and improve. Simultaneously students would slowly develop habits to become independent autonomous learners where they made the choice to take advantage of assessment for/as learning.

The table below, referred to as Bloom-Constructivist Assessment table, links the aforementioned Bloom-Constructivism table with Growing Success (2010) different types of assessments. By looking at the table, specifically at assessment purpose, I find that assessment for learning takes place when applying the first three constructivist principles (eliciting prior knowledge, creating cognitive dissonance, and applying with feedback), and assessment as learning is applied with the fourth constructivist principle (reflection on learning). On another hand, by looking at the nature of assessments, teachers can use diagnostic assessments to bring out students’ prior knowledge, undergo formative assessment via guidance, observations, conferences, and questioning through the subsequently two constructivist principles (i.e. when giving a puzzle creating student cognitive dissonance, and when continuously giving feedback as students apply knowledge). In addition, if one realizes from the table, I included the summative or assessment of learning piece as separate or outside the framework because, as participants brought up, the formative assessment practice should resemble the summative. Hence when students go through all four constructivist principles and are guided via proper assessment for and as learning strategies, teachers can provide a similar summative piece where they now judge students’ performance.

It is important to note that this is not the idealistic table showing the complex relations between Bloom’s revised taxonomy, constructivist principles, and constructivist assessments and evaluations. For example, critiquing it, one may find that reflecting on learning is applied to the whole ‘metacognition knowledge’ domain/row, or that assessment for learning also takes place with assessment as learning when students reflect on their learning. Though agreeing with these two examples, and more to come, this table can be a starting point to visualizing the three-way relationship.
Lastly, the participants’ goal of using constructivist assessments was developing better thinkers, creators, innovators, and self-directed leaders. The shift to evaluating process meant students were responsible for their own learning and that could be achieved by valuing important learning skills or work habits needed when graduating. The original Bloom’s Taxonomy mentioned two other domains (other than cognitive), one of which was affective. According to Growing Success (2010), work habits or learning skills are not evaluated (p. 10) and so it is up to students to change their attitude by taking the lead in deciding whether they would take advantage of assessment for/as learning supporting assessment of learning. This might slightly bring in the fourth part in Bloom’s knowledge domain (metacognitive knowledge where students think about their thinking). However this is where I might slightly criticize the revised taxonomy. Though assessment for/as/of learning requires both valuing process and product (or cognitive process and knowledge domain), Bloom’s taxonomy remains decontextualized by not eliciting the required attitudes and working habits needed to develop and master skills presented by Bloom.

4.3.3 Teacher’s role – Assessment for/as/of Learning:

Similar to instruction, the teacher’s role in a constructivist class is a coach when assessing, and an impartial judge when evaluating. To summarize the integration of constructivism, Bloom’s taxonomy, pragmatic application and teacher’s role in a Secondary Science class, here is an example. When setting a unit plan, Mark had at least 2-3 evaluation pieces that were different (ex: lab report, Biology test). He further examined different pieces like
inquiry thinking, authentic performance, application, and/or knowledge (i.e. different levels of Bloom’s cognitive processes and knowledge domains). Those evaluations were used when interacting with students or parents about gaps or strengths a student had. In those evaluations the teacher acted as an impartial judge where he/she figured out the student’s level and whether it met provincial standards. At this point, the teacher was not coaching or making the students successful, but merely seeing where they were. So in evaluation, the teacher was not working with students (unlike in assessment) but was an impartial judge giving marks.

Before the evaluation piece, the participant also prepared several assessments (ex: quizzes, practice rounds like biological drawings) where the teacher’s role was giving feedback and taking anecdotes. Then using those notes, the teacher discussed with parents and students specific troubles. This shows constructivist principles application with feedback and reflection on learning. So after this point, the teacher had done his/her piece. The rest should come from the student him/herself, which returned to the point of work habits and learning skills. Throughout those assessments, the teacher acted as a coach where he/she observed students, and conferenced with them.

Furthermore, an example of an actual authentic assessment in grade 11 Biology could be genetics case study. Nancy’s students were required to act as genetic counselors to educate the family in whatever method they chose in analyzing the assigned case study. In the case study, the students were required to diagnose a patient, give family history, form Punnett square and a family pedigree, and then propose a course of action. This exemplified applying Bloom’s taxonomy (higher order levels) in a constructivist assessment task (authentic task). It similarly showed third constructivist principle: application with feedback. Hence in those kinds of assessment pieces, the teacher was a coach who worked with students to help them become more successful. In addition, the assessment pieces resembled the actual evaluation piece, so the same assessment tools could be used for different assessment purposes (for/as/of learning). This related to Harlen’s (2006) point that the difference between formative and summative is not how they are different kinds of assessment or different methods of gathering evidence, but rather how the information is used.

Moreover, depending on the teacher’s own style, having a more flexible assessment plan like Nancy’s by throwing in assessments, eliminating earlier evaluations, and/or repeating evaluations may be useful to students. This demonstrated a good pragmatic example applying
Growing Success’s point by looking at students’ consistent level throughout but giving more emphasis on students’ recent development and products (p. 41). Also for students who did not initially value assessments as learning opportunities and who subsequently performed poorly on an evaluation piece, by having a repeated evaluation and eliminating the prior one, they got a chance to see the value of both process and product by following the fourth constructivist principle reflection on learning. As a result, they took the repeated evaluation as an opportunity to improve.

Moreover, Nancy’s practice in throwing in assessments and repeating evaluations actually revealed the realistic situation by which mastering a specific level in Bloom’s taxonomy required time depending on the student and multiple supporting factors (ex: private versus public school, parental involvement, student motivation to learn). Hence it was important that the teacher used his/her professional judgment in allowing students to practice those different levels by using a mix of the 19 categories reflecting cognitive processes and knowledge domains.

In addition, when evaluating, participants accentuated the need to be in class to see everything to ensure the work was the student’s own even if it required multiple days. Mark shared an example where an assessment package could be returned at the end of class to the teacher and retrieved at the beginning of next class. The in-class observations and assessments further allowed the teacher to reflect on his/her own practice (i.e. being his own constructivist learner) by asking questions and taking notes. This related back to Growing Success point ensuring equity (p.39), and again showed teachers the student’s true pace when it came to mastering particular stages from Bloom’s Taxonomy.

To summarize, constructivist assessments already take place when setting up an environment where constructivist learning takes place. In this environment, the teacher is a facilitator by giving feedback and observing students (examples of assessment for learning). When it comes to evaluation, the teacher is an impartial judge deciding the student’s level, and maybe internally thinking about how to aid the student once he/she becomes a coach again. Hence realistically pedagogy and assessments are not two distinct parts but overlap with each other. To be a true constructivist assessor/evaluator, teachers need to value the framework and persist through its challenges. They need an open-mind where if one activity/assessment did not work well, that is fine and he/she can change it up. As Mark mentioned, it is the idea that failed, not the teacher.
Furthermore, when setting up an assessment plan, teachers need to consider the linkage between objectives, instructions, and assessments. By using both dimensions in Bloom’s taxonomy (cognitive process and knowledge domain) when setting up objectives, instruction with assessment for/as learning, and evaluations with assessment of learning, teachers will find themselves applying the four constructivist principles (going back to the Bloom-Constructivism table) and gradually students will develop multiple skills. Also, although students may not value process yet, making it difficult to apply constructivist assessment/evaluations, teachers should continuously communicate and open the space to allow students to see the interrelationship between process and product (in that without valuing the process, the product is negatively impacted). If students do not see it, then with time it will be observed by their poor performance on their evaluation tasks. This will subsequently prove the teachers’ rationale in valuing assessment for learning to prepare for assessment of learning, and in this case the teacher can start eliminating earlier evaluations where students did not value the process by adding in an extra/repeated evaluation task.

4.4 Supports & Challenges in constructive assessments:

4.4.1 Benefits and Supports:

Though students might not necessarily immediately enjoy constructivist approaches in assessment and evaluation, these approaches might allow them to develop skills and actively engage in their learning. The assessment for/as learning opened a wide spectrum where students could explore and critically think to construct meaning by knowing, understanding, applying, analyzing, evaluating, and creating (i.e. Bloom’s cognitive processes). As Nancy mentioned, the whole assessment for learning piece is the constructivist piece of evaluation in that students get a better understanding of what is expected of them, and how to produce whatever is expected of them. Hence as both participants mentioned, this push towards Growing Success was actually a push towards the constructivist idea of having students use assessment as a learning tool so students find out what they know and do not know, and subsequently build on that via Bloom’s revised taxonomy. Supports included sharing and discussing expectations, and modeling to allow students to produce what is expected from them and learn how to learn skills.

In addition, there was opportunity to differentiate assessment and to allow students to design their own tools of assessment (assessment as learning) via co-creating rubrics and critically thinking about criteria, all demonstrating contexts where students used different
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categories from Bloom’s Taxonomy. The constructivist skills developed in Nancy’s and Mark’s classes led to long-term impacts and goals to the point that when students went to university, they felt more prepared than many of their peers who did not pursue constructivist assessment. As Mark mentioned, they felt pride even in their knowledge domains:

My students come during holidays saying in university, I’ve already learned everything and so the kid beside me doesn’t know how ribosomes work, and I’m like how come your teacher has not taught it, and we learned it in school. So they feel a lot of joy and pride in how well they know the material.

In addition, with both participants, students gradually appreciated practice assessments to the point that they took the initiative to ask for guidance and to ask when was the next practice assessment. This showed slow development of valuing assessment for/as learning, developing cognitive thinking skills, and building long-term work habits.

Furthermore, unlike the traditional approach, the constructivist approach kept pedagogy interesting, which was further transferred to students. So the same curriculum/material taught every year changed when teachers used the constructivist approach as opposed to lecturing. In addition, it encouraged positive collaboration and sharing between staff, and encouraged building rapport with students by sharing their learning philosophies, convincing them of the value of each assessment, and basically opening up the space to discuss the relevance of objectives (relating back to using Bloom’s verb and noun in communicating those objectives).

Finally, one of the challenges brought out by Nancy was theory to practice gap where students, when getting to university, were assimilated to lecturing and grades again. However through her practice and examples, one finds she does a good job in applying constructivist assessments in types of tasks and with questioning style that students go through in university. For example, Nancy used multiple-choice questions as a learning tool to build students’ competence in taking tests and addressing misconceptions. Similarly, both participants used multiple resources including exam banks, Internet, study guides, Biology competitions, previous standardized tests, and global exams to build constructivist thinkers who are also ready for post-secondary. This reveals that even techniques like standardized tests and multiple-choice questions does not necessarily oppose the constructivist viewpoint when used as one of the variety of assessment tools out there. Hence, as both participants brought out, having a variety of
assessments in both formative and summative forms allowed students to develop diverse constructivist skills and knowledge.

4.4.2 Challenges in Constructivist Assessments:

Though there were supporting factors, there were still some existing challenges and obstacles demotivating teachers to pursue constructivism. Similar to the last point, some challenges in applying constructivist assessment and evaluations included theory to practice gap. The reality of high schools was students had many responsibilities at this age and were stressed to the point that they could not focus; hence there was somehow a loss of time to focus on constructive thinking and learning. In addition, both participants mentioned time as the main obstacle in applying constructivist framework; this approach was slower than the older traditional method (both in terms of instruction, assessment, and evaluation), but teachers viewed the active learning as more important.

With regards to time being a constraint, Mark mentioned that he used flipped classroom because of this challenge. Though this model may lead to having constructivist discussions after students prepare at home and apply in class, he understands that he is taking time off kids and the reality is high school students are very busy. He brought out that if every teacher did what he was doing, students would not be able to finish their curriculum. Hence because he realized that other teachers were not doing it, Mark used flipped classes. This shows that the shift towards use of constructivist teaching and assessments shows time as a challenge, and when responding to that challenge by integrating a flipped class model to focus class time on the difficult application questions, the model is actually painful to students. Hence one asks then whether constructivist teaching is what students want. This actually brings up the point that sometimes direct teaching is not as bad as assumed, and that at the end application of constructivist teaching may not necessarily oppose use of direct teaching, but can rather integrate it appropriately.

To add, some challenges were beyond teachers’ control where there was a need to change students’ attitudes about learning by which they value process and product. The value on marks made assessment for learning difficult, hence amplifying theory to practice gap. Hence the problem emanates from putting the theory found in Growing Success (2010) document into play. Nancy evoked that the school system is a bit problematic because entry into university has become so difficult that students are really focused on what to do to get admission. So it is not even about the grades, but about what to do to enter university (ex: extracurricular, clubs,
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grades). She brought out an example where if students got a 90 in her Biology class, they dropped it and went to a private school or night school, so they did whatever it took to just get into university. As a result, 11th and 12th graders are what she refers to as ‘mark hungry’; they do not do anything that is not for marks, making it very difficult for teachers to apply assessment for learning. As a result of this difficulty, teachers cannot get a true picture of what students know and do not know. This subsequently shows how constructivist assessment and evaluations become timely and difficult to implement. For example, Nancy students’ excuses become:

Well I didn’t really study for this quiz or I didn’t put my full effort into it, so they can’t themselves tell that they do and don’t know and how they should progress from there. So I think that the reality of school and stress that is on the kids and the fact that they’re doing a million other things and they can’t focus.. they don’t have time to kind of fully focus on one particular thing makes it difficult to put the theory to practice.

Realistically teachers are set in a dilemma where there is a conflict between pursuing effective constructivist teaching and post-secondary preparation because the latter still executes mere lecturing. Even when it came to applying a flipped class model, students might not like it because it took time off their already busy schedules (and teachers were aware of that). Hence, as Nancy revealed, there is a need to what she referred to as structural de-emphasizing view of grades and that it might be hard to nail down how to reduce that gap between constructivist or effective teaching in secondary with applying to and learning in post-secondary:

I think this is the system. This is the way it is right now for young people… somehow there has to be… I don’t know. I don’t even think we should … like I don’t agree that there should be an entrance exam to university that we see.. I think that’s a good option. But this somehow de-emphasizing this idea that grades are everything now and that’s it. Like I have students in my class who don’t perform well on assessments and evaluations for whatever reason but are hugely interested in the topic, very engaged and very interested but don’t study or perform well or whatever, but still enjoy the subject of Biology… so what do you do with those kids?

Many students might be motivated to go into university, but to reach that stage still required mostly students’ grades. As a result of the aforementioned challenges, realistically with all responsibilities and teaching in particular contexts (ex: type of students), the teacher might find the challenges daunting to the point that they were unsure what comprised effective teaching
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and assessment. As Nancy shared: “So I’ve been teaching for a long time and I still haven’t figured it out… so I’m not sure what advice..”. That may show why constructivist assessment and evaluation became fickle.

In addition, another challenge to implementing constructivist assessments might be the factors influencing students’ motivation to learn. When inquired whether students were intrinsically or extrinsically motivated, Nancy mentioned that it depends on the student but that if one teased aspects out, students are intrinsically motivated to go to university in that they want it. However their extrinsic motivator is their university grades. The motivation is not necessarily due to the joy of learning, but the true question becomes how to separate students’ intrinsic motivation to work to get into university and their extrinsic motivation that is their grades. Considering this then, one may think that students’ degree of motivation and specifically the factors (extrinsic or intrinsic) influencing motivation may be another realistic challenge when teachers apply constructivist principles in teaching or assessments.

4.5 Student Responses and Outcomes:

When it came to applying constructivist learning framework in assessments and evaluations, both participants mentioned different student responses. Nancy mentioned student frustration and their preference of the traditional way where they just sat and took notes without thinking, and that even her best students preferred that because it was less challenging and did not require them to have to think. This point might relate back to the challenge of finding out what factors (intrinsic or extrinsic) influence students’ motivation to learn.

Mark mentioned similar students’ feelings in that, before the Growing Success (2010) document, students did not value whatever was not counted and so they would not work well. However in this case, with time, his students became very engaged as they felt ownership and motivation to learn. They were quite relaxed with this approach and they built more confidence as they tried new things. This relates to Palmer’s (2005) point mentioning that in constructivist learning, it is not the teacher but the learner who is his own motivator. Hence the learner’s perception is crucial as the question is not if a task is authentic or engaging, but whether it is perceived as such by the students.

The reason there were different student responses might be due to multiple factors such as school type (Mark’s private school versus Nancy’s public school). Another factor could be student behavior and ability (Savasci & Berlin, 2012). As Ryan and Deci (2000) reveal, students
take responsibility of their own learning by relying on their motivation through aspects like deep-level thinking, curiosity, exploration, and self-regulation. In order for constructivist assessments to be effective then, student behavior and work habits are very influential aspects as some students may not know what they are doing or may easily lose concentration or engagement in the activity because they are not motivated to initiate thinking. This shows some behaviors and attitudes students need in order to take advantage of constructivist learning assessments.

In addition, parental involvement in the student’s education might be an influential factor. In Nancy’s public school, there was low parental involvement (though that did not mean they were not pleased), but in Mark’s private school, there was a close student-teacher-parent communication. When it came to assessment for and of learning, Mark consistently mentioned communicating the results with parents and asking them how their child was doing at home:

Oh look your child was having trouble with this particular microscope work … I invited her to come and meet with me after school on Wednesday. She hasn’t come… she says she’ll come but she doesn’t show up… why don’t you tell me what’s happening at home, what’s the reason that she’s not coming… is it that she’s afraid of me… is that she’s got other commitments because here’s the thing is that I’ve given her multiple pieces of assessment but this is an area that she needs to work on, and she’s not doing it. So I’ve done my piece. You tell me what’s happening from the home end as to what’s going on.

This may correlate with Savasci & Berlin’s (2012) study mentioning that private school teachers reported more parental influence on their instruction and teachers there tended to be more responsive to parental interests and concerns.

Moreover, both teachers emphasized rapport building. Nancy brought out that by talking to students about how their brains work and sharing learning theories and importance of consolidation, she set time to talk about this in an attempt to help students realize that they need to do what is being asked because it is going to help them and their future. Through these conversations, her 11th and 12 graders became convinced to the point that if she got the same class two years in a row, the students got right to work because she had these talks with them and they knew that when she asked them to do a task, it was to help them succeed.

Similarly, Mark also emphasized differentiated assessment and rapport building with students by which initially he would give them the space where they were allowed to use their own learning system and see if it works. After trying out and seeing the degree of effectiveness
of their own learning system and studying habits, students started to see the value of the teachers’ recommended learning system and shifted to using it. That means that students knew that they needed to take advantage of assessment for learning activities, quizzes and resources to help prepare for assessment of learning. Hence instead of forcing them, the teacher gave students their space and subsequently gained their trust; they knew that whatever he gave was to help them. Hence with time and rapport building, students became more engaged and motivated to learn via valuing teacher’s constructivist framework and use of Bloom’s taxonomy.

In addition, when applying constructivist approaches, students valued the practice because, no matter how much scaffolding or modeling or rubric sharing that took place, students did not understand how to apply until they actually did the task themselves. Nancy mentioned that once they got feedback from their own work and could see exactly for themselves what was meant, things started to improve. The feedback resulted in improvement as students reflected on their learning during the assessment for and assessment as learning pieces. This again showed the crucial fourth constructivist principle: reflection on learning (Windschitl, 2002). Nancy mentioned that the whole theory/intent to do different instruction and assessment allowed students to know their pace in building thinking skills. With time, even the participants received feedback where students came up to teachers grateful because they felt engaged with the content and, without consciously knowing it immediately, they felt prepared when entering post-secondary institutions.

To summarize, at the beginning of using constructivist framework and working with students on building Bloom’s taxonomy skills and knowledge, students may feel frustrated and may prefer the old traditional way where teachers merely feed them the knowledge. I believe one reason is the initial challenge students face as they are confronted with situations where they have to apply higher-order thinking levels and hence are getting out of their comfort zone. With time though, students realize the value and benefits they actually gain from the constructivist approach in building skills, allowing them to be autonomous independent learners, expanding their knowledge, and actually preparing for post-secondary or employment opportunities. For this shift to take place, students might have undergone the experience where they did not value assessment for/as learning and subsequently did not do well in evaluations. From there, through reflection and important learning skills and working habits (ex: motivation to learn, autonomy), students learned the value of their teachers’ assessments for/as learning (through practice,
modeling, rubrics, and feedback) in preparing them for their assessment of learning and subsequently for real life opportunities.

4.6 Conclusion:

In conclusion, there are many lens and angles where constructivist assessment can become beneficial or challenging to implement. It starts by whether teachers believe in the use of this framework in building students’ knowledge and how to learn skills. To value it, teachers need to practice it and to go through the higher cognitive processes that are then expected from their own students. It is important to note that with cognitive processes lays the subject’s knowledge domain where teacher consolidation, misconceptions errors, and even some direct teaching are used. Hence teachers need practice on Bloom’s two axes: diverse cognitive processes across the different knowledge domains.

Via following the revised Bloom taxonomy with the two axes, teachers are inherently applying the four main constructivist principles: eliciting prior knowledge, creating cognitive dissonance, applying with feedback, and reflecting on learning. These contextualize learning as both teachers and students know whether for example they are bringing out background information or reflecting on a task. By contextualizing, constructivist teachers developed objectives (using both cognitive processes verb and knowledge domain noun to write it) and are to subsequently communicate them with students (note: the Bloom-Constructivism table provides a good visual). After setting and communicating the objective with students, constructivist teachers build instructional activities and assessments to target them.

Constructivist assessments already take place when setting a constructivist-learning environment in that it incorporates lots of assessment of learning and assessment as learning opportunities. These formative assessments should support the summative assessment piece (i.e. assessment of learning) by having identical practice questions and tasks. The Bloom-Constructivist Assessment table provides a good visual of the relationship between Bloom’s two-axes, constructivist principles, and Growing Success (2010) assessment document. In addition, with regards to teacher’s role, they facilitate during formative assessments, and they judge or give a grade during summative. It is important to note that, in constructivism, realistically pedagogy and assessments are not two distinct parts but rather they overlap. Throughout, teachers need to be open-minded and need to have the persistence to differentiate according to students’ needs. Being a constructivist teacher and assessor is an on-going professional
development and hence it does not require teachers to be perfect but rather to be willing and spontaneous in changing up tasks if needed. It follows Mark’s quote: “it is the idea that failed, not the teacher”.

The push towards Ontario Growing Success (2010) assessment document may be a push towards the constructivist idea of having students use assessments (assessment for and as learning) as a learning tool so they find out what they know and need to build on before their assessment of learning. However, though this push with constructivist assessment and evaluation allows students to build skills, become autonomous independent learners, and sometimes prepare for post-secondary education or employment opportunities, it has its challenges. Some of the major challenges emphasized by participants include: time, the use of flipped model that may be inequitable for some students and may not take into account their busy lives, students’ attitudes by not valuing assessment for/as learning as learning opportunities, students’ source of motivation and working habits which are foundational to constructivist assessment effectiveness, and the theory-practice gap that may also result from the secondary and post-secondary gap. As a result, many students (even high-achieving ones) may prefer the old traditional approach where they do not have to initiate thinking. To deal with those challenges, there is a need to shift students’ attitudes that, as participants brought up, requires lots of rapport building and a structural de-emphasizing of grades.

To summarize, depending on the context teachers are teaching in and considering factors like student behavior, student ability, student goals, school type, parental involvement, availability of resources, staff collaboration, external factors including school systems, post-secondary admission, and cultural values, teachers decide the degree by which they apply constructivist learning assessments and evaluations. Though it may be overwhelming, the constructivist approach allows people to see the value of teaching as a profession, and allows teachers to know that this profession is all about creativity, innovation, and flexibility. It is about seeing what is needed in life after school completion and what is the teacher’s responsibility to ensure his/her learners are prepared for that life. It is about preparing for post-secondary education as well as building independent autonomous learners. When teachers use constructivist assessment framework with their students, they are also constructivist assessors of themselves because they improve and develop their practices to ensure they are up to date to getting the students where they need to be. By using constructivism, teachers become educators.
Chapter 5: Implications

5.0 Introduction:

In this chapter, pondering chapter 2 literature review, chapter 3 methodology, and chapter 4 findings, one brings out key findings or pieces of learning gained from this study. Taking these, one sets broad implications for the educational research community (ex: students, parents, teachers, administrators, educational research agenda, and teacher education), as well as narrow implications focused on one’s own professional development and practice. Afterwards one shares some recommendations as a result of these findings, and areas for further research. Finally, one ends with some concluding comments summarizing the significance of this study and the reason behind undergoing it.

5.1 Overview of key findings:

Going back to the main research question how do Secondary School Science teachers enact constructivist learning framework when assessing and evaluating students, one finds that there is no universal response or one right option. By interviewing two Ontarian Secondary Science teachers, one working within a public school and the other working within a private school, responses had similarities and differences. The responses were analyzed in relation to the revised Bloom’s taxonomy with its two-dimensional axes (cognitive processes and knowledge domain). Both teachers revealed similar understanding of what constructivism means, the kind of environment it entails (ex: focusing on bringing out prior knowledge and allowing students to explore), and their role when it comes to undergoing constructivist-learning classes and assessments (i.e. facilitators rather than lecturers). Both mention some use and challenges of a flipped class model, and that effective constructivist assessment is about linking the formative with the summative and using a variety of authentic tools rather than sticking with one strategy. To add, the main obstacles brought out by both teachers were time, student attitudes and work habits, students’ source of motivation, and the existing gap between school teaching and/or assessment and post-secondary education (theory to practice gap). The obstacles may encourage teachers to persist in applying this framework (such as the current two participants), but may also discourage others from approaching it since it may be perceived as entailing too many complexities.

5.2 – Implications:

5.2.1 Broad Implications - Educational Research Community:
One main finding participants brought out is the importance of continuously trying and exploring constructivist framework when teaching and assessing. It requires a clear framework so students would not buy out and it requires true value and belief in its effectiveness. This finding implies that students need chances and time to get used to thinking in different ways and basically applying Bloom’s different levels. Yet with assessment differentiation and individual pacing, this gets a bit complicated on the teacher. The finding further implies that teachers are not necessarily trained to truly apply constructivist assessments, and that teacher education programs may not be preparing new teachers on how to effectively use constructivist assessment through Bloom’s revised taxonomy (integrating cognitive process and Science knowledge domains, and not merely the former or the latter alone). Hence if teachers were not modeled how to apply constructivist assessment in say a Science unit, they do not learn how to apply Bloom’s revised taxonomy effectively which may lead to the diverse misuses and misconceptions brought up in literature, as well as both students’ and teachers’ preference of the old traditional way. There is the initial challenge students face (especially those coming from different cultures) as they are confronted with situations where they have to apply higher-order thinking and basically getting out of their comfort zones. Having teachers who are not prepared or trained may in fact lead to teachers feeling uncomfortable applying the framework in class just as their students would feel when they initially execute it.

Furthermore, diagnostic, formative, and summative assessments also lie within the four constructivist teaching principles: eliciting prior knowledge, creating cognitive resonance, applying with feedback, and reflecting on learning (Baviskar et al., 2009). In addition to their inter-linkage, diagnostic assessment may take place as students elicit their prior knowledge, and formative assessment can take place when teachers provide situations with cognitive resonance and examples where students apply skills and knowledge and receive feedback. Also summative assessment can take place as students reflect on their learning and undergo metacognitive thinking. Plus, Bloom’s revised taxonomy also lies within the four constructivist teaching principles. Just as one cannot start at a higher Bloom level without first practicing (and even being an expert on) the previous ones, one cannot use the second or third constructivist principle without targeting the first. Similarly, one cannot undergo summative assessment (assessment of learning) without having the chance to practice and get feedback throughout the diagnostic and formative assessments (assessment for and as learning) in a unit. This implies that students may
feel disengaged or lost if teachers misapply constructivist approach in the subject, especially if students do not have the prior scientific knowledge. So to skip specific Bloom levels, subsequently a constructivist principle, and assessment preparation, the teaching method becomes decontextualized and students may end up having no idea what they are doing. That is why sometimes when merely setting groupings or cooperative learning, the teachers need to make sure to communicate with students the objective (ex: that they are bringing out what they know first). However this finding may further imply that teachers may be aware of inquiry-based learning or problem based learning (or different terms relevant to constructivism) but many are actually unfamiliar with the revised Bloom’s taxonomy that is the practical aspect of setting objectives and presumably assessments in class. That is why when it comes to applying constructivist principles; they remain theoretical as they are not necessarily set within a pragmatic pedagogical setting. So by saying creating cognitive dissonance, what does that mean in terms of proper pedagogical strategies or assessment tools? This implies that the educational research may not be writing their findings relating to constructivism with teachers as targeted audience (rather then maybe only academics) and so many teachers may be missing out on some valuable findings. In addition, researchers may be writing their findings without directly linking it to effective pedagogy with pragmatic strategies, tools, and even examples such as those shared by participants. Also by looking at the difference lying between what happens in teacher education classes and what happens when student teachers are in practicums, teacher education programs may still not be targeting this existing theory to practice gap.

Moreover, specifically with Science as a subject and the emphasis on primarily bringing out misconceptions or ensuring students do not leave class having solidified misconceptions, the constructivist approach does not merely mean sticking with one teaching strategy or one assessment tool. The examples brought out by participants imply that educational researchers are not necessarily ‘right’ when saying that a constructivist approach requires a subjective lens where the knowledge is in the eye of the beholder or that there is no one truth. Yet Science as a subject is sometimes seen as an ‘objective’ domain with factual knowledge, processes and terminology. Hence this implies that Science teachers may find a gap there in the use of constructivism within such a ‘factual-based’ discipline. This finding may imply that the students who see themselves as ‘not good in Science’ may be due to finding it as pure memorization of unfamiliar terms and processes without teachers showing emphasis on building understanding.
and scientific critical thinking (i.e. constructivism). Pondering these, Kirschner, Sweller, & Clark (2006) mentioned, it is important to realize the difference between teaching a subject as inquiry versus teaching by inquiry. Confusing the two may similarly lead to misuse of the approach and poor student outcomes (such as those revealed in the literature review by Nykiel-Herbet, 2004). In fact this may show the validity of Bloom’s revised two axes because this is when the knowledge does not overshadow the importance of constructivist thinking skills, but also one should not focus on the opposite relation where thinking overshadows foundational knowledge. This also implies that researchers generalize the term ‘constructivism’ to the point that practitioners may just know the meaning of it and may use a couple of strategies implying its use (ex: groupings, reflection writing), but there is rarely an emphasis on the sequence of steps and the inter-linkage with conceptual framework (like Bloom’s taxonomy) or pedagogical terminology. Multiple terms like ‘cooperative learning’, ‘inquiry based’, ‘problem-based learning’, ‘guided work’, and ‘critical inquiry’ that all lie within constructivist thinking may actually confuse teachers more because unconsciously teachers may only be applying one aspect and therefore they are not aware of the importance of sequential steps when enacting constructivist principles and subsequently assessments.

Furthermore, assessments and evaluations following a constructivist framework were sometimes found to be fickle and not straightforward to figure. Hence the challenge that remains is bringing in evaluation as a learning tool for high school students. This implies that students still find grades and whatever it takes to get into university to be the ultimate important factors rather than the actual learning and progress happening throughout say a unit. The difficulty in valuing assessments for and as learning, and shifting student attitudes from valuing merely the assessment of learning (or the grades coming out of it) further implies that the schooling structure (including post-secondary) still value it more. It further implies that teachers are caught in the middle between quality teaching and preparing for post-secondary style.

This also implies that schools are not set in a niche and that there is huge linkage to post-secondary education (whether that be university, college, or vocational). So policymakers and boards still cannot reform and motivate a shift towards constructivist assessments (ex: emergence of the Ontario Growing Success document) if there is no connection with what higher education systems do. This further implies that students and even parents will continuously value that grade that brings admission to whatever place students are targeting to be in after completing
high school. Finally, for educational research, the finding may imply that research is focusing more on constructivist teaching and assessments at the school level but one wonders to what degree is there as much research and changes at the post-secondary level.

Both teachers’ goal in using constructivist assessments and evaluations is primarily to develop better thinkers, innovators and self-directed learners. The shift that took place by introducing the Growing Success (2010) document where there is a focus on assessment for/as learning through conferencing, observations, modeling, practice support and scaffolding, may show a good first step in achieving the goal of developing independent autonomous thinkers. However one brings out the factor student motivation and work habits. With high school students in particular, the teachers can do so much to differentiate and accommodate, but at the end it comes down to students’ willingness to learn, motivation, and subsequent work habits. So, and brought out in chapter 4, though assessments for/as/of learning require valuing both process and product (cognitive processes and knowledge domain), Bloom’s taxonomy remains decontextualized by not evoking the required affective attitudes and working habits needed to develop these skills. As Palmer (2005) mentioned, it is not the teacher but the learner who is his own motivator. It is the learner’s perception that is crucial as the question is not if a task is authentic or engaging, but whether it is perceived as such by the students. Thus intrinsic motivation is a crucial factor in constructivist learning. This implies a chicken-egg dilemma in which one asks which comes first: does constructivist approaches lead to motivation to learn or does the student’s motivation to learn lead to constructing his/her learning. By motivation, one does not merely mean engagement in a class or two, but more of a long-term intrinsic willingness to develop. This further implies that teachers are guides but at the end of the day they are not the learner’s decision makers. So to say a teacher is an effective constructivist teacher does not mean that all students must be motivated all the time because at the end it is the student’s choice. This implies that research not only needs to focus more on integrating pragmatically the revised Bloom’s taxonomy comprising both cognitive processes and knowledge domain, but also bring out the realistic context of the affective aspect like students’ work habits. Students mostly value grades, and currently there are trials to motivate students to value the process of learning (assessment for/as learning) as well. However within the process of learning lie the affective domain work habits and attitudes, which further include knowledge about the student’s life and situations outside of school. In addition, students’ frustration (part of
affective domain) and their subsequent preference of the old traditional way may indeed be due to low practice using higher-order constructivist thinking and trying to get out of their comfort zones or due to less time available to practice independently (ex: students working after school). Hence taking these into consideration implies the degree by which students show persistence, perseverance, and motivation (all may be aspects of affective domain).

Taking the aforementioned three-way relation (knowledge domain, cognitive process, and affective resulting in specific work habits), and looking at the currently formed Growing Success document, this implies that policymakers merely focused on shifting valuing product to valuing process (assessment for/as learning), but there is rarely help on how to address the work habits. There is only mentioning what constitutes work habits in the document (referred to as learning skills) and that they should not be evaluated. So this further implies that teachers are just left to figure things out while simultaneously teachers are not the students’ decision-makers. They try to be the best coach that is foundational to constructivist learning and assessments, but at the end teachers do not control student attitudes, environment (ex: home), and culture. This is where the complexity emanates.

5.2.2 Narrow Implications – Professional Identity & Practice:

As a teacher, I find the trial and error in executing different constructivist approaches and assessment tools reveal the flexibility, open-mindedness, and passion that teachers need to have as their own work habits. Sometimes when a strategy does not work, it negatively impacts the teachers in that they reconsider their own capabilities and/or they may blame that the framework does not fit a realistic pedagogical context within a class. I feel that as I read and explore more practically the ups and downs of this approach, depending on the teacher’s character, it may act as either a motivating or an impeding factor to improve. The reflective side is crucial and it is what makes teaching a profession requiring analytical skills, observation, and creativity (i.e. deviating away from the misconception that anyone can teach). Saying this though also brings out a crucial working habit; perfectionism. With this framework, I realize that I do not need to be perfect every time, and having that in mind allows me to explore more constructivist assessment approaches as opposed to sticking with what I do best (thus merely making myself feel better by using easier, yet not as effective, teaching and evaluating methods). Being flexible and seeking to improve without the priority of being perfect is what teachers may need to incorporate in their professional identity. Saying that does not mean going to the other extreme.
by trying out a few strategies (ex: group work) thinking that is constructivist assessment for/as learning and not caring much about how effective or purposeful the strategy is. So it is finding that balance and looking into what can work next and how can one take what he/she observed during assessments for/as learning to improve their practice. That is also why I mentioned that this is when teachers become constructivist educators with the primary aim of continuously helping develop students into autonomous independent thinkers.

Furthermore, I find that shifting student attitudes would be challenging but that at the end of the day, as both participants revealed, the assessment of learning piece is impacted by whether students value the assessments for/as learning (i.e. the constructivist piece) to prepare them. This in itself teaches accountability, responsibility, and initiative, which are working habits needed when these students graduate and meet life’s demands. So as a classroom teacher, I may open the space and share my teaching philosophy in that what is selected and done in class is preparing them for whatever they undergo afterwards, and that if there are challenges at this stage, that is the best time to work on them rather than finding themselves stuck with these same challenges as they enter post-secondary or the job market. Thus, even as a researcher, I would look more into intrinsic motivation to learn and how that may be a third axis within Bloom’s taxonomy and how it may be the missing piece foundational to real constructivist learning.

Moreover, as brought out in the broad implications, since Bloom’s revised taxonomy with its two axes lie within the four constructivist teaching principles and the nature of having the sequence of diagnostic, formative, and summative assessments, that two-dimensional framework targeted a theory to pedagogy gap I felt at the beginning of the study. By understanding how to set objectives via Bloom’s framework, and how to subsequently choose instructional activities and assessment techniques, constructivist practice becomes doable and contextualized. Hence in my teaching practice, I always need to communicate this three-way relation to students in that I state the objective targeted (ex: today we will understand Mendel’s law of segregation and why do we learn this) and which of the four principles I am working on (ex: today I want students to bring out what they know about Meiosis). In addition, I use the variety of techniques brought out especially integrating the authentic aspect in how students relate what they are learning in school to real-life. Being transparent is paramount so students would not lose sight of why they for example are doing group work or reflections or similar ‘decontextualized’ tasks. Hence I am making transparency and communication a key part of my
teaching approach so that I know how students are feeling and why they are feeling as such. That is also why I mentioned in the earlier chapter four that constructivist teachers are constructivist learners themselves, as they know from the students what worked, what did not work, and what needs modification.

Also brought out in the broad implications, one of the difficulties and actually another reason behind selecting my research question is how can a teacher constructively assess thinking within a more perceived to be factual based discipline like Science. By having my participants give concrete examples (like misconceptions, glycolysis, or trans fat molecules), it shows clearly Hodson’s (1988) point that it is an error to assume that pedagogic content is identical to methods/processes of the discipline being studied. That distinction with practical examples made me feel more aware in my teaching practice in that I sometimes confuse skills and knowledge or I unconsciously assess one over the other. In fact, though both are achieved simultaneously, both are quite distinct when assessing (ex: skill of analyzing and the foundational knowledge of Mendel’s laws). Also, as a researcher, it made me more aware that the shift of learning is not from valuing product to only valuing process but it is to value both and realize that both are actually interdependent.

In addition, it was interesting how both participants elaborated on the fact that the practice example given during assessment for/as learning should almost be identical to the assessment of learning piece. That is a key lesson to my own class practice. Indeed it reminded me of my days as a student in the International Baccalaureate Diploma where we were being examined using a variety of multiple choice, short answers, long answers, case studies and lab reports (including incorporating a mix of the 19 different categories from Bloom). Having two years to practice through mocks (ex: mock orals, mock exam questions) allowed one to go through the experience and, after rigorous yet genuine teacher feedback and time to develop, I reached a better understanding of what is expected by the time I was being evaluated.

On the other hand, the fact that assessments and evaluations remain fickle and an issue today shows that as a teacher I will be having similar difficulties especially if post-secondary education does not apply these constructivist methodologies and if admission into these places focuses primarily on grades. I find that nowadays there is more than grades when getting admission into university (ex: portfolio, volunteering, experience) yet to what degree is the latter factor as prioritized as the former grade factor, and to what degree will these new requirements
negatively or positively impact my use of constructivist learning and assessments. Taking this back to a pedagogical level, in my practice, I find somehow there is a way to balance effective teaching and preparing for university. I find that getting into say university or college may indeed value grades, but how these grades are set is where I and other teachers come in. Some teachers may focus on merely giving quizzes, other may integrate lab reports, and others may incorporate authentic case studies. To apply constructivist approaches, we need to provide a mix. Even tests can still be constructivist in nature by the type of questions presented. Bloom provides 19 different verbs describing objectives mixing different cognitive levels and knowledge domains. If the test comprises of a mix of these (i.e. multiple Bloom levels), then it may be more constructivist than a test that is solely based on ‘listing’ (i.e. merely one Bloom level). To even be more constructivist, it is paramount to have a true variety, cross-curricular connections (ex: science and literacy), and mainly student-teacher rapport where students are provided with multiple chances to improve so they would not fear being evaluated. In addition, to be a constructivist teacher, one needs to do his/her own research where university/college level questions are brought into the class. This sort of browsing shows initiative, planning, and motivation from the teacher side. It further shows that one cannot be constructivist for a day or a week or a month, but because the student impact is more visible on the long-term (as students need time to build those higher-order skills and working habits), teachers need to be patient. That usually comes when teachers actually value the framework more than when they are being told to use it by force. Though initially students may feel frustrated, teachers valuing constructivist approach may see outcomes more on the long term. Subsequently, as a researcher, I feel that I would look more into long-term observations and the actual assessment tools that teachers use with their students as well as post-secondary tools (while considering to what degree are we expanding or closing this gap).

5.3 Recommendations:

First teacher education programs need to effectively apply constructivist approaches within the proper contexts. Specialized instructors need to effectively apply different levels of constructivism depending on the subject they teach and the degree it is perceived to be more subjective or a ‘factually-based’ discipline (ex: comparing Drama and Science) while integrating cross-curricular aspects (ex: Science and Literacy) and real-life relevance. As a pre-service Science teacher, one finds that there is low focus on the subject curriculum. We, pre-service
teachers, may be using some constructivist approaches (ex: forming a presentation with activities, writing reflections, researching about Science misconceptions, or having a backward design framework when setting up assessments) but at the end when entering practicum with our students, one asks what one learned about the actual curriculum and how to apply what was learned in the course by integrating the knowledge domain (i.e. curriculum). This is when one perceives that teacher education may still be using the old Bloom’s taxonomy where the focus is only shifting to working on the cognitive processes, student-centered approaches, and basically just away from lecturing. However where did the Science knowledge aspect go? It is not necessarily either one extreme with telling the knowledge or the other where students are behaviorally active. It is however having some expectations from students to use their cognitive constructivist skills within the context of the subject’s knowledge and, through that, addressing misconceptions and incorporating some direct teaching. Hence one recommends teacher education subject-specific instructors to use constructivist approaches and without eliminating the importance of explored knowledge. By going over the curricular units (just as we are to do when we have our own classes), instructors should model both axes on Bloom’s revised taxonomy (cognitive and knowledge domains), instructional strategies, assessment tools and resources (ex: bringing out a case study and seeing how we go through it), and ways to differentiate and accommodate. As Savasci & Berlin (2012) reveal, pre-service teacher education programs could provide more opportunities for prospective science teachers to experience specific constructivist components in their university science content and method courses along with specific assignments to implement constructivist components in their specific field and student teaching experiences. We further need to learn about the diverse misuses and misconceptions of constructivist approaches, and how to use frameworks similar to Bloom’s by linking objectives, pedagogy, assessment, and attitudes.

Furthermore, with regards to teachers, one recommends that they start by looking at this study (particularly chapter 2 literature review and chapter 4 findings). The examples, benefits, and obstacles brought out by participants may relate to other teachers, and may give them ideas on how to proceed (ex: strategy on glycolysis, and the authentic garden water assignment). From there, teachers should take it slow and gradual and that was actually one advice mentioned by both participants (especially to new teachers). By going over the Ontario Growing Success Assessment document (including assessment for/as/of learning) and by looking at Bloom’s
revised taxonomy two axes, teachers can start having objectives in relation to a particular unit. Using these two, teachers can start trying out strategies that bring out student prior knowledge, create cognitive dissonance, allow students to authentically apply while giving feedback, and allow them to reflect on their learning. Some of the main challenges in applying constructivism are time, student attitudes and working habits, student’s source of motivation, and theory-practice gap. However some of these challenges (ex: time) will not necessarily change especially since it also takes time for students to build higher-order skills and many students do not initially have the time out of class to practice. However this is when teachers may look at whether benefits outweigh the cons, whose benefit are we looking for in the end, and how to accommodate and differentiate for students with different needs and circumstances.

In addition, some teachers can make use of the flipped class model where students watch a clip or do a reading at home, however some students dislike that because they are already so busy out of school. One recommendation I would give teachers then is apply the flipped class model but give students time beforehand to watch or read, and do not give too many at one point. Hence a video can be of short duration or basically whatever is assigned should not take up a lot of time outside class. In addition, instead of giving a video or pre-assigned reading the day before, maybe give it on the weekend or a few days in advance. That way, students again are developing their own work habits where they manage their time and choose when they can watch or read. In addition, the flipped class model can be applied every now and then (not necessarily for every lesson). Another long-term benefit of flipped class may be getting students used to what they need to do if they choose university/college; by that I mean the assigned tasks they will be told to do by their professors/instructors. Hence again teachers should try to have a balance.

Moreover, it is of crucial importance that teachers collaborate. That is also why when using a flipped class model, teachers should share a good timeline where students get a chance to manage their time without ending up having to do a reading for every class they have. Teachers should therefore be transparent with students about what students are assigned in other classes as well as how they perceive the methods used in class. Doing these show that the teacher is a constructivist learner and educator him/herself. Savasci & Berlin (2012) also recommend that both pre-service and in-service Science teachers should collaborate in peer class observations and have chances to discuss and reflect on their constructivist class practice. That way ideas,
challenges and resources are shared, making the process more fulfilling while setting this positive teacher atmosphere with the aim of helping students.

In terms of policy makers, school boards, and the Ministry of Education, coming up with the Growing Success Assessment document is a good step but there is much to be done after. The point of student work habits or learning skills need to be elaborated on as teachers cannot force students to value assessment for/as learning, yet they also cannot intervene because some students still prioritize grades. This is not to say that teachers should evaluate working habits. On the contrary, I merely recommend exploring the challenges teachers face from applying Growing Success with students who do not have the working habits and subsequently do not value constructivist assessments (probably starting with what motivates students to go to school and to learn). In addition, I recommend the formation of another version of Growing Success written in a way that is easily comprehended by parents and high school students so they would know what is expected from them. If all three educational actors (teachers, students, and parents) are on the same page in how they are assessed and why, then maybe that is one step where some of the challenges (including student attitudes and outcomes) can be ameliorated. Also schools and administrators can set two or three sessions where they go over the document with parents and students so they would know what is expected throughout the year.

Finally, in terms of professional development, specialized teachers may need more concrete examples using Bloom’s revised taxonomy with Growing Success Assessment document and constructivist framework principles. This can be gradual and can continuously provide teachers with new resources coming out (like the use of Gizmos in Math and Science and how that can be integrated). Hopefully teachers value and gain confidence practicing this approach while collaborating to bring up and address some of its challenges.

5.4 Areas for further research:

For researchers, in terms of methodology, one finds the need to undergo more interviews and more importantly observations and/or a long-term study looking at how pragmatically Secondary Science teachers enact constructivist assessment and evaluations (including assessment for/as/of learning) with their students. Researchers can look at the tools used, time spent facilitating, students’ attitudes and beliefs, and teachers’ professional development within this framework. Savasci & Berlin (2012) illustrate that there is inconsistency between teacher perceived (via interviewing) and observed classroom practice, and this suggests that teachers
may not be able to realistically evaluate how well they implement components of constructivism in their classrooms. That is why a future study using observations and more participants is needed when focusing on how secondary school Science teachers assess and evaluate using constructivist framework.

In addition, researchers can look into how instructors at post-secondary level or employment teach and assess learners; why they may or may not be integrating constructivist approaches in teaching and assessment (other than the few reasons known like cheaper way and class size), whether and how they are preparing students for the workforce after, and whether or how post-secondary science disciplines can shift towards a more authentically constructivist approach as well. There needs to be a focus on the high school to post-secondary gap. From experience, most of the post-secondary Science exams and midterms follow a multiple-choice format and maybe include a lab report. Considering this, and since this study focused on Science per se, researchers can look into doing studies by having interviews or observing post-secondary Science professors or instructors or workers in a Science field (ex: disease research facilities, medical training), focusing on whether they constructively assess learners to prepare them for their future and employability chances.

Moreover, since this research focused only on interviewing high school teachers, further research can look into interviewing high school students and sometimes parents about their own perceptions of assessment, and what benefits or challenges they face. That way, studies can be compared to know where some gaps are (and if both teachers and students mentioned similar gaps, then that is an area which even further research can look into). In addition, observations and long-term studies on both teachers and students can show to what degree is enacting constructivist assessment suitable or effective in contrast to traditional methods.

Moreover, there needs to be some research focused on teacher education and pre-service teachers looking at whether or how they are prepared to enact quality constructivist approaches in their own courses, what they have experienced in practicum and how that differs or resembles what they take in teacher education courses. Some teachers actually may not know what the term ‘constructivism’ is and hence many may be unfamiliar with the publications that looked into its principles, benefits, misuses and practices. That may also be why teachers may be incorporating one aspect of it leading to misuse or incomplete de-contextualized use with no purpose. In addition, sometimes teachers stick with only two or three strategies and they tend to use only
these few too frequently, hence reducing the effectiveness of those few methods when used too often and removing the purpose of trying and exploring different constructivist assessment resources within a particular knowledge domain. Therefore further research can look into how pre-service teachers are aware of constructivism and how they are trained or prepared to apply the revised Bloom’s taxonomy in their own specialty. This is actually a very important step as only then can teacher education programs modify or reform to ensure they prepare their own teacher candidates for sound pedagogy and constructivist assessment with the aim of helping them develop critical thinkers prepared with 21st century skills, expertise, and knowledge base.

5.5 Conclusion

The purpose of this study was to gain insights into how Secondary school Science teachers demonstrating leadership and expertise in constructivism enact this framework when assessing and evaluating their students. By interviewing two Science teachers, both proved through their strategies and thinking process that constructivist assessments can be integrated within the Science discipline. In fact, it is needed because only then do teachers build independent autonomous scientific thinkers with how to learn skills. The focus on having a Bloom’s taxonomy lens was to look at how the revised framework comprising two axes (cognitive process and knowledge domain) is grounded within the constructivist framework and the new Ontario Growing Success Assessment document.

To summarize, pre-service and in-service teachers need quality effective training using the constructivist framework within assessment in particular. There has been lots of literature review publications focusing on the pedagogy but it is important to note that constructivist pedagogy and assessment are interlinked in that both are happening simultaneously (think of the nature of the class with assessment for and as learning). Trainings to apply constructivist assessment will rarely be effective if taught in a lectured based method. Instead what is needed is allowing pre-service teachers (and in-service during professional development) to actually try out and continuously figure what works and what does not. Professional development sessions after the emergence of the Growing Success assessment document are a good start.

In addition, what is ‘new’ or particularly crucial pedagogically are diagnostic assessments where teachers set an environment in which students primarily bring out their prior knowledge. Without this primary step, the whole sequence or steps in implementing effective constructivist pedagogy and assessments is negatively impacted leading to what literature review may refer to
As misapplications of the framework, and practically this is where the learning becomes de-contextualized. Pondering this, direct teaching does not necessarily mean the opposite of constructivist teaching as shown by some teachers taking advantage of the flipped class model where they record background information to work with students’ prior knowledge in the subject. As a result, during constructivist assessment, the teacher guides students. During assessment of learning (i.e. evaluation), the teacher is an impartial judge. Relating to guided versus unguided constructivism, and applying Bloom’s knowledge domain, the teacher can use direct teaching to consolidate and address misconceptions, thus revealing the importance of both skills and knowledge (not one over the other). This further allows students to continuously undergo metacognition and reflection on learning.

On the other hand, though there are constructivist benefits, there are also challenges. Those include: time which may make sense as it takes trials and chances to fail in order to gradually develop higher-order thinking, theory-practice gap (or structural emphasizing grades) which is evident by how post-secondary system still values grades and merely lecturing, and student attitudes and learner motivation which are paramount to benefit from constructivist assessments and prepare for constructivist evaluations.

As recommendations, it is important that teachers become open-minded, organized yet flexible in their assessment plan, creatively collaborative and always passionate to seek new resources and constructivist strategies. They further provide equitable measures by assuring that all constructivist assessments take place in class (and maybe that is why some incorporate flipped class model). The push towards Growing Success is actually a push towards the constructivist idea of having students use assessment as a learning tool so they find out what they know and do not know. This brings out the questionable affective domain where currently one may assume that students may feel frustrated on the short-term but proud and rewarded on the long run. In any case, with assessment for/as learning, as with pre-service teachers in teacher education programs, students should be allowed to undergo the task themselves even if told what the rubric constitutes. The reason is differentiated feedback (part of differentiated assessments) that allows students to know their pace, and allow students chances to improve as they may not know what the teacher expects unless they try working with the task themselves.

This research study may be an important first step for pre-service teachers and teacher education instructors, in-service teachers and professional development trainers, policy makers
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(e especially assessments), and even school students. One may find the results of this research important in allowing these educational actors to realize what is missing from their own side. For example, teachers misapplying steps of effective constructivist assessment principles, students knowing their teachers’ views and the value of assessment tools for evaluation, and assessment document makers looking into the affective side like student work habits or attitudes from situations happening out of school, and how they relate to the shift towards assessment for/as/of learning. In addition, teacher education instructors teaching about constructivist assessments via the proper order of principles and Bloom’s revised taxonomy by allowing candidates to explore what works with them.

Finally, it is important to remember that by becoming constructivist teachers and assessors, we simultaneously become constructivist learners and self-assessors as we observe, communicate and reflect back on what we saw from students’ work, thoughts, and feelings. Indeed as Gordon (2009) highlight, the authority of knowledge still rests heavily on teachers’ own knowledge and experiences and consequently their pedagogical approach raises the bar for students by demanding far more from them than teacher-centered models. On the other hand, it also raises the bar for teachers as they realize, especially via continuous assessment techniques, that in the process they are also their students’ constructivist learners. So by undertaking this simultaneous teacher-learner, a teacher is an on-going authentic assessor who may eventually really impact a student, and subsequently may be an example of a true constructivist educator. These teachers are the ones who may not think that they have a set stock of knowledge and skills to deliver and merely evaluate whether students achieved them, but who are continuously modifying and gaining their own knowledge and skill set from their own students, making them not powerless but equal in terms of approaching and valuing learning.
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References:


Alvarez, R., & Urla, J. (2002). Tell me a good story: using narrative analysis to examine information requirements interviews during an ERP implementation. *ACM SIGMIS Database, 33*(1), 38-52.


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Rowe, K. (2006). Effective teaching practices for students with and without learning difficulties: Constructivism as a legitimate theory of learning AND of teaching?.


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Appendix A: Letter of Signed Consent for Interview

Date: ___________________

Dear ___________________,

My name is Raghda Abulnour. I am a graduate student at OISE, University of Toronto, and am currently enrolled as a Master of Teaching candidate. I am studying how teachers demonstrating leadership or expertise in the area of constructivist learning theory enact assessment and evaluation in their teaching practice for the purposes of investigating this educational topic as a major assignment for our program. I think that your knowledge and experience will provide insights into this topic.

I am writing a report on this study as a requirement of the Master of Teaching Program. My course instructor who is providing support for the process this year is Dr. Angela McDonald. The purpose of this requirement is to allow us to become familiar with a variety of ways to do research. My data collection consists of a 45-minute interview that will be tape-recorded. I would be grateful if you would allow me to interview you at a place and time convenient to you. I can conduct the interview at your office or workplace, in a public place, or anywhere else that you might prefer.

The contents of this interview will be used for my assignment, which will include a final paper, as well as informal presentations to my classmates and/or potentially at a conference or publication. I will not use your name or anything else that might identify you in my written work, oral presentations, or publications. This information remains confidential. The only people who will have access to my assignment work will be my research supervisor and my course instructor. You are free to change your mind at any time, and to withdraw even after you have consented to participate. You may decline to answer any specific questions. I will destroy the tape recording after the paper has been presented and/or published which may take up to five years after the data has been collected. There are no known risks or benefits to you for assisting in the project, and I will share with you a copy of my notes to ensure accuracy.

Please sign the attached form, if you agree to be interviewed. The second copy is for your records. Thank you very much for your help.

Sincerely,
Raghda Abulnour

Researcher name: Raghda Abulnour
Phone number:
E-mail:
Course Instructor’s Name: Angela MacDonald & Eloise Tan

**Consent Form**
I acknowledge that the topic of this interview has been explained to me and that any questions that I have asked have been answered to my satisfaction. I understand that I can withdraw from this research study at any time without penalty.

I have read the letter provided to me by Raghda Abulnour and agree to participate in an interview for the purposes described. I agree to have the interview audio-recorded.

Signature: ______________________________________

Name: (printed) _______________________________________________

Date: ________________________________
Appendix B – Interview Protocol/Questions

Thank you for agreeing to participate in this research study. The aim of this study is to learn how teachers demonstrating leadership or expertise in the area of constructivist learning theory enact assessment and evaluation in their teaching practice.

The interview will be approximately 45 minutes and will be audio recorded. I will ask you questions related to your understanding of constructivist learning, your teaching practice, your modes of assessment and evaluations, and supports and challenges you face. I would like to remind you of your right to skip questions or withdraw at any point and/or you may stop for a break. The interview will be audio recorded. Before we begin do you have any questions for me?

Section 1 – Background information:
To start, I would love to hear more about your teaching experience.
1. What grades and subject areas do you currently teach? Have you always taught these grades and subjects, or have you taught others as well?
2. How many years have you worked as a teacher and how many years have you been teaching in this school?
3. Can you tell me a bit about your school and the students who attend it?
4. How did you become involved or interested in constructivist learning?
   • Do you recall learning about constructivism in your teacher education program?
   • What related or relevant courses and/or professional development in this area have you participated in?

Section 2 – Teacher beliefs and practices (What/How):
5. What does constructivism mean to you? And constructivist learning theory?
6. What does this mean for your teaching? What does constructivist learning theory look and sound like in your classroom? Can you give me an example?
7. In your experience, how do students respond to this approach to teaching and learning? What indicators have you observed?
8. One aspect of pedagogy that I am particularly interested in learning more about in relation to constructivist learning theory is assessment and evaluation. How do you understand assessment and evaluation within the framework of constructivist learning theory?
9. Can you tell me more about how you assess and evaluate students in ways that you feel reconcile with this theory?
10. Can you give me an example of how you have applied these practices?
11. In your experience, how do students respond to these assessment and evaluation practices?
12. What tools or assessment techniques do you find the most effective (both summative and formative)? What indicators of effectiveness have you observed from students?
13. What do you believe students can gain from the constructivist approach in assessing and evaluating?
Section 3 – Influencing factors:
14. What resources do you use to enact constructivist learning when assessing and evaluating students? How do you access these resources?
15. What other factors support you in this work?
16. Have you faced any obstacles or challenges when using constructivist framework in assessing and evaluating in your practice? How do you respond to these challenges?
17. What kind of feedback have you had from people outside the classroom regarding your practice of using constructivist ways of assessing and evaluating students in your classroom?

Section 4 – Next steps (what next?)
18. What advice would you give to a beginning teacher looking to apply constructivist learning theory in their assessment and evaluation strategies in their own classroom?
19. What long range goals do you have for your use of constructivist assessment and evaluation in the classroom?
20. What recommendations, if any, do you have with regard to how the education system, including teacher education and development, can further support the enactment of constructivist learning theories in schools and classrooms generally, and in assessment and evaluation specifically?

Thank you very much for your insights and the time you have given me today.
Appendix C - Structure of Bloom Original Taxonomy (Krathwohl, 2002):

<table>
<thead>
<tr>
<th>Structure of the Original Taxonomy</th>
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<tbody>
<tr>
<td><strong>1.0 Knowledge</strong></td>
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<tr>
<td>1.10 Knowledge of specifics</td>
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<tr>
<td>1.11 Knowledge of terminology</td>
</tr>
<tr>
<td>1.12 Knowledge of specific facts</td>
</tr>
<tr>
<td>1.20 Knowledge of ways and means of dealing with specifics</td>
</tr>
<tr>
<td>1.21 Knowledge of conventions</td>
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<tr>
<td>1.22 Knowledge of trends and sequences</td>
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<tr>
<td>1.23 Knowledge of classifications and categories</td>
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<tr>
<td>1.24 Knowledge of criteria</td>
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<tr>
<td>1.25 Knowledge of methodology</td>
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<tr>
<td>1.30 Knowledge of universals and abstractions in a field</td>
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<td>1.31 Knowledge of principles and generalizations</td>
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<td>1.32 Knowledge of theories and structures</td>
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<tr>
<td><strong>2.0 Comprehension</strong></td>
</tr>
<tr>
<td>2.1 Translation</td>
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<tr>
<td>2.2 Interpretation</td>
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<tr>
<td>2.3 Extrapolation</td>
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<tr>
<td><strong>3.0 Application</strong></td>
</tr>
<tr>
<td><strong>4.0 Analysis</strong></td>
</tr>
<tr>
<td>4.1 Analysis of elements</td>
</tr>
<tr>
<td>4.2 Analysis of relationships</td>
</tr>
<tr>
<td>4.3 Analysis of organizational principles</td>
</tr>
<tr>
<td><strong>5.0 Synthesis</strong></td>
</tr>
<tr>
<td>5.1 Production of a unique communication</td>
</tr>
<tr>
<td>5.2 Production of a plan, or proposed set of operations</td>
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<tr>
<td>5.3 Derivation of a set of abstract relations</td>
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<tr>
<td><strong>6.0 Evaluation</strong></td>
</tr>
<tr>
<td>6.1 Evaluation in terms of internal evidence</td>
</tr>
<tr>
<td>6.2 Judgments in terms of external criteria</td>
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</table>
Appendix D - Bloom’s revised taxonomy (Krathwohl, 2002):

<table>
<thead>
<tr>
<th>Structure of the Knowledge Dimension of the Revised Taxonomy</th>
<th>Structure of the Cognitive Process Dimension of the Revised Taxonomy</th>
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</thead>
<tbody>
<tr>
<td><strong>A. Factual Knowledge</strong> – The basic elements that students must know to be acquainted with a discipline or solve problems in it.</td>
<td><strong>1.0 Remember</strong> – Retrieving relevant knowledge from long-term memory.</td>
</tr>
<tr>
<td>Aa. Knowledge of terminology</td>
<td>1.1 Recognizing</td>
</tr>
<tr>
<td>Ab. Knowledge of specific details and elements</td>
<td>1.2 Recalling</td>
</tr>
<tr>
<td><strong>B. Conceptual Knowledge</strong> – The interrelationships among the basic elements within a larger structure that enable them to function together.</td>
<td><strong>2.0 Understand</strong> – Determining the meaning of instructional messages, including oral, written, and graphic communication.</td>
</tr>
<tr>
<td>Ba. Knowledge of classifications and categories</td>
<td>2.1 Interpreting</td>
</tr>
<tr>
<td>Bb. Knowledge of principles and generalizations</td>
<td>2.2 Exemplifying</td>
</tr>
<tr>
<td>Bc. Knowledge of theories, models, and structures</td>
<td>2.3 Classifying</td>
</tr>
<tr>
<td><strong>C. Procedural Knowledge</strong> – How to do something; methods of inquiry, and criteria for using skills, algorithms, techniques, and methods.</td>
<td>2.4 Summarizing</td>
</tr>
<tr>
<td>Ca. Knowledge of subject-specific skills and algorithms</td>
<td>2.5 Inferring</td>
</tr>
<tr>
<td>Cb. Knowledge of subject-specific techniques and methods</td>
<td>2.6 Comparing</td>
</tr>
<tr>
<td>Cc. Knowledge of criteria for determining when to use appropriate procedures</td>
<td>2.7 Explaining</td>
</tr>
<tr>
<td><strong>D. Metacognitive Knowledge</strong> – Knowledge of cognition in general as well as awareness and knowledge of one’s own cognition.</td>
<td><strong>3.0 Apply</strong> – Carrying out or using a procedure in a given situation.</td>
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<tr>
<td>Da. Strategic knowledge</td>
<td>3.1 Executing</td>
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<td>Db. Knowledge about cognitive tasks, including appropriate contextual and conditional knowledge</td>
<td>3.2 Implementing</td>
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<tr>
<td>Dc. Self-knowledge</td>
<td><strong>4.0 Analyze</strong> – Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose.</td>
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<tr>
<td></td>
<td>4.1 Differentiating</td>
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<td>4.2 Organizing</td>
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<td>4.3 Atributing</td>
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<td><strong>5.0 Evaluate</strong> – Making judgments based on criteria and standards.</td>
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<td></td>
<td>5.1 Checking</td>
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<td></td>
<td>5.2 Critiquing</td>
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<td></td>
<td><strong>6.0 Create</strong> – Putting elements together to form a novel, coherent whole or make an original product.</td>
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<tr>
<td></td>
<td>6.1 Generating</td>
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<td>6.2 Planning</td>
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<td>6.3 Producing</td>
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# The Cognitive Process Dimension

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<tr>
<td>A. Factual Knowledge</td>
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<td>B. Conceptual Knowledge</td>
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<td>C. Procedural Knowledge</td>
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<tr>
<td>D. Metacognitive Knowledge</td>
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