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Navigating Uncertainty in Automotive Technology Instruction: The Subjective Experiences of Automotive Instructors During Laboratory Activities

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- Jon F. Wergin, PhD, Committee Chair
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Dedication

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Abstract

Educational researchers have conducted very few studies on the subjective experiences of both trained and self-taught auto mechanics (Barber, 2003, 2004; Nelsen, 1997, 2010). Further, no present studies explore the subjective experience of the automotive instructor as he or she experiences uncertainty in the automotive lab. This study addresses a gap in the current literature on career/technical instructor development. For this study, data were gathered by video recording automotive laboratory activities at three Midwestern automotive programs. Interpersonal Process Recall (IPR) interviews were conducted with automotive instructors as they observed themselves navigating the lab environment. Data from the IPR interviews were analyzed using emergent thematic analysis. The research revealed that most instructors in this study were aware, after reflection, of the reasoning behind many of the intuitive and improvisational behaviors, and had an awareness of the nuances of skill assessment the importance of modeling behavior. This study also identified *transfer of artistry* as a concept of advanced skill attainment in automotive subjects. Transfer of artistry is the result of an instructor's ability to manage several paradigms of the laboratory experience at once, to create the appropriate conditions for a student to develop the cognitive, spatial, and tactile skills necessary for performing advanced automotive diagnostics and repair. This dissertation is available in open access at AURA: Antioch University Repository and Archive, http://aura.antioch.edu/ and OhioLINK ETD Center, https://etd.ohiolink.edu/

Keywords: Post-Secondary, Career/Technical, Automotive, Technology, Laboratory, Improvisation, Instructor, Mechanic, Technician, Reflection, Artistry, IPR, Interpersonal Process Recall, Thematic Analysis, Schön.

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Chapter I: Introduction and Background

Automotive technology programs are facing a negative response from many stakeholders in the automotive industry. The automotive shop owners and new car manufacturers are dissatisfied with the skill level of student/graduate performance in the field (Thurlow, 2014). These concerns are specifically directed toward the areas of advanced automotive system diagnostics and reflective abilities involved in written and verbal communication necessary to navigate many of the organizational aspects of automotive repair. These skills are closely related—important not just for the diagnosis and repair of automobiles, but also critical for the student in acquiring the requisite training and development, maintaining communication with parts and service management, and navigating the commission-based pay system. Stakeholders such as automotive service managers and advisors, as well as manufacturing executives, are asking automotive technology programs to focus on teaching practices that will increase student skills in the areas of critical thinking, systems diagnosis, or what is sometimes referred to as troubleshooting.

The paradox inherent in this request is that the key stakeholders mentioned above have played a major part in perpetuating a system of education that inhibits the reflective practice necessary to perform these procedures. The manufacturers and accrediting bodies have established guidelines for curriculum, as well as teacher credentialing, based on the concept of technical rationality—a system that lends itself to establishing clear and manageable goals for assessment, but does very little to address the complexities inherent not only in servicing automobiles but also teaching automotive subjects. Philosopher Robert Pirsig (1974) specifically addresses the complexity of automotive technology when he asserts:

> An untrained observer will see only the physical labor and often get the idea that physical labor is mainly what the mechanic does. Actually, the physical labor is the smallest and

> easiest part of what the mechanic does. By far the greatest part of his work is careful observation and precise thinking … to expand their hierarchy of knowledge … and compare it to the correct hierarchy in their mind. They are looking at underlying forms. (p. 96)

Pirsig's assertion concerning automotive mechanics can easily be juxtaposed with the complexity in teaching automotive subjects. This complexity is readily apparent in automotive lab activities where the instructor is performing a balancing act of teaching and demonstrating, but also guiding the teaching process for multiple students of variable skill levels, protecting the tools and equipment, and assuring the safety of the students.

As both a professor of automotive technology and a reviewer of automotive programs, I understand how a busy automotive shop class can look like chaos to an outside observer. However, I believe there is, more often than not, a method to the madness. In a system where structure and consistency are dictated by industry, semi-structure is often the best anyone can achieve in an automotive technology program. I believe by understanding the thought processes behind the time off-script, when the instructors are improvising, may lead to improvements in curriculum design, instructor training, program assessment, and student learning. Quite possibly, a study like this would create new measures to assess program effectiveness and offer insight into the automotive industry as to why the current curriculum fails to meet their demands for skilled automotive technicians. In order to understand the nuances of teaching practices within automotive programs, implicit knowledge of the processes of teaching practice must be made explicit.

The research in this dissertation will observe and study teaching practices in automotive subjects and identify those that could be aligned with the concept of *reflective practice,* defined by Schön (1983) as the ability to "surface and criticize the tacit understandings that have grown up around the repetitive experience of a specialized practice, and can make new sense of the

situations of uncertainty or uniqueness which he may allow himself to experience" (p. 61). In other words, reflective practice is a mechanism to facilitate a process of continuous learning during specialized practice. Since the ultimate goal of the study is to understand better the specialized practice of automotive instructors, the research will include background work on the experiences of the instructor, an assessment of their current level of reflectivity, and observing how this reflective ability is transferred to the student during various teacher/student exchanges. Since Jackson and Chang (2013) asserted that an instructor's teaching style is "a direct reflection of their personal transformative training experience" (p. 151), I believe direct observation of the teacher-learner exchange, and then follow-up interviews with the instructor based on observations of the exchange, has the potential to increase the instructor's awareness of their practice and may prompt them to recall their own transformative experiences.

The dissertation will include video observations and interview techniques to uncover the subtleties of teaching practice as well as tacit aspects of teaching related to experience, in hopes of developing a reflective model for teaching vocational subjects such as automotive technology. While the impact of instructor quality on student learning has been quantified in multiple studies (Goldhaber, 2002; Goldhaber & Anthony, 2007), the reasoning behind this correlation remains unknown. According to Goldhaber (2002), data reveal teacher effectiveness as making a higher contribution than any other school factor:

> Only about 3 percent of the contribution teachers made to student learning was associated with teacher experience, degree attained, and other readily observable characteristics. The remaining 97 percent of their contribution was associated with qualities or behaviors that could not be isolated and identified. (p. 53)

Also, most of the quantitative and qualitative data on higher education teacher effectiveness have been gathered in traditional academic and professional training areas. By comparison, very little scholarship exists related to post-secondary career/technical education programs such as

automotive technology. Although scholars such as Young and Shaw (1999), Bain (2004), Berk (2005), and McGowan and Graham (2009) conducted research on effective academic classroom instruction in higher education, I wanted to increase what is known about teaching career/technical subjects or skilled trades in a laboratory environment to provide guidelines for increasing the effectiveness of automotive teaching practice.

Qualitative interviews based on direct observation of classroom behavior may yield theory related to skill acquisition, reflective practice, and the role of mentors in the development of effective teachers. I am curious to put into practice Argyris and Schön's (1974) assertion that someone's "espoused theory of action" may not govern their actual actions, and the only way to understand their actual "theory in use" is through "observations of his behavior" (p. 7). In this study, I discuss how I videotaped the teaching practice of post-secondary automotive instructors, identified critical moments in the teacher–learner exchange, and conducted follow-up interviews with the instructor based on my observations of their teaching and then documented the instructor's reactions to the recording. I wanted to know the instructor's reasoning behind certain teaching skills or behaviors and possibly, where and how these skills or behaviors were developed.

This study presents opportunities for automotive programs to engage in practices that could increase the effectiveness of teachers assisting students in the development of reflective skills associated with automotive diagnosis. Furthermore, this dissertation also addresses historical factors and current marketing practices that present barriers to the development of reflective skills in automotive technology programs.

Research Question and Rationale

The research question for this dissertation asks: What are the subjective experiences of automotive instructors as they navigate experiential learning activities in the lab? I was particularly interested in the antecedents of reflective practice and how this practice crosses the boundaries between teaching and doing. The rationale for researching this question was to identify the implications of changing the current paradigm of automotive education to include a curriculum that fosters reflection. The importance to the field of automotive education involves the likelihood of positive change in the level of transferable skills possessed by the student mechanic, as well as, the aspiring automotive instructor.

The major hurdle in this study involved the overall resistance to change when it came to curriculum. Teaching is an unbelievably complex task, and many of the nuances are overlooked by the casual observer, as well as the instructor. My goal was to surface this complexity to gain insight into a better understanding of teaching practice.

The epistemological approach for framing the study and its findings included:

- Prior research focused on reflective teaching practice;
- Personal reflection of prior experience with the automotive industry, and utilization of industry contacts with current or prior experience in the automotive industry;
- Research focused on specific areas to add depth to this body of work including technical rationality, reflective practice, and the role of mentors in teaching automotive subjects;
- Research on the impact of career technical education as an academic discipline or a professional development strategy for increasing an instructor's capacity to reflect.

Throughout my career as an automotive instructor, I have observed that the majority of my colleagues have learned about automotive systems in much the same way as the students they teach, that is, by attending traditional 2-year associate degree programs in automotive technology. This method of instruction tends to be lockstep and highly-structured and follows the concept of technical rationality; a construct that uses strict scientific rules to inform practice. Furthermore, to teach in these associate degree programs, the automotive instructors must obtain a bachelor's degree. These degrees vary widely from my experience as my colleagues have earned degrees in business, religious studies, agricultural technology, and psychology. Actually, in my department, I am the only faculty member (out of 15) with an undergraduate major in education and one of two faculty members with a master's degree related to teaching. However, these members of the faculty, regardless of their undergraduate experience, seem to have little to no trouble navigating the established curriculum. As such, I am curious to discern if there are any hurdles an instructor must overcome when they lack a background in the formal study of education. Are they researching effective teaching methods, are they modeling other teachers, or are they reflecting on their earlier experiences as a student?

To understand what makes automotive instructors effective in the classroom, it may be necessary to study automotive mechanics who are considered to be effective in practice. From my experience working at an independent shop and a new car dealership, as well as attending over 1,500 hours of professional automotive training, I have interacted with enough automotive technicians to identify certain attributes. It is my opinion that successful automotive technicians have the capacity to be reflective, but often they rely on experience and tacit knowledge to properly diagnose and repair a vehicle. Furthermore, since most automotive instructors have spent significant amounts of time in the field, in many cases five years of relevant shop

experience required to qualify for a teaching position, it stands to reason that the same methods these instructors used to navigate their automotive service career are now being used to inform teaching practices. What I would like to do is help promote reflection among automotive faculty by encouraging reflection on their teaching practice and, by uncovering their own heuristics and tacit knowledge, try to get them to increase their understanding of certain behaviors in the classroom.

The focus of my work is current research on automotive technology programs and the role of technical rationality and reflective practice as it relates to the development and practice of automotive instructors. Since it is common practice for automotive programs to hire former automotive technicians as faculty, it is important to understand the formal and informal educational experiences of automotive educators and the role of technical rationality versus reflective practice as they navigate the teacher/learner exchange. In my current role as a professor of automotive technology, I am driven to reflect deeply on the current state of automotive technology programs, and hopefully, improve understanding of the complexity inherent in the teaching of vocational subjects. Given this context, my research question will focus on the creation of knowledge and skill development in automotive technology programs, and the ways a teacher of automotive technology can effectively endow the students with the capacity to reflect-in-action (Schön, 1983, 1987).

My inspiration for this research involves my personal observations and research as both a student and an educator. Furthermore, my experience as a mechanic in an independent repair shop and a new car dealership, combined with my teaching experience offer a unique perspective on this study. Ergo, once a practitioner evolves the ability to examine and articulate the underlying tacit knowledge, it seems reasonable to assume that person can also teach others

about the connection. This insight, applied to my field, raised several questions that remain unanswered. Are reflective mechanics also reflective teachers? Are technically rational mechanics bound by the same paradigm when they move into a teaching position? These questions get little if any attention in the current scholarship on reflective practice. Schön (1983) wrote:

> In order to study reflection-in-action, we must observe someone engaged in action … Often, merely by asking a question like 'How are you thinking about it now?' we produce an intended or unintended intervention which changes the subject's understanding and shifts the direction of action. (p. 322)

Schön's assertion solidified my choice of Interpersonal Process Recall (IPR) as a method of gathering data, as well as a potential assessment tool, and a method of increasing an instructor's reflective capacity. IPR is a data gathering method developed by Kagan, Krathwohl, and Miller (1963) that involves video documentation of a specific social interaction, followed by a recall (interview) session where the video is replayed for the participants. Questions are open-ended and designed to prompt the participants to reflect on their observed behavior. Kagan (1995) explains the ability of IPR to uncover tacit behaviors, based on the following notions:

1. As human beings, we have an incredible ability to read other peoples' emotional states.
2. IPR is based on our abilities to use intuition and anticipate future actions based on our own unique experiences.
3. IPR is useful in putting names on unnamed experiences. (Video 1)

Because of IPR's expressed ability to surface the complexity of social interactions and human behaviors, I am certain it will be useful in collecting data for this study. To solidify my methodological choice, in addition to familiarizing myself with IPR scholarship, I worked closely with a researcher with IPR experience to conduct a pilot study of automotive instructors. The success of the pilot study in revealing the instructor's perceptions of their observed behavior reinforced my decision to use IPR in my dissertation.

This research also includes a study of skill acquisition, reflective practice, and the role of mentors in the development of effective teachers. In this study, I videotaped the teaching practice of post-secondary automotive instructors, identified critical moments in the teacher–learner exchange and interviewed the instructor based on my observations and the instructor's reactions to the recording. I wanted to know the instructor's reasoning behind certain teaching skills or behaviors and where these skills or behaviors were developed.

Delimitations, Limitations, and Assumptions

I pursued this study because I am curious about the experiences of other practitioners in my field and I wanted to improve the current standards in automotive technology education. I have observed the behaviors of my colleagues, and their teaching skills appear to transcend any measures put forth by our accrediting bodies. It seems the instructors know the approved script when it comes time to present to the accreditors, but in the midst of learning, they dexterously apply a complex lattice of experience, personality, humor, empathy, and practicality that goes well beyond anything learned at an instructor training seminar, train the trainer session or other professional development activities. From my observations, and numerous conversations with master automotive instructors, I have found, as the instructor's experience grows, they seem more able to demonstrate concrete, as well as, abstract concepts to students using tools such as analogies and metaphors when the body language or facial expressions or tone of voice of the students change. Given that they are not necessarily formally trained in career/technical education, I want to understand where it comes from, and more importantly, why is this never addressed in departmental reviews or accreditation audits? In sum, I would like to add to the body of knowledge that exists concerning automotive technology education to improve professional practice. Other delimitations in this study include the use of IPR and thematic

analysis to gather data versus other methods that may not be as capable of getting to the authentic views of the instructors, such as quantitative survey-based inquiries. Although there are instruments available to measure the level of a participant's reflective capacity, I am more interested in understanding the subjective experiences of the instructor based on his or her self-observation.

The limitations of this study include the choice of participants, as well as, environmental and geographical concerns. Because I am interested in understanding the experiences of automotive instructors, it was beneficial to either choose a subpopulation of instructors based on certain demographics (i.e., year of teaching, years working in automotive, teaching specialization) that could give a focused view of the phenomenon—a study of new instructors versus seasoned instructors for example. Alternatively, it would have also been beneficial to diffuse the demographics to encompass a variety of automotive areas, levels of teaching/automotive experience, gender, ethnicity, geographic location, etc. to get a very broad spectrum of participants. Unfortunately, in order to get a good sample of participants, I was at the mercy of any automotive instructor willing to allow me to record them teaching in a laboratory environment then participate in a subsequent interview. Also, because of financial constraints, family and work obligations, and the time it takes to video record a class, edit the footage, create a presentation, and conduct an interview; I was limited to areas I would be able to drive within a few hours of Dayton, OH. Therefore, because I am studying automotive colleges within a 200-mile radius of Ohio, further limitations include the inability to make generalizations to other career/technical areas, as well as automotive colleges in other regions within, or outside, the United States. Another limitation to the study has to do with traditional teaching assessment and the possibility of the participants either not participating or withholding information out of

framing the observation and interview as an assessment of their teaching skill. It is also possible that increasing the visibility of teaching practice through an instructor's own reflection may be considered pandering to my colleagues, or participation may be viewed as fodder for promotion, tenure, or to assist in obtaining additional pay for meritorious activities. Also, my own ego may also be bolstered as I am trying to increase the professional status of my own field. Throughout my career, I was continuously reminded how automotive technology was somehow less than other careers.

It will be assumed that the participants will all be certified automotive instructors with qualifications needed to teach in a post-secondary accredited automotive program. Also, the participants will have some degree of experience in both the automotive industry and teaching field. Because of the open-ended and subjective questions inherent in the IPR process, as well as assurance of anonymity, the participants should have no problems providing honest and truthful responses to the open-ended questions.

This study presented opportunities for automotive programs to engage in practices that could increase the effectiveness of teachers assisting students in the development of reflective skills associated with automotive diagnostics. Furthermore, this dissertation also addresses historical factors and current marketing practices that present barriers to the development of reflective skills in automotive technology programs.

The Dissertation Outline

The following outline includes a brief overview of the remaining chapters of this dissertation.

Chapter II is the literature review. It explores the literature related to reflective practice in the teaching of automotive subjects with specific attention paid to the development of reflective skill and the experience of the teacher. Also, this foundational chapter includes an

overview of the current body of scholarship, the identification of any gaps in the scholarship, and a summary of major statements by scholars involved in reflective practice, such as Donald Schön (1983, 1987) and Stephen Brookfield (1995), and transformative aspects of education, such as Jack Mezirow (1990, 1991).

Chapter III describes the methodology of thematic analysis, utilizing the Interpersonal Process Recall (IPR) method of gathering qualitative data related to an instructors' metacognition of their own teaching practice (Kagan, 1995). Although IPR has been traditionally reserved for counseling and psychotherapy, I am in agreement with Dawes (1999) that it provided a deeper understanding of the teaching–learning exchange observed in this type of study.

In addition to providing details concerning the audio/visual equipment necessary to perform IPR sessions, Chapter III discusses the development of a standard set of open-ended questions to ask each participant. It also describes the details of how I created specific contextual questions while reviewing the videotaped sessions. Careful observation of the IPR session prompted questions specific to the behavior of the participant, such as "It looked like you changed directions with that demonstration; can you elaborate on your thought process?" or "Do you remember how you learned this particular concept?"

Survey participants. Participants in this study included automotive instructors teaching in post-secondary accredited community college programs that included both manufacturer-supported internship programs and comprehensive, non-internship programs. The participants were chosen based on years of experience in both teaching and automotive practice. I specifically sought out instructors who had proven themselves to be leaders in the field of

automotive education. This population added depth to the study by providing stories of their own successes and failures as well as insight into their own development as effective teachers.

Number of participants. Since this was a qualitative study with complex interview structure and significant data processing, limiting the study to 12 participants was determined to be sufficient to create a clearer picture of the individual experience of an automotive instructor.

Method review. A pilot test of the IPR process was conducted prior to this research. The equipment necessary to record the exchange was practiced, open-ended interview questions were created, and critical sections of the video were identified.

In Chapter IV, I discuss the findings of the IPR interviews. Furthermore, this chapter incorporates alternative views, as well as, research findings consistent with previously proposed theories regarding reflective teaching practice, as well as new findings that provide insights contributing to the field of career/technical education.

The final chapter of this dissertation provides conclusions and considerations for future work in the area of career/technical teacher education. This study of teacher development proved to be insightful, as it revealed certain common experiences and practices of effective teachers. Additionally, this section discusses opportunities for future research related to increasing the effectiveness of teachers in programs such as automotive technology.

Chapter II: Review of Literature

Philosophical Overview

The catalyst for this inquiry involved some overarching ideas that had been organizing themselves in my mind for several years. The literary influences that had the greatest impact during my academic career were the works of Robert Pirsig (1974), Carl Jung (1969), and Joseph Campbell (1968). The works of these authors fundamentally changed my way of thinking about my everyday experiences. Where Pirsig helped me understand the subjective concept of quality and the experiential nature of understanding through mindful practice, Jung's work helped me understand the overwhelming majority of what influenced human behavior exists in the subconscious mind, and many times our motives are a mystery. The work of Campbell tied much of the work of the authors above together with his work involving mythological symbols and rituals as a conduit to our subconscious, as well as, the key to the development of the mental maturity necessary for navigating society. These works helped me develop a metaphysical view of educational practice and a deep appreciation for the complexities inherent in the teaching and learning process. Most of all, they helped me understand the symbolic significance, power, and ultimate fragility of the construct of the expert teacher, mentor, guru, or sensei.

Three later works that address these same complexities as they relate to the process of teaching and learning include Granger's (2006) work comparing the work of John Dewey and Robert Pirsig, Kahneman's (2011) book where he defines two unique thought processes in everyday experiences and how we draw on both processes depending on the situation, and Mayes' (2005, 2007, 2010) books about the relevance of Jung and Campbell's work to modern teaching practice.

Global/Cultural Perspectives

At this point, many of the ideas I have presented are global in nature, and the authors mentioned above take a progressive stance on everyday experiences that give the reader a broad framework to assess existing literature on education. As such, it is important to note that many of the perspectives of educational practices have as much to do with intuitive judgments based on societal norms and customs than solid research. What makes progressive educators "progressive" involves going against what is universally considered to be Western ways of thinking and aligning themselves more with Eastern or Confucian ways of thinking. The Vietnamese Buddhist monk, Thich Nhat Hanh (2011), urged his readers to create a note that asks, "are you sure?" and keep it in plain view to train our perceptions (p. 107). Kahneman (2011) addressed the cognitive limitations of "WYSIATI" or "What you see is all there is" (p. 85), as well as Jung's (1971) assertion that intuition can either be "subjective or objective" or "concrete or abstract" depending on thoughts, feelings, or sensations (p. 453). Dewey (1931) wrote that scientific modes of thinking are not immune to "qualitative existence" (p. 116), which is aligned with Pirsig's (1974) metacognition as he doubts the effectiveness of his technical methods during his account of lecturing students in a college course. Furthermore, Campbell's (1968) work on the significance of myths, symbols, ceremonies, and rites of passage to promote our mental maturity further reinforces the need to symbolize cultural dynamics involved in teaching and learning. These cultural aspects of the teacher/learner exchange are critical to the understanding of the one-on-one interactions that frequently occur within experiential learning.

Dualism in Career/Technical Education

Following this metaphysical view of education, I would like to introduce concepts that have created a dualism in the modern discourse concerning education, but specifically teaching and learning in the professions. As far back as Dewey's (1916) *Democracy and Education*, we

read warnings of purely rational, technical, or scientific ways of learning. Fifteen years later, Dewey (1931) added:

> Thought which denies the existential reality of qualitative things is therefore bound to end in self-contradiction and in denying itself. 'Scientific' thinking that expressed in physical science, never gets away from qualitative existence. Directly, it always has its own qualitative background; indirectly, it has that of the world in which the ordinary experience of the common man is lived. (p. 116)

By surfacing this paradox of scientific thinking, Dewey gave voice to both observable and quantifiable behaviors to better understand some of the tacit aspects of instructor quality. Regarding the education of teachers, Kincheloe (2006) maintained:

> Many of teaching methods courses and textbooks that are based on traditional forms of empirical research reduce teaching to step-by-step recipes removed from any consideration of pedagogical purpose that transcends the mechanical transfer of data from teacher to student. (p. 87)

Both Dewey and Kincheloe are referring to what Kincheloe (2006) calls an "epistemological mismatch" (p. 89). In the following sections, I will utilize this perspective to explore literature that deals with the education of professional practitioners, and ultimately narrow my focus to the educational practices of the automotive industry.

Technical Rationality and Reflective Practice

Two terms that I would like to incorporate as I move through the literature has to do with the "dualism" that exists in educational philosophies as espoused by Dewey in 1916 and reiterated by Granger 90 years later, "to expand our perceptions of the meaning and value of what happens in our schools and classrooms beyond what can be articulated and known according to the tenets of scientific rationality" (2006, p. 274). This call to arms is related to the balance (or imbalance) of the tenets of what has been more recently referred to as *technical rationality* versus *reflective practice*.

By technical rationality, I refer to the positivist epistemology defined by Schön (1983) as "instrumental problem solving made rigorous by the application of scientific theory and technique" (p. 21), which is also referred to as "instrumental rationality" (Hyslop-Margison & Armstrong, 2004, p. 43), "scientific rationality" (Granger, 2006, p. 274), or "traditional modes of practice" (Osterman & Kottkamp, 1993, p. 15). Within this epistemology, Schön (1987) asserted that "professional practitioners solve well-formed instrumental problems by applying theory and technique derived from the systematic, preferably scientific knowledge" (pp. 3–4). Schön, like many experienced practitioners, understood that, while there is nothing inherently false about the tenets of technical rationality, it is too narrow in scope to address the myriad novel situations that arise during real-world practice. Schön sought to surface the complexity of professional practice and used the term reflective practice to describe the continuous cycle of reflection that practitioners engage to solve problems and develop heuristics to build universal and adaptable knowledge related to their practice.

Although I am specifically studying the experiences of automotive instructors during lab instruction, it is important for this review to look at some other clinical practices in professional fields. Russell (2005) asserted, "There seems to be more rhetoric about the value of reflective practice than there is detail about how professional educators can help beginning professionals develop the skills of reflective practice and acquire initial experiences" (p. 199). In this light, many of the scholars listed in this review spent their efforts explaining reflective practice conceptually and discussed observations of professionals reflecting either *in* (real time) or *on* (retrospective) a particular action. However, research has been conducted that looked at ways to teach others to be reflective, ways to foster reflective capacity and ways to measure reflectivity. I have included literature specific to teaching reflective practice, such as Schön's (1987) follow

up *Educating the Reflective Practitioner* where he writes about developing a "reflective practicum" that creates a realistic environment to practice the profession (p. 170). Schön developed multiple case studies that observed the teacher/learner exchange, in a clinical atmosphere, with architectural design students, music classes, psychoanalytic practice, and counseling. While painting a vivid picture of the interaction between the teacher and student during real-world examples, Schön did not explicitly direct an aspiring teacher of reflective practice with any cut and dried method of developing a reflective curriculum. Instead, throughout his work, he relies on the master teacher to develop experiences for the students based on his or her own reflection of the reality of the profession. Schön (1987) asserted, "in order to be credible and legitimate, a practicum must become a world with its own culture, including its own language, norms, and rituals" (p. 170). This would be a culture that would need to be developed, nurtured, and protected from technical rationality. However, according to Canning (2011), Schön's dualism between reflective practice and technical rationality came at a time when technical rationality was the dominant force in professional practice. Some European studies even discuss overreliance of reflective practice, as the metaphorical pendulum swings the other way in professional modes of learning (Canning, 2011; Edwards & Thomas, 2010; Hobbs, 2007). Beyond this critique, the lack of tangibility inherent in the concept of reflective practice was called into question.

This lack of clear direction in the execution of reflective teaching was reinforced by several scholars, such as Russell (2005), who after looking at current models of teaching reflective practice as something learned by a particular assignment, posited that the only way that reflective practice can be taught involved the teachers modeling reflective practice as they teach reflective practice. Russell (2005) further asserts "that reflective practice can and should be

taught—explicitly, directly, thoughtfully and patiently—using personal reflection-in-action to interpret and improve one's teaching of reflective practice to others" (pp. 203–204). Edwards and Thomas (2010), who agree with Russell that teachers increase the student's reflective practice through modeling, but boldly assert that "context-free reflective practice is a chimera and therefore attempts in education to teach it should stop" (p. 412). Hobbs (2007), questioned the legitimacy of reflective practice assignments within the political framework of grades based education, and further wrote, "creating a forced RP [reflective practice] assignment that evokes genuine and uninhibited response is a difficult undertaking. In my opinion, it is nearly impossible" (p. 415). These three scholars all agreed that reflective practice was important in the educational process, specifically the education of teachers. However, they all discussed the façade created by jamming reflective practice into a culture of technicism.

Reflective Practice in Other Professional Fields

Beyond the scope of teacher education, there have been multiple studies that attempt to foster reflective practice in other professional areas. Redmond (2004) worked with medical professionals and attempted to create a learning environment that would allow students to learn naturally. During her research, she developed multiple assignments such as reflective writing, drawing/mapping exercises, and discussions. However, it became clear to her that, because students were so used to the traditional teaching methods, they questioned the legitimacy of the work. Canning (2011) also discussed the legitimacy of "keeping diaries to completing inventories and teaching logs" to foster reflection in new teachers (p. 609). Like Redmond, Canning values reflective practice but is concerned about the student's readiness to engage in reflective practice. Furthermore, Schön (1983, 1987), Russell (2005), Hobbs (2007), and Edwards and Thomas (2010) agree that educators, administrators, and practitioners all tout the

importance of reflective practice, but its legitimacy is often questioned due to its slippery epistemology.

Additionally, Crow and Smith (2005) blended both higher education and medical professionals, citing multiple methods of reflective practice such as:

1. Individual self-reflection (often recorded in diaries and learning logs)
2. Reflection on student evaluations
3. Peer observation of teaching
4. Reflective conversations with a mentor
5. Reflective conversations with a 'critical colleague'
6. Joint reflective conversations on shared teaching experience (p. 242)

The article identified inadequacies of teaching reflective practices through forced implementation of methods such as items one through four in the list above. The authors focused on the concept of co-teaching as an effective means of fostering reflective capacity in healthcare instructors through joint reflective conversations. However, the authors did present the all too familiar barrier to effective practice—obtaining the funding to allow for co-teaching.

In addition to the healthcare industry, there are several other academic areas that have been studied under the umbrella of Schön's (1983, 1987) reflective practice include architectural design (Hanson, 2001; Roberts, 2009), software engineers (Bull & Whittle, 2014), engineering designers (Adams, Turns, & Atman, 2003), and athletic coaches (Carson, 2008; Z. Knowles, Gilbourne, Borrie, & Nevill, 2001).

The athletic coaches, like many other disciplines researched in this chapter, define their day-to-day activities using terms like artistry, craft work, and tacit knowledge. In addition, Z. Knowles et al. (2001) performed an action research study that assessed the reflective capacity of student higher education athletic coaches based on reflective writing assignments. However, Carson's (2008) study on reflective practice on student athletic coaches utilized video playback. The video playback allowed the student coaches to move beyond many of the hurdles that Z.

Knowles et al. encountered, such as accuracy of reflection. In Carson's study, the students watched themselves during practice and were able to get a more accurate view of their behavior. According to Carson, self-reflection, based on a video recording of the participant's behavior, allows an uncontestable account of coaching behavior, but this also brought up questions about the inexperienced coach or student coach's ability to reflect in a meaningful way.

Software design is another interesting area that has been experimenting with reflective practice. Bull and Whittle (2014) created a software design studio to foster reflective practice. The creation of a real world, believable environment to practice the artistry of the craft was a critical component of their course, and according to the authors, also allowed the course designers, faculty and staff, to reflect on the most important components of a live studio. Furthermore, this concept of real-world simulation was used in a study by Adams et al. (2003) when they studied engineering design students as they navigated simulations, positing that factors such as academic advancement (Freshmen versus Seniors) and a history of high academic performance, was an indicator of a deeper level of reflective behavior among students. Measuring reflective behavior in a clinical environment reinforces much of the research, which looks at the appropriateness of teaching reflective practice, or the idea that it can even be taught. Roberts (2009) discovered three areas that affected a student's ability to engage in reflective practice:

> First, there was the student's propensity to reflect: whether they are naturally inclined to spontaneously reflect even when not required; whether they will reflect when provided with support and guidance, or whether they struggle to engage with the whole concept of reflection. Second, there was the student's perceptions of the required purpose or focus of reflection: whether they perceive the purpose of the exercise as highlighting their reflections on a process, or focusing on the product of their actions. Third, there was the degree to which support, guidance, frameworks and structure are provided. (p. 640)

This passage clearly demonstrates the complexity of teaching reflective practice. Roberts surfaces the complexity inherent in the subjective experience of the instructor, but also the

subjective experience of the student. The propensity to reflect is based on a myriad of internal and external factors, and it would be naïve to assume that a simple recipe for reflection exists. However, the pursuit of this recipe is critical for meaningful learning.

Also, according to Blackwell, Bowes, Harvey, Hesketh, and Knight (2001) in a study of workplace learning integration in higher education, the design of the learning experience is contingent on the assumption "that students have the wherewithal to gain from the experience … [and] … the quality of students' reflection is fundamental to the quality of learning" (p. 283). This raises the question of how to go about designing a curriculum that fosters metacognition and reflective practice. Blackwell et al. provide two possible answers. First has to do with restructuring of programs away from "semesterized, modularized, bite-sized" courses, and more toward a structure that fosters "continuity, coherence and progression" (p. 283). Secondly, Blackwell et al. (2001) posited:

> It is not enough to proclaim the importance of reflection, although it is necessary. If reflection is to be an aid to students engaging in work experience, then they need to be able to distinguish reflection (in the sense of deep and wide analysis of thinking and action) from commonplace, casual and superficial thinking. It raises questions about how students learn to reflect and how higher education teaches them to do it better. (pp. 283–284)

Additionally, Canning (2011) looked at critical incidents of 60 student teachers to understand better the role of reflective practice in initial teacher education. Three major themes emerging from the study were: (a) student teachers attached importance to "formal and informal relationships, including relationships with mentors" placing value on "the process of simply watching and learning from fellow experienced teachers in the classroom" (p. 612); (b) "an awareness of the novice teachers that their own initial perceptions of events often provided an inadequate guide to what was actually occurring around them" (p. 613); and (c) "the recognition by the trainees that teaching was more than simply writing a good lesson plan and that, at times,

no amount of preparation could prepare them for what was about to happen" (p. 614). In essence, Canning was arguing for a contextual approach to new teacher training, while he argued that more experienced instructors could benefit from more "reflective approaches to learning," he asserted that novice teachers might require different approaches to learning.

Regardless of the assignment or method of teaching, several studies sought to identify certain triggers to a particular kind of transformation where the result was an enhanced awareness or sense of self. These articles referred to this self-awareness as enhanced maturity, or a transition from a state of ego-dependence to a state of independence. This transformation is where the balance shifts, resulting in maturity or perspective change. Tremmel (1993) insists that "[e]ncouraging students to reflect does not mean just leading them to change their minds in the sense of changing perspective; it means rather, trying to help them change the way their minds work so that they are prepared for reflection" (p. 441). Tremmel (1993) related educational practices to the practice of Zen Buddhism when he suggested:

> [T]here is an important common ground between mindfulness and reflection in action. Mindfulness is reflection-in-action moved from the sphere of professional practice in which Schön located it and extended to encompass the whole practice of living. (p. 444)

Ergas (2014) synonymously reinforces this view by juxtaposing the Buddhist tradition of mindfulness to "contemplative practice" in education (p. 68).

The articles by Tremmel (1993) and Ergas (2014) support Mortari's (2012) suggestion that "mindfulness practice is relevant … in educative contexts … through learning the mindfulness method, a person can develop the capability of being present to him/herself and thus reflect on his/her life of the mind" (p. 528). However, Merriam (2004) attributes the aforementioned capacity for reflective practice to cognitive maturity and asserts that "mature

cognitive development is foundational to engaging in critical reflection and rational discourse necessary for transformational learning" (p. 65).

Many of the articles identified the triggers to this enhanced self-awareness as some sort of disorienting dilemma (Mezirow, 1991), life crisis (Markus & Nurius, 1986), tension (Berry, 2009), the emotional effects of vulnerability (Kelchtermans, 2009) or a symbolic death, which has appeared historically in the forms of myths, rites, rituals, and initializations (Egger-Biniores, 2007). Through these events, Egger-Biniores (2007) stresses, "One's identity is completely disrupted … leading to a necessary search for a new sense of rootedness" (p. 151). It is a triggering event for maturity in many respects. Mezirow (1978) provided possible antecedents to this transformational change in perspective when he suggested:

> The sudden loss of a mate or a job, a change of residence, graduation from college, betrayal or rejection, and scores of less significant interpersonal encounters, as well as rapidly changing behavioral norms, can create social or personal problems for which there are no readymade answers. (p. 102)

Whether real or perceived, generated internally or externally, Mezirow's (1991) "disorienting dilemma" (p. 168), Schön's (1987) "predicament" (p. 93), or Dewey's (1934/2005) "perplexing condition" (p. 200) act to force a more accurate reflection of the nature of being. This self-reflective practice is antecedent to maturity, to personal growth, or the concept of *phronesis*, which Aristotle defines as a "true state, reasoned, and capable of action with regard to things that are good or bad for man" (Flyvbjerg, 2001, p. 2).

Mezirow (1978) suggested that a "crucial dimension of adult development involves a structural reorganization in the way a person looks at himself and his relationships" (p. 108). Additionally, Berry (2009), attributes self-understanding as a precursor step to teacher expertise. She concludes that "finely nuanced" understanding of one's self, shape teaching practice (pp. 315–316). Along these same lines, Tremmel (1993) asserts:

> Like all rigorous practice, the way of teaching demands a long journey that does not have any easily identifiable destination. It does not end with pre-service, or graduation, or after one year, or after all the criteria are met. It is beyond all criteria. It is a journey that I believe must include a backward step into the self, and it is a journey that is its own destination. (p. 456)

Furthermore, the literature discusses the outcome of crossing the threshold of self-awareness. The articles from Markus and Nurius (1986) and Schussler, Stooksberry, and Bercaw (2010) tied these transitions through various triggers to an increased level of self-efficacy and more positive dispositions toward teaching and learning.

Reflective practice is a term used by Schön (1983) that posits that deep reflection on action is paramount to transformational change. Schön is cited heavily in the work of Mezirow, and Mezirow also aligns Schön's work with the work of Carl Jung. Once the research is viewed as a whole, it is apparent that when the authors speak of *mindfulness*, *self-awareness*, *awakening*, or *reflexivity*, they are talking about the individual journey of transformation. These descriptors are the precursors to transformation. This transformation is where the balance is shifted, and the result is regarded as maturity, perspective change, or self-awareness. Reflective practice is what binds much of the research together. In the quantitative study by Brock (2009), data collected in the study of college students reinforced Mezirow's position that reflection is a critical component of transformative learning (p. 134).

Reflective Practice in the Automotive Repair Profession

Reflective practice is not a term that is generally associated with the automotive repair industry. In fact, the industry prides itself on efficiency and objective clarity. According to Shoemaker (1989), the automotive industry was the first to establish a national set of standards for vocational schools. These standards were developed by the National Automotive Technician Education Foundation (NATEF)—an assembly of automotive professionals and industry leaders.

To achieve accreditation through NATEF, an automotive technology program must demonstrate that it has the facilities, tools, and equipment necessary to operate the program, as well as, trained instructors and a curriculum that addresses a prioritized list of over 450 individual and measurable tasks. These tasks involve things such as measuring, removing, replacing, and adjusting mechanical, electrical, and hydraulic components (Lewis & Gill, 1995). The lockstep nature of the established prototype of a NATEF accredited automotive program is the epitome of technical rationality.

In contrast to the framework of technical rationality, many progressive educators such as Mezirow (1990, 1991, 2000), Schön (1983, 1987), and Jarvis (1993, 1995, 2011), stress that over-reliance on technical rationality is a hindrance to navigating the novel situations encountered in everyday professional practice. This is especially true in the field of automotive technology where there are numerous electronic, hydraulic, and mechanical systems working together and influencing one another continually.

Based on the work of Schön, Barber (2003, 2004) and Hyslop-Margison and Armstrong (2004) posit that technical rationality is applicable for entry-level mechanical repairs such as proper procedures for brake repairs, tire service, steering alignment, and many mechanical repairs that require the removal and replacement of major components. However, once the automotive technician faces a complex problem such as an electronic failure, computer communication failure, hydraulic failure, or engine management (air, fuel, and ignition) failure, their formal training falls short. There are just too many variables at play to make a short list of rules that will lead to a specific outcome. This leads me to turn to the alternative approaches of reflective practice, or variants defined by Mezirow, Schön, Jarvis and other progressive

educators, such as *critical thinking*, *intuition*, *reflection*, *awareness*, *mindfulness*, and *metacognition*.

Over the past 20 years, automotive educators and scholars have maintained that students graduating from automotive programs lack the social and critical thinking skills necessary to perform complex repairs (Cash, Behrmann, Stadt, & Daniels, 1997; Heyman & Daly, 1992; Nelsen, 1997, 2010; Thurlow, 2014). As a result, some scholars are promoting a more rigorous approach to the current approved curriculum executed in a lockstep fashion, with specific times to complete certain tasks in a certain amount of time for a specified number of credits and a grading system based on the completion of these mechanical tasks (Wiblin, 1993; Savin, 2007). However, just like in a real automotive shop, to the untrained observer, if the students are working in a nonlinear progression or chaotic fashion, the educational exercise could be considered to be ineffective. However, if the observer reveres the complexity of the master/apprentice–teacher/student relationship in the way that myths, legends, and fables have attempted (Campbell, 1968), there would be a deeper understanding of the learning exchange.

This idea is further reinforced by Pirsig (1974) when he wrote about untrained observers watching what a mechanic (or a teacher of mechanics) is doing. There is quite a bit more going on than just turning wrenches. But turning wrenches is precisely what the outside observer wants to see when they observe our classrooms or assess our curriculum. In other words, when students are allowed to explore, experiment, or reflect, it often looks like chaos. Even if the reflective and experiential curriculum is effective, it could prove difficult to promote these methods to the automotive advisory committee, the students, and even many of the teachers.

The automotive industry's overuse of the term critical thinking is also questionable when discussing the students' diagnostic capabilities or the instructor's ability to convey them.

Brookfield (2000) asserts that merely adding the word "critical" in front of terms such as thinking or reflection "does not imply a deeper understanding" (p. 126). However, this is how those who influence many decisions of automotive technology programs define their needs (Nelsen, 1997; Thurlow, 2014). I assert that not assigning a contextual meaning to the term critical thinking creates a gap in the research that intersects automotive technology education and reflective practice.

Research Goals

Hyslop-Margison and Armstrong (2004) asserted educational institutions are so mired in the paradigm of technical rationality that they use technical rationality to quantify learning that is reflective, which does a disservice to the students as well as the artistry of reflective practice. This is further reinforced by Edwards and Thomas (2010) when they wrote, "reflective practice cannot be a prescriptive rubric of skills to be taught; in fact, to see it in this way reverts to the very technicist assumptions reflective practice was meant to exile" (p. 404).

Both Barber (2003, 2004) and Crawford (2009) contend that successful automotive technicians have the capacity to be reflective, but often they rely on experience and tacit knowledge to properly diagnose and repair a vehicle, which is to say that relying on experience and tacit knowledge without a mechanism for continuous reflection may inhibit a practitioner's capacity for professional growth. This is similar to the antecedents of "perspective transformation" as defined by Mezirow (1978). Furthermore, Redmond (2004) elaborated on Polanyi's (1966) theory of tacit knowledge to discuss reflective practice when she stated:

> Polanyi's theory has relevance for situations where practitioners may be guided by implicit practice wisdom but have no means of testing either the reliability of such knowledge or of passing it on to somebody else in a planned way. (p. 25)

However, just like any systematic procedure, the introduction of fragmented, incomplete, or apocryphal information can compromise the entire system. In other words, it would be

impossible to grow as a practitioner if the mechanic is incapable of surfacing the tacit knowledge and suspending or questioning his or her experience during novel situations that occur in professional practice.

While searching the literature for connections between the rigid dichotomy of technical rationality and reflective practice, I started noticing that, depending on what part of the world was discussing progressive educational philosophies, the terms to describe theory varied much more than the content itself. Many tenets of transformational learning theory, as developed by Mezirow, are referred to in Europe and Canada as "reflective learning theory" as introduced by Jarvis in the late 80s (Wang & King, 2006). But Jarvis (1995) goes on to critique Mezirow's theory as being too narrow in scope. Furthermore, outside of the United States, it seems that educational researchers are focusing on the more psychospiritual or Eastern aspects of transformative learning theory/reflective learning theory. While both Mezirow and Jarvis lean on Schön's practical observations to undergird their theory, they are not short on critiques for one another's work.

A notable critique of Schön comes from Ixer (1999) where he posits that Schön's work (1983–1991) "creates more questions than answers" (p. 514). I believe that this criticism misses the point Schön was making in his work, which aligns itself very much to the truth shared by professionals, artists, and craftsman—the master of craft understands the folly of proclaiming definitive truths about the nature of work and the dialectic line of questioning uncovers the naivety of those demanding answers. Historians agree that avoiding concrete answers was something that got Socrates into trouble from time to time (Stone, 1989). However, Schön's work addressed the complexity of professional practice and made a strong case for reverence for the unobservable or unidentifiable aspects of professional work. According to Grimmett (1989),

Schön "studied how practitioners function[ed] in action settings and uncovered that they do not follow the procedures and strategies often sanctioned by professional schools" (p.26). In essence, Schön created a practical framework based on about 2,500 years of learning theory, observed student and teacher behavior based on that framework, and looped his observations back to the original theory offering some practical methods for addressing complex problems encountered during practice. Furthermore, because of the overt similarities in practice, scholars have adopted much of Schön's theory in creating models for professional learning in many trades such as nursing, public planning, teaching, music, psychology, health services, and social work (Redmond, 2004). Due to the nature of these frequently studied populations, there is little argument among scholars over their legitimacy as professions, whereas, in the field of automotive repair, the legitimacy of the field as a profession is itself in question, which also places the value of studying educators of automotive technology in question. Moreover, the underlying premise of this work is rooted in the practice of automotive diagnosis and repair and that this practice is no less than and no different from the professions Schön studied. This philosophy is echoed in the work of Miller (1996) when he asserted:

> Even though everyone is an intellectual, not every intellectual is a scholar. It is the same with plumbing … sometimes plumbers talk to the rest of us mortals and tell us how to use the disposal; other times plumbers talk to other plumbers, and the rest of us don't know what they are talking about. (p. 58)

I am interested in what can be revealed when an effort is made to understand what is understood between the plumber and the plumber, the mechanic and the mechanic, or the teacher and the teacher. Given this focus, in the following section, I will define relevant educational terms in the context of automotive technology.

Application of Terms in Automotive Training: Reflective Practice and Tacit Knowledge

To understand this phenomenon, it is necessary first to appreciate the *tacit* aspects of teaching and learning within post-secondary automotive technology programs and, second, understand how automotive instructors develop the knowledge and skills necessary to engage in reflective practice, both as a practicing mechanic and as a teacher of automotive technology. Barber (2003) wrote of the universal interest of the automotive instructor in understanding skill acquisition and offered that "if these skill acquisition strategies can be delineated and the limitations/benefits established, this information can be useful in the development of vocational training processes" (p. 134).

When I am talking about tacit knowledge in the context of automotive technology, I agree with the definition provided by Barber's (2004) study of automotive mechanics. He described tacit knowledge as a:

> [F]orm of knowledge [that] operates beneath the explicit sphere, modifying our [behaviors] and learning patterns. Propositional and episodic knowledge may lie in the tacit sphere, as may bodily knowledge such as balance and 'feel.' There is a continuum in this discussion of tacit knowledge, as some forms of this may be quite easily made explicit, while others are difficult, if not impossible to do so. (p. 131)

Schön (1995) and Redmond (2004) both worked with Polanyi's (1966) original ideas about tacit knowledge and how these related to reflective practice. However, Schön (1983) also suggested a positive relationship between tacit knowledge and reflective practice, weaving the terms seamlessly to define practices such as "knowing-in-action" and "reflection-in-action" (pp. 49–69). In essence, Schön's knowing-in-action is related to performance based on tacit knowledge and reflection-in-action is related to the practitioner's ability to dissect tacit assumptions during the performance to assess the accuracy or efficiency of the performance.

On the contrary, Barber (2003, 2004) wrote about how tacit knowledge with automotive mechanics, while indispensable on a daily basis, could hinder reflection in certain contexts.

From Barber's perspective, a mechanic must be able to suspend tacit knowledge at times to accurately reflect on a problem. If a mechanic has built up a store of experience, tacit knowledge, and the ability to know-in-action, there are still cause-and-effect rules in our subconscious that control our actions based on the aggregate of our experience. If a mechanic does the same diagnostic procedure for years with reasonable success and, all of a sudden, this procedure no longer works, then the mechanic has the following choices: (a) keep doing the same procedure because it meets his or her current mental model, or (b) suspend the internal belief in the procedure, reevaluate the procedure, or investigate changes to the assumed similarities of the system. Schön (1983) adds insight to Barber's claim with his explanation of "overlearning" and prescribes reflection as a "corrective" action (p. 61). This is aligned with Carson's (2008) study of sports coaching when he posited, "The coach may be constrained by their prior knowledge of the coaching process, good coaching practice, and reflection" (p. 388).

So there appears to be a prevalence of reliance on tacit knowledge that occurs through repetition (Barber, 2004), symbols (Nelsen, 1997), and heuristics (Hyslop-Margison & Armstrong, 2004). But where Schön (1983) is defining reflective practice as a skill to harness tacit knowledge, Barber is issuing a gentle caveat related to the pernicious effects of internal biases. Schön's (1983) reflection-in-action is addressing this caveat by asserting that, if the practitioner is not questioning these tacit habits of mind, they are not skillfully employing reflection-in-action. Barber does not disagree with Schön's assertions as they are the basis of his research. However, his manner of making the trap of tacit knowledge specific to the daily activities of automotive mechanics more explicit served to reveal the possible source of some of the seemingly non-reflective behaviors exhibited in the repair shop such as over-repairing or making quick decisions, which may be construed as guessing (Beck, Kerschbamer, Qiu, &

Sutter, 2013; Nelsen, 1997). Developing reflective skill has not been touted as being easy by either Barber or Schön, and their assertions are similar in concept to the Dreyfus model of expert skill acquisition (Dreyfus & Dreyfus, 1980). An updated version of this model was described by Benner (1982):

> At the expert level, the performer no longer relies on an analytical principle (rule, guideline, maxim) to connect her/his understanding of the situation to an appropriate action … It is very frustrating to try to capture verbal descriptions of expert performance because the expert operates from a deep understanding of the situation, much like the chess master who, when asked why he made a particularly masterful move, will just say, "Because it felt right. It looked good." (p. 405)

Although Schön (1983) maintained that reflection-in-action is very much reliant on tacit knowledge, it becomes obvious that the same tacit knowledge in one field (nursing) does not necessarily translate to another field (auto mechanics), but the capacity to reflect is needed in both. A seasoned auto mechanic knows the feel of a worn brake caliper slide mechanism and understands how it may inhibit the sliding action of the brake pads—fully understanding the reasoning behind a brake pull or uneven pad wear. However, he or she cannot use this same tacit knowledge to find a vein to attach an I.V. to a patient. So, there is a foundational component to the process of reflection, and this is rooted in technical rationality. It is not about the technical rationality in and of itself; it is about developing the capacity to reflect on the experience and that experience changes in real time. It is this phenomenon upon which Schön based his observations of reflection-in-action. Where Barber (2003, 2004) sees tacit knowledge as having the capacity to inhibit change in habits of mind, Schön is referring to reflection-in-action as a specific (and developable) skill utilized by practitioners to articulate their tacit practices to refine their habits of mind. This was alluded to in Schön's (1987) description of "double-loop" learning or "learning about the values and assumptions that drive one's own or the other person's behavior" (p. 256). This insight, applied to my field, raised several questions that remain unanswered. Are

reflective mechanics also reflective teachers? Are technically rational mechanics also bound by that paradigm when they move into a teaching position? Once a practitioner evolves the ability to examine and articulate the underlying tacit knowledge, it seems reasonable to assume that that person can also teach others about the connection. However, automotive technology programs have very few required qualifications to teach as opposed to other teaching fields. While expertise in technical content is necessary to teach automotive technology, it is improper to assume that technical expertise ensures teaching quality.

Connections Between Professional Practice and Transformative/Reflective Learning

Like Schön, Mezirow (1991) was trying to move the transformative/reflective aspects of education from theory to practice. Mezirow, a pioneering scholar of the transformative aspects of learning, leaned heavily on the work of Schön and Dewey and, like Jarvis (1993, 2011), breaks practice into distinct areas of non-reflective action, introspection, reflection, and reflective action. Mezirow (1991) directly compares Schön's theories in action or "frames" to his term "meaning perspectives" (p. 113). Furthermore, he uses other terms synonymously to add dimensions to what transformative education scholars refer to as reflection, such as "metacognition, reflection-in-action, and mindfulness" (p. 112). Mezirow focused on concepts of self-awareness as a way to better understand action but gave credit to many of his predecessors and contemporaries in explaining the psychology, sociology, or spirituality that lies behind meaning perspectives.

Beyond self-awareness, Mezirow (1990) focused on critical thinking as an antecedent to transformative learning. As in his previous works, Mezirow brought in the concept of *meaning schemes* defined as lower-order skills that are "habitual, implicit rules for interpreting" in comparison to meaning perspectives being higher-order skills acquired mainly through the

process of socialization (p. 2). This concept is echoed in Nelsen's (1997) and Barber's (2003, 2004) work on the development of informal learning in the automotive repair industry. These informally learned heuristics influence the ways we behave not only in social interactions but also in daily problem-solving activities encountered during professional practice. Similarly, in a study of clinical learning practices in software engineering programs, Bull and Whittle (2014) discovered that "elements of this culture include a sharing ethos, being social, treating the space like a second home, maintaining a good work ethic, utilizing peer learning, and accommodating serendipity into interactions and learning" (p. 45).

The reproduction of culture is a key theme in fostering reflective practice. Bull and Whittle (2014), while admitting to the ambiguous attributes of a realistic work setting, agree that it needs to consist of a "dedicated physical space" where instructors play the role of the mentor as students tackle "complex, partially specified problems" (p. 45). These complex, partially specified problems, are intimately related to Mezirow's (1990) "externally imposed disorienting dilemma" and was the basis of some progressive automotive training programs in the 1970s which surpassed the expectations of realistic work setting by creating a fully functional automotive repair facility where students worked on customer vehicles (p. 13). Unfortunately, due to fluctuations in the type of work, plus personal conflicts with students, the restrictive nature of semesters, the credit hours system, and financial aid stipulations the programs were sacrificed for educational models that fit more easily into the accepted model of technical rationality (B. Moser, personal communication, January 25, 2013).

Although the source of the example above is related to technical rationality as a systemic inhibitor of reflective practice, I am not implying that it has no place in education. However, language needs to be developed to aid leaders in making choices that positively support learning.

I agree with Mezirow (1990) who treated technical rationality and reflective practice with a respectful position and defended both ideologies' need to co-exist to develop learners fully.

Automotive Education as Professional Practice

Automotive educators learn the trade through formal training and experience; then they learn to teach by the seat of their pants. There is usually a high level of experience in practical automotive service work, but little teaching experience. Furthermore, to maintain their status as a qualified automotive educator, ASE certification is required, in addition to 40 hours of relevant automotive training ("Program Standards," n.d.). If the automotive program chooses to participate in a manufacturer-sponsored program, additional corporate training is required. At no time is teaching expertise addressed in automotive technology programs. From a technical rationality stance, the automotive instructor is obtaining repeatable facts, skills, and practices that can be regurgitated to the students and then repeated or demonstrated to the instructor for course credit. Jarvis (1995) addressed this phenomenon when he wrote about "emerging fields of practice" and the need to study the development of educators in these fields. Jarvis (1995) stated, "exposure to experts in practice is an essential part of learning practical knowledge" (p. 262) and "the expert in practice appears to be the best person to research [practice]" (p. 264). These statements by Jarvis reinforce my thoughts on the importance of expert teacher involvement in the development of a balanced curriculum for preparing automotive instructors to teach, as well as, teaching automotive students to repair vehicles.

Understanding Automotive Technology Education

In order to present an organized view of automotive technology education, I have divided this section into four specific content areas, beginning with (a) scholarship that addressed the complexity of automotive subjects and how reflection is an important skill that must be

developed in order to navigate complex problems, (b) literature that explored the role of technical rationality in teaching these highly complex subjects, (c) research related to the role of social interaction and the importance of reflection in understanding automotive systems, and (d) the marginalizing effects of the current educational model used to teach automotive technology.

The nature of automotive work. To get a clearer picture of the nature of automotive repair, Charette (2009) discussed the complexity of modern automobiles through interviews with automotive design professionals and educators. Charette sees misdiagnosis of electronic systems as rampant in the field of auto repair. Furthermore, according to one of the interviewees, vehicles are evolving at a pace where maintenance and repairs are becoming "too complex and demanding" for most mechanics, and theorizes that "remote diagnostics and repair" (diagnosis and repair via internet or satellite communication directly to the vehicle's onboard network of computers) "are likely to render mechanics obsolete for many tasks" (Charette, 2009, p. 3).

Concerning the skill development of automotive technicians, Barber (2003) created a hierarchy of knowledge and skills developed wholly on the job. These "practical skills" are broken into three types of "mechanic knowledge" that increase in complexity. *Repetitive knowledge* involves repeating a task so many times that there is automaticity established. Essentially, this development of automaticity is the development of tacit knowledge in a more tactile sense. This knowledge is sometimes referred to as *muscle memory*, and is similar to what Dreyfus and Dreyfus (1980) wrote about manually shifting a transmission, or what Schön was referring to when he wrote about improvisational practices of jazz musicians, or what Barber (2004) referred to as "bodily tacit knowledge" (p. 131). Mechanics who engage in lower order tasks such as oil changes, tire service, and brakes are usually paid by the flat-rate hour (commission based on an itemized labor guide, not actual time on the job) and become

unbelievably proficient at these seemingly simple tasks. The average car owner is capable of doing many of these tasks, but the bodily tacit knowledge allows the experienced and practiced technician to perform these tasks more efficiently. Barber (2003) discussed technical rationality as being the second level of skill acquisition. In other words, the mechanic is gaining proficiency through repetition and is increasing his fundamental knowledge of the systems he is engaging. The third type of mechanic knowledge, according to Barber, is *problem definition*. This would be the highest order thinking in the day to day activity of the auto mechanic. For example, problem definition would be implemented when a mechanic encounters a failure in the electronic system, the fuel management system, the emission controls, or the automatic transmission system. These systems are unbelievably complex and rely on both a strong foundational knowledge (technical rationality), as well as, the ability to reflect on how the systems interact with one another (problem definition). Barber further asserts, outside of the widely accepted juxtaposition of reflective practice and technical rationality as being two sides of the same coin, that reflection is antecedent to the development of both technical rationality and problem definition.

Barber (2004) revealed in a subsequent study that he is both a practicing mechanic and an automotive instructor, which adds additional validity to his arguments as a practitioner. In his recent study, he worked in a repair facility in India and compared his experiences working alongside other mechanics to his earlier research in Scotland. He discussed tacit knowledge as a developed skill and, in India, where automotive training is largely informal and experience based, the actual practice is considered privileged. In other words, there is a social aspect to getting the types of experience from which a technician can learn and, according to Nelsen

(2010), it is only until the student becomes proficient at the social aspects of the job that he or she will have access to this privileged information.

Technical rationality in automotive skill development. Going beyond the on-the-job training associated with many informally trained mechanics, Cash et al. (1997) explicitly address the shortcomings of the current paradigm of technical rationality in automotive technology programs that utilize a formal internship experience. While the authors do not identify technical rationality as a key term, they use the term *traditional apprenticeship* to discuss the limitations of a non-reflective experience versus their concept of *cognitive apprenticeship*, which involves many of the same philosophies as Schön's reflective practice or Mezirow's transformative learning. My concerns with this study involved the researchers' attempt to quantify the effectiveness of cognitive apprenticeship without providing the reader with much information regarding the specifics of the treatment or information regarding the reflective skill of the instructors or mentoring technicians at the internship site. Hyslop-Margison and Armstrong (2004) address these concerns, warning that "[w]ithin career education, for example, critical thinking conceived as technical rationality refers to means/end reasoning that pursues human capital and business objectives with the maximum possible efficiency" (p. 43). This leads me to believe that Cash et al. are promoting an apprenticeship system that would satisfy those who assess automotive technology programs, but may ignore many of the effective aspects of reflective practice.

In the tradition of Schön, Nelsen (1997) asserts that informal training through experimentation and reflection constitutes the majority of professional knowledge and is:

> [E]mbedded in heuristics, shortcuts, and makeshift measures … [where] … technicians routinely employ shortcuts by substituting procedures of their own design for those in manuals, and they omit steps specified in a diagnostic or repair procedure deemed unnecessary for achieving desired results. (pp. 93–94)

Also, Nelsen focused on the importance of social interaction within the automotive field as an antecedent to access the aforementioned privileged heuristics passed among auto mechanics.

If access to this privileged knowledge is contingent on the student's social skills, then the auto mechanics that possess the skills necessary to obtain this information and develop their craft are most likely good candidates to teach. Nevertheless, do these high performers share similar traits to the majority of their peers? Threeton and Walter (2009) found a connection between automotive technology student's personality type and their preferred learning style. This study revealed data that made a very clear case that people with certain personality/learning styles are somehow drawn to automotive technology programs. The results from the study revealed several important characteristics of the typical automotive student such as (a) almost all (98%) of the participants were young men; (b) 84% of the automotive students identified as a "realistic" personality, which the authors explain indicates a proclivity for learning through mechanical manipulation; (c) 98% of the automotive students expressed satisfaction with the program (pp. 64–67). Threeton and Walter (2009) posits that this could be due to the tracking of students with low academic ability. In other words, if a high school student does not perform academically, it is assumed by counselors that he/she must be good with their hands and tracks students into vocational areas. Furthermore, students of low academic ability are often satisfied with programs that have less academic rigor. A curriculum based on technical rationality would be satisfying to certain students who lack academic ability but can navigate the well-defined and lock-step curriculum which is the current method of teaching automotive subjects (Bauder, 2001; Threeton & Walter, 2009). However, once they graduate, many of their employers complain that the graduates are unable to engage in effective problem solving (Thurlow, 2014).

Although the research conducted by Threeton and Walter (2009) dealt mainly with automotive students, there are useful data that may increase what is known about automotive instructors. If the automotive instructors are selected from the population of automotive technology students, then it would be intuitive that the majority of automotive instructors have a realistic/mechanical learning style and be comfortable teaching within the paradigm of technical rationality.

To further discuss the need for social interaction as an antecedent to reflective learning, Nelsen (1997) describes two case studies of automotive repair shops, where she observed automotive practices, interviewed automotive technicians, paying specific attention to the significance of symbols present in the automotive repair industry. To be respected in the automotive field, the technician must create an "occupational image" that symbolizes "competence, professionalism, and membership in the community of practice" (Nelsen, 1997, p. 78). These can be anything from patches or plaques that denote training or certification, time on the job, or especially the quality of technicians tools and tool box. All of these things work together to build credibility in the workplace. Lewis and Gill (1995) discuss the concept of credibility in a study of the effect of automotive programs accredited by the National Institute for Automotive Service Excellence (ASE). In this study, the researchers administered standardized tests developed by ASE to students attending 15 non-certified and 33 certified post-secondary automotive programs. The results showed that programs certified by the creators of the test (ASE) scored significantly higher ($p < .05$) than programs not certified by ASE. However, these statistics were only achieved after a stronger non-accredited program in Florida was awarded certification and was moved into the accredited column. In line with Nelsen's earlier assertion, Lewis and Gill (1995) posited that the idealization of a certified program yields symbolic power

that could possibly motivate students and positively influence the school's "linkage with the labor market" that could potentially affect the school's ability to obtain donations of vehicles, tools, and learning materials (p.10). However, a critical view expressed by Kincheloe (2006) suggests "the idea that such tests measure student achievement or ability and teacher effectiveness is an interpretation—nothing more, nothing less" (p. 97).

If Kincheloe and Nelsen's assertions above are true, then many of the assertions made by accrediting bodies such as NATEF, are making claims that do not take into account the social and cultural aspects of automotive education. Undoubtedly, the study which best addressed the culture of the automotive industry was Nelsen's (2010) study of the significant changes to the automotive service industry following the introduction of high-tech systems such as microelectronics. She discusses the changes in technology increasing the demand for expert laborers in dealing with these complex systems and the impact of technology de-skilling workers, as many low and mid-level skills are rendered obsolete by technology. This is echoed in the Charette (2009) article, which outlines the rapid increase in microprocessor controlled functions in modern automobiles. Outside of this debate, Nelsen takes a more sociological approach and studies the symbolic significance of what she defends as a unique group of service professionals—automotive mechanics. Nelsen (2010) sums up her study with the following statement:

> [T]echnical workers must be given the opportunity to shift public views and opinions of themselves and their work in social encounters, one encounter at a time. Absent this, it is unlikely that the public as a whole will ever confront the anomalous nature of these workers and design a new pattern of cultural meanings in which they have a fitting place. (p. 235)

These cultural meanings can be easily skewed as evidenced by Dant and Bowles (2003) in a study that dealt with both the automotive technician's pragmatic approach to dirt and dirty jobs, compared to the customer's view of dirty jobs—creating an observable social stratification.

Many sections of the article reinforced Pirsig's (1974) idea of the ignorance of the untrained observer when making generalizations concerning automotive repair, and the necessity of destroying the shibboleth of the automotive mechanic. Also, Dant and Bowles (2003) elaborate on their perceived "moral division of labor"—an idea they draw from Everett Hughes (p. 3) and identify certain social stigmas associated with many of the skilled trades that deal with dirt (p. 3). Hughes (1958) used polarized examples of the physician who gains prestige by undertaking high moral dirty work such as "healing the sick" compared to low moral dirty work such as the janitor's role in dealing with other people's garbage (pp. 45–47). However, Dant and Bowles (2003) offer that, although the nature of car repair does not elicit high levels of prestige, the public perception of the automotive technician falls somewhere in between the physician and janitor in the Hughes' moral division of labor. Also, some stigmas associated with auto mechanics originate from actual perceived negative behaviors rather than the physical dirt associated with the job. Beck et al. (2013) discussed *credence goods* such as automotive service and addressed the likelihood of fraud when there is a large difference between knowledge between the consumer and the provider. However, the part of this article that was most beneficial to this study had to do with the reasoning behind the fraudulent behavior. Auto mechanics were addressed specifically in Beck et al.'s discussion on over-servicing or providing higher quality repairs than necessary due to a system that inadvertently inhibits reflection. The authors note consequences such as comebacks, chargebacks, and loss of reputation for the technician if the vehicle is not fixed correctly on the first visit. Also, considering the typical automotive technician's pay is based on the speed of repair, since developing reflective practice is a long process, many times a technician will replace entire components or set of components rather than make an adjustment or repair a part of the component. Rather than diagnosing

problems, it is more lucrative to make an educated guess and replace major system components or multiple components. Furthermore, Beck et al. (2013) asserted, "While sellers learn that quality by performing a diagnosis, consumers are unable to judge which quality is the surplus-maximizing one. Moreover, in many cases, consumers are not even *ex-post* able to observe the received quality" (p. 1). Could this be carried over into the automotive training area? Could it be that the type of expertise possessed by automotive instructors is so far removed from the funders that they truly are unable to assess quality accurately?

In addition to the aforementioned research relative to the effectiveness of "cognitive apprenticeships" by Cash et al. (1997), Heyman and Daly (1992) provide the reader with specific techniques to increase the interdisciplinary component of traditional vocational education, such as specific examples of interdisciplinary exercises, peer mentoring, and case study exercises. Furthermore, they provide the reader with suggestions for testing and evaluation techniques for "testing critical thinking skills" (p. 107). They conclude with a cautionary note that these methods will result in more work for the teacher and most likely be poorly received by the students. However, I agree that the most intuitive teaching methods are not always the best methods to increase a student's capacity to learn. Additionally, Bull and Whittle (2014) discussed the concept of impromptu teaching in a studio environment:

> [W]hich is where a staff member teaches or demonstrates to a student, a group, or the entire room, at any time, based on his or her assessment of whether the students require it or not. One important part of the studio is its flexibility for teaching. It provides additional opportunities for the students to reflect on their understanding of a subject, but staff can also reflect on students' progress and the course itself, providing impromptu teaching where necessary, for example, with demonstrations or short discussions. (p. 48)

In sum, there are fundamental elements to learning, as well as improvisational elements to learning. What is missed in the attempted technocratic quantification of the learning process is the nuanced relationship between the teacher and the students in novel situations.

Reflective practice in career/technical/adult education. As stated earlier, a major hurdle in understanding the complexity of teaching automotive technology is the myriad terminology used by academics to describe closely related constructs such as critical thinking, intuition, reflection, awareness, mindfulness, and metacognition. I desired to study the overlap of these terms to communicate better the phenomenon of reflective practice as it relates to teaching automotive subjects. Petress (2004) attempts to provide context to the wide use of the term critical thinking "to better allow speakers, listeners, readers, and writers to better use this pervasive term in academic literature" (p. 7). However, according to Hyslop-Margison and Armstrong (2004):

> [C]urrent models of critical thinking in career education are conceptually problematic, epistemologically incomplete, virtually ignore dispositions, and merely promote technical rationality aimed at improving human capital efficiency within difficult labor market and working conditions. (p. 46)

This is along the same lines as the assertion by Brookfield (1995) that reflective practice "has become a catch-all term embracing ideologies and orientations that are often contradictory" (p. 215). So, improving critical thinking skills does not necessarily promote the reflective capacity of students or teachers, especially if the construct of critical thinking is viewed through the lens of human capital theory or technical rationality.

Forces Working For and Against Reflection in Automotive Practice and Teaching

Hierarchies that emerged from the studies of automotive service are easily transferred to teaching automotive subjects. Barber's (2003, 2004) case studies on technician skill acquisition illustrate the creation of skills present in the automotive service center such as doing repetitive work or performing medium level tasks that rely heavily on tenets of technical rationality, or higher-level tasks that rely on the technician's ability to be reflective. The thread that seemed to run through the work of Barber (2003, 2004), Nelsen (1997, 2010), and Heyman and Daly

(1992) involved the concept of developing the capacity to reflect deeply. Many times, other skills necessary for both repairing vehicles and teaching about repairing vehicles were referred to by Barber, Nelsen, and Heyman and Daly using terms such as *acquired* or *obtained*. Yet, when these authors spoke about higher order thinking skills, they many times referred to terms such as *developed*. I agree that many of the skills associated with automotive repair can be obtained through repetition and, with minimal direction and practice, an automotive technician is capable of becoming an expert at mounting tires on a wheel and balancing the assembly. However, there are many aspects of automotive repair that are not so cut-and-dried and cannot be easily learned by rote. It would also be difficult to break automotive tasks into low, medium, or high levels of reflection without blurring the edges. It would be more accurate to think of it as a spectrum of reflection rather than a hierarchy.

In any automotive shop, technicians are going to be divided based on skill level and knowledge level. Barber (2003) has delineated the types of skills that exist in the shop and juxtaposed this with the work of Schön. As noted earlier in this chapter, Barber designates three developmental categories: repetitive practices, technical rationality and, closest to Schön's reflective practice, *problem defining.* The physical aspect is there, but there is more. Barber (2003) describes such a situation:

> Often the mechanic had been confronted with a problem where the situation had not been defined. Perhaps the car would not start. In a case such as this, the combination of problems that could cause such a situation is almost unlimited. The dilemma becomes that of defining the problem. . . Once the problem has been defined, the lower levels of skill acquisition such as technical rationality or [memorized] procedures are [utilized]. (p. 139)

The routine physical work is seen easily by the untrained observer, so it is no surprise that this is what the majority of the population identifies as the primary aspect of the auto mechanic's job. There is no harm in the untrained observer ignoring the nuances of a skilled trade. However, the

perniciousness arises when the observer is involved in creating policy that inhibits the education and reflective practice of skilled workers. Giving credence to the complexity of automotive repair not only adds to the validity of automotive education but also has the potential to drive change in the education of automotive technicians to include problem definition and reflectivity. There can be no shift in this public misperception of auto mechanics until someone demonstrates that there is much more going on than can be seen.

Conclusion and Directions Forward

The current research on automotive technology programs has been overwhelmingly focused on curriculum, assessment, and student learning. There is virtually no research being done on reflective career/technical teacher development. By this, I mean research on training teachers to be able to teach reflective skills in programs of technical education. Research in this area will contribute to the field of automotive technology and will add to the body of knowledge concerning career/technical education. Along the same lines as Redmond's research in health and social service education, I would like to have automotive instructors re-examine their tacit beliefs about automotive training the way they were trained, the way they teach, and the way they view the needs of the students—in hopes that they will be better equipped to understand and be critical of the curriculum. This reflective stance should equip the instructor to participate in the changes necessary to enrich the curriculum and especially to inculcate skills of reflection and problem definition.

Automotive repair is a job that is challenging enough to stimulate both the physical and mental demands of the individual. Dewey (1934/2005) describes "the intelligent mechanic engaged in his job, interested in doing well and finding satisfaction in his handiwork, caring for his materials and tools with genuine affection is artistically engaged" (p. 4). Although the mechanic described by Dewey in 1934 is not the same mechanic working in shops in 2017, the

same basic principles have been echoed through the years by Pirsig (1974) and more recently, by Crawford (2009). All three authors, writing decades apart from one another, agree that, at times, the craftsmanship and artistry of the mechanic become compromised, and the "fault … is oftentimes not so much with the worker as with the conditions of the market for which his product is designed" (Dewey, 1934/2005, p. 4). If this is indeed true of mechanics, can it also be true for educators of mechanics? In other words, the majority of research in this literature review focuses on the education of future practitioners, and I believe that a gap exists in the research involving the education of educators in fields such as automotive technology.

In summary, this review of literature provided a solid foundation of theory and research to aid in understanding the reflective process, why it is important, and how to implement it. Philosophically, the importance of reflective practice is heralded as paramount to growth as a person as well as a practitioner. Powell (1989) suggested, "further studies of the area of reflection in action … are necessary for all practice professions" (p. 831). However, in the realm of education and professional development, reflective practice is elusive. How do you teach it? How do you teach others to teach it? How do you define it? How do you measure it? Reflective practice is a moving target and often paradoxical. The act of observing the behavior has the potential to change the behavior. A person with little to no experience will have a difficult time with reflection, but experience does not guarantee reflective practice. Could reflective practice be as easy as memorizing the rudiments of and artistry then practicing incessantly until the repetition of these skills forms an aggregate form of practice that is as natural as breathing? Some of the articles above spoke of assignments that fostered reflective practice, but in essence, that is no guarantee that it will be developed. From the literature, it is never contested that reflective practice occurs naturally, when conditions are correct, so trying to force reflection may

guarantee that it does not occur. Furthermore, the modern modularized and compartmentalized structure of higher education and training is the antithesis of an environment that fosters reflection. However, creating a realistic learning environment may allow the researcher to make direct observations of reflective practice. This metaphorical snapshot will be the basis of my research, as it will allow me to observe reflection in action (or what I interpret as reflective practice) and ask the practitioners about their experiences directly. Furthermore, little research has been conducted on automotive instructors, and virtually no research has been conducted on reflective practice and automotive instructors. In fact, I contend no other professional area has put as many resources into technical rationality than automotive technology and introducing the concept of reflective practice will undoubtedly uncover unique data.

This study will significantly enhance and extend previous work on reflective practice by introducing another population of practitioners as they navigate complex and unique problems. Many scholars research reflective teaching practices to develop assignments or isolate behaviors based on observations and personal interpretations. I am looking to understand the subjective experiences of automotive instructors as they observe themselves engaged in reflective practice. I believe that this will have relevance not only to the development of automotive instructors but also to other professional practitioners. This method of understanding is universal. While there is something to be learned from the subjective experience of any practitioner, I am certain that within the highly structured and technical constraints of post-secondary automotive programs, reflective behavior will be a shining beacon, and the reasoning behind the instructor's observed behavior during novel situations will yield important, and possibly surprising, results.

This review uncovered some of the forces working to educate automotive professionals, especially as these forces relate to reflective, intuitive, or improvisational skills automotive

instructors utilize during teaching practice. Patterns emerged into a spectrum that spanned the most practical to the most psychospiritual aspects of transformative learning/reflective practice—developing a strong argument that educators should foster an interdependent relationship between technical rationality and reflective practice. In the next chapter, I will be demonstrating how the method of Interpersonal Process Recall will prompt automotive educators to reflect on their teaching practice to surface the complexities mentioned above inherent in teaching, as well as, their skill development in addressing the multiple novel scenarios inherent in automotive education.

Chapter III: Method

Throughout the literature review, I leaned heavily on the work of Donald Schön (1983), and his concept of reflection-in-action, to uncover many of the tacit aspects of teaching vocational subjects. There is more complexity to teaching and learning, which transcends the metrics provided by the administration of Career/Technical Education. In this chapter, I am discussing the method of Interpersonal Process Recall (IPR), as the means used to uncover some of the attributes of master automotive teachers to isolate certain aspects of effective teaching practice in the teacher/learner exchange (Kagan & Kagan, 1991). Following the collection of data from the IPR observations and interviews, I relied on thematic analysis as a method of data analysis (Boyatzis, 1998; Guest, MacQueen, & Namey, 2012).

IPR is a method of inquiry developed by Kagan, Krathwohl, and Miller (1963) as a means to assist counselors in increasing self-awareness by prompting them to reflect on video interactions between the counselor and client. It consists of an investigator videotaping an interpersonal interaction and interviewing the participants, prompting them to reflect on their own behavior with the use of open-ended questions, essentially allowing the participant to as assume the role of an observer. Following its success in studying counselors, scholars have chosen IPR to study other populations such as psychologists, teachers, physicians, and military personnel (Kagan, 1995).

IPR proved to be an effective methodological fit since it is widely considered a potent method of uncovering the thought strategy in an interpersonal exchange. Furthermore, recording an exchange (in this case it was between the instructor and learners) and then replaying the recording for the participant (instructor) during an interview served to uncover certain nuances that were not readily apparent to the observer or participant while they are positioned within their field of practice. This proved to be an effective method of surfacing the complexity of teaching

automotive subjects and was useful in both designing curricula for teacher development, as well as, assessing teaching practice.

I collected data utilizing IPR techniques because I was interested in making the implicit aspects of vocational teaching behavior explicit, or according to Kagan (1995), putting into words the "unnamed experiences" such as experiences based on personal perceptions or intuition (video lesson 1). The research question for this dissertation asked: What are the subjective experiences of automotive instructors as they navigate experiential learning activities in the lab? I am particularly interested in the antecedents of reflective practice, and how this practice crosses the boundaries between teaching and doing. Through the analysis of the data I collected during the IPR process, I found answers to questions such as:

1. Is the instructor exhibiting behavior aligned with any existing educational or leadership theory?
2. Is the instructor aware of his own thought processes during improvisational teaching moments?
3. Does the instructor attribute improvisational or reflective skill to any learning event such as teacher education workshops, mentoring, or trial and error?
4. How does an instructor's perception of a student modify their behavior when navigating novel situations in a lab environment?

Furthermore, since IPR is a method for collecting but not analyzing data, I used emergent thematic analysis to process the data gathered. Thematic analysis is popular among qualitative researchers because it is rooted in discovery (Boyatzis, 1998; Guest, MacQueen, & Namey, 2012; Saldaña, 2015). It is a way to process themes that emerge from qualitative interviewing by generating "codes" which are conceptual models that capture the "richness of [a] phenomenon"

(Boyatzis, 1998, p. 31). I used these codes to uncover themes that emerged as the instructor engaged in dialogue regarding the observation of their own teaching practice.

It is common practice in higher education to have peer reviews, usually conducted by the department chair or a senior faculty member. I have been peer-reviewed, and I have reviewed my peers. However, a rigid rubric exists to assist the reviewer in assessing the class. However, this rubric only addresses the technical aspects of the class—is the material organized? Is the instructor enthusiastic? Does the instructor make use of visual aids? I am sure that all of these easily measurable constructs are important, but none of them addressed the instructor's intuitive ability to navigate novel situations during lab instruction.

Appropriateness of the Research Design

IPR was a suitable method for this study because it created an opportunity for the instructor to reflect on his or her teaching practice—transcending the narrow scope of traditional teaching evaluation. Furthermore, through thematic analysis, I was able to look beyond the traditional lens of the outside observer and analyze the observation of the participant. By looking at themes generated from the participant's self-reflection, I was able to look at automotive technology instructors through their lens and not the lens of a scholar/observer, which had the capacity to result in a misinterpretation of the participant's actions.

Research Design

IPR questions used for this study were open-ended and designed to prompt the participants to reflect on their observed behavior. Kagan (1995) explains the ability of IPR to uncover tacit behaviors, based on the following notions:

1. As human beings, we have an incredible ability to read other people's emotional states.
2. IPR is based on our abilities to use intuition and anticipate future actions based on our unique experiences.

3. IPR is useful in putting names on unnamed experiences. (Video lesson 1)

Because of IPR's ability to surface the complexity of social interactions and human behaviors, it was useful in collecting data for this study. For this study, I recorded video of the teaching practices of post-secondary automotive instructors identified critical moments in the teacher–learner exchange and interviewed the instructor based on my observations and the instructor's reactions to the recording. This helped illuminate the instructor's reasoning behind certain teaching skills or behaviors and how instructors developed these skills or behaviors. Ladany and Inman (2012) assert:

> [N]onverbal behaviors such as gestures, facial expressions, head nods, glances, changes in tone of voice, keeping an open body posture are critical ways that alter or emphasize what we say and do. These non-verbal forms of communication provide depth to the emotions underlying one's experience and are often more important than what is being said orally. (p. 182)

For this study, I was more interested in the interviewee's perceptions of their non-verbal behavior demonstrated in the observation video. While I was interested in the instructor's reactions both verbally and physically to the recall session, I will be limiting this investigation to transcribed audio and field notes from the interview.

Kagan and Kagan (1991) describe IPR as a "powerful tool … for discovery and training" (p. 222). They continue by describing three facets of IPR that align themselves with my research. First and foremost, IPR is used as a research tool to examine behavior based on direct observations and the participants' perceptions of the recorded behavior. Second, IPR is "a training model for improving the interpersonal abilities of … teachers." And third, IPR "contributes to theory and knowledge about human interaction that emerges from its application in research … [and] … training" (pp. 221–222). I concentrated on a focused area of career technical education with a lens that looks beyond the standard quantitative measures, as well as,

addressing some of the cultural biases and misinterpretations inherent in the existing qualitative studies of automotive technology.

Once I collected the data through interpersonal process recall sessions, I processed the data using a type of thematic analysis that specifically looks for emergent themes rather than attempting to force the data into an existing educational model such as reflective practice or transformative learning. I based this study largely on the constructivist epistemology of co-creation of knowledge to understand a particular phenomenon. Furthermore, my use of thematic analysis was based largely on the work of Guest et al. (2012) and Boyatzis (1998) and provided a framework for analyzing the data generated from the recall sessions, a demographic survey, and my personal research journal. This study articulated the intuitive capability of career/technical instructors in action and framed this behavior as a developed skill. In this study, I attempted to bring these improvisational skills to consciousness, study them, and through the development of understanding, possibly uncover themes to help other instructors utilized these skills more effectively. According to Boyatzis (1998), researchers "using thematic analysis may appear to be making the observations and coming to insights 'intuitively.' For them, the use of the process of analysis has become unconscious, much as multiplying single digits is for many people" (p. 2). This is in alignment with the work of Kagan and Kagan (1990) grounding their work on the assumption that practitioners have "encyclopedic knowledge" of their craft, and what is seemingly natural can be surfaced as a highly-refined skill (p. 437).

Pilot Study

To validate the effectiveness of the IPR process, I conducted a pilot study during the Fall semester of 2016. In this pilot, I solicited two colleagues to participate in the study. The pilot not only helped me navigate the process of obtaining the proper equipment, but it also provided a

safe space for me to practice using the equipment, giving me the ability to refine camera and microphone placement, as well as, developing a protocol for the interviews. Through the pilot, I was able to construct the framework for the dissertation and fine-tune the research design based on both the challenges and successes. Furthermore, although I did not intend to analyze the data obtained during the pilot, both my cursory journaling and notes from the interviews yielded some interesting viewpoints shared by both interviewees.

Two interesting phenomena that occurred during the pilot had to do with the instructor's perceptions of the students. First, during the recall session, both instructors began by making broad and vague judgements of the students based on constructs such as "strong" or "weak," but the more the instructors were allowed to expand, they began to identify details such as body language or certain behaviors from prior interaction with the student. In addition, during the pilot observation of the manual transmission class, seven out of nine pairs of students performed the lab activity incorrectly. During the interview process, the instructor noted that a smaller portion of the students failed to make the repair the second time, but interestingly, he made the comment that he was unsure if the students who performed the task correctly the first time could repeat the performance a second time. I found this to be profound, based on our department's collective ethos of outcome-based learning, which assumes that meeting a formal standardized objective implies causation for skill attainment.

Recording Equipment for IPR Observations

The best audio/visual setup I discovered during the pilot included two high-definition cameras placed in the two front corners of the classroom to eliminate any blind spots during filming, and a lapel microphone on the instructor to ensure a consistent volume during the dialogue between him and the student regardless of his location in the room. During editing, I

cut out sections of the video when the instructor walked off camera one, switching to camera two, effectively following the instructor around the room. I deleted the audio from camera one and camera two and synchronized the audio from the lapel microphone. This way, the instructor was listening to the audio between himself and the students, as well as visually placing himself in the room. This gave the instructor full access to his and the student's facial expressions, body language, and tone of voice. Based on positive feedback from the interviewees, this was an excellent prompt to assist an instructor in the recall interview.

Setting and Participants

To gather universal themes across post-secondary automotive lab experiences, I decided to interview post-secondary automotive instructors from different colleges with accredited automotive technology associate degree programs. I interviewed 12 instructors from three different community colleges—six observations and interviews were conducted at a community college in Dayton, Ohio, three were conducted at a community college outside of Chicago, Illinois, and three were conducted at a community college in Indianapolis, Indiana. By interviewing at least three instructors from four to six different colleges, I decrease the chance of biases that could have arisen from the institution's culture. I was able to collect data that reflected the faculty as an individual as well as reflecting the culture of the institution. In other words, through careful coding of the interviews, as well as careful and thoughtful reflection of my field notes, I was able to focus on generalizations and distinguish between institutional versus cultural practices as well as behaviors related to the individual instructor's personal style. Additionally, I consulted with the interviewees as the narrative unfolded. By checking in with the interviewees, I was able to co-construct an accurate narrative depicting the thoughts and feelings of the interviewee during observation, as well as, the recall session.

I selected participants from the population of automotive instructors from accredited colleges with post-secondary automotive programs. Since it is a relatively small and focused population, I was not able to select participants solely based on professional experience, tenure, or reputation. However, basing my participant selection on their willingness to participate yielded more diverse population (see Table 3.1) and, more importantly, willingness to participate.

Participants

I selected thirteen instructors from three different automotive programs at community colleges from three Midwestern states for observations and interviews. In a recruitment letter, (see Appendix A) I asked the instructors to be active in the lab for at least one hour of hands-on experiential learning. However, three observations needed to be re-recorded because the instructors either did not take the students into the lab during the observation, solely relying on lecture or demonstration, or they did not meet long enough for the one-hour requirement. Once I met with the instructors again, it became clear that they misinterpreted what I was requesting as an observation of their teaching methods, not how they navigated lab activities. Following this interaction, two instructors agreed to be re-recorded, and one instructor decided not to participate. Luckily, I was able to find another instructor at a different college to participate.

In this study, I identified the three participating colleges as Program A, Program B, and Program C. Both Programs A and C had multiple program paths including a comprehensive program that provides training on multiple makes and models, and corporate sponsored internship programs, such as Chrysler MCAP (Mopar Career Automotive Program), GMASEP (General Motors Automotive Service Education Program), Toyota TTEN (Technician Training and Education Network), Honda PACT (Professional Automotive Career Training), and Ford

ASSET (Automotive Student Service Educational Training). Program B had a comprehensive program but chose not to participate in a corporate sponsored program.

Corporate supported programs were created in the early 1970s to address a shortage of technicians. The automotive manufacturers utilized the existing talent at community colleges to train entry-level technicians. However, in the 1980s, there was an increased influence of the manufactures in the educational process. The programs supply instructor training, student access to the corporate network and technician resources, curriculum, vehicles, special tools, equipment, and additional funding to the host college. The relationship is legal and contractual and sometimes interferes or conflicts with the policies of the college. The corporate programs require that the college appoint a corporate program coordinator and almost all corporate sponsored programs include an internship that is monitored and managed by the program coordinator.

The manufacturer sponsored programs work in the same way. Students are recruited to the programs by a manufacturer-sponsored program coordinator who is an employee of the community college. The coordinator will place the student at a local new car dealership. After the student takes an accelerated course (8 weeks) the student will finish the remainder of the remainder of the 16-week semester working at a new car dealership. The coordinator manages the internships, ensures that the faculty members are certified by the particular manufacturer, and manages a fleet of donated vehicles and a collection of donated tools and equipment.

While all of the courses were automotive, there was a diverse sampling of content. At Program C, I observed a corporate sponsored GMASEP engines class, a comprehensive fuel systems class, and a Toyota TTEN air conditioning class. At Program A, I observed a Chrysler MCAP automatic transmission class, engines class, and fuel systems class, a comprehensive

heating, ventilation, and air conditioning (HVAC) and brakes class, and a Honda PACT manual transmission class, and at Program B, I observed three comprehensive courses; a basic automotive electrical course, an introductory automotive systems course, and an advanced fuel system course.

Twelve interviews were conducted with 12 participants, based on approximately 18 hours of observation, 3.5 hours of improvisational time broken up into 165 clips, and 9 hours of dialogue from the interviews. After the interviews, a total of 402 improvisations emerged to be used in the analysis. Additionally, while the instructors were not diverse regarding culture, gender, or ethnicity, they were very diverse in experience and subject matter expertise. Many of the participants had worked in automotive shops for more than five years, three participants served as department chairpersons, and one participant was a former department chairperson (see Table 3.1).

Table 3.1

Demographics of IPR Participants

Demographic	Frequency	% of Sample
Age Range		
26–30	1	8.3
31–35	1	8.3
36–40	4	33.3
41–45	1	8.3
46–50	0	0.0
51–55	1	8.3
56–60	1	8.3
61–65	3	25.0
Years of Tenure		
0–5	3	25.0
6–10	1	8.3
11–15	3	25.0
16–20	1	8.3
21–25	0	0.0
26–30	1	8.3
31–35	1	8.3
36–40	1	8.3
41–45	1	8.3
Years of Professional Experience		
0–5	3	25.0
6–10	6	50.0
11–15	1	8.3
16–20	0	0.0
21–25	0	0.0
26–30	0	0.0
31–35	1	8.3
36–40	1	8.3
Job Title		
Professor/Chairperson	3	25.0
Professor	3	25.0
Assistant Professor	2	16.7
Associate Professor	0	0.0
Instructor	4	33.3
Education Level		
Associate	2	25.0
Bachelor’s	2	16.7
Master’s	7	58.3

n = 12

Data Collection

Prior to the laboratory observations, I had set up two cameras and recording device with a lapel microphone designed to pick up any dialogue within the general area surrounding the instructor. I used a reference tone to synchronize the audio and video and used the stopwatch on my smartphone to make timestamps that corresponded to the notes in my field journal. Throughout the observations, I made notes of times that it seemed as if the instructor was improvising based on the criteria set in Chapter III. I allowed the camera to run until I was sure I had at least ten good clips to review during the video editing process. Some classes took longer than others to get the ten instances.

The courses varied between subject material and skill level (see Table 3.2). Courses such as *Introduction to Automotive Systems*, *Basic Electrical and Electronics*, and *Automotive Brakes* are considered beginner level courses and usually have a population of freshman students within their first two semesters. However, courses that involve manual transmissions, HVAC, and engine mechanical systems are considered as intermediate level classes and are usually taken by a mix of first-year and second-year students. Automatic transmissions and engine performance courses are advanced subjects and are suggested to be taken during a student's last two semesters.

In reference to Table 3.2, it is reflected that brakes, manual transmissions, and automatic transmissions were the longest video observation. That was because these tasks required the students to perform the most preparation work to actually get to the task. Students had to raise the vehicles on lifts, remove wheels, exhaust systems, or drain fluids to get to the actual components. Sometimes these preparatory activities take as long as the actual task. I allowed the cameral to run until I had picked up what I considered an adequate number of interventions.

It just took much longer to service drum brakes in comparison to activities like a static refrigerant pressure test where the students are connecting gauges to a service fitting or using a micrometer to measure a predetermined set of components.

While creating the video clips, I made sure to create at least three seconds of dead space, black screen, between the clips. I did this to help me identify when a clip would start or stop, but also, during the interview, I learned that it was a good place to prompt the instructor to reflect on the previous clip if he had not paused the clip.

Table 3.2

Subject Matter Information

Subject	Instructor	Skill Level	Length of Observation	Task
Introduction to Automotive	B3	Beginner	68	Precision Measurement
Basic Electrical	B2	Beginner	60	Building Circuits
Brakes	A2	Beginner	112	Rebuilding Drum Brakes
Manual Transmissions	A3	Intermediate	129	Removal and Replacement
HVAC	C3	Intermediate	100	Pressure/Performance Test
	A6		68	Identification/Pressure Test
Engine Mechanical	A5	Intermediate	60	Engine Disassembly
	C1		94	Engine Disassembly
Automatic Transmissions	A1	Advanced	144	Removal and Replacement
Engine Performance	A4	Advanced	74	Spark Plug Service
	C2		94	O2 Sensor Diagnosis
	B1		70	IAC Sensor Diagnosis

n = 12

Observations at Program A

Program A employs 11 full-time automotive faculty members, four part-time faculty members, four lab technicians, and usually enrolls approximately 250 students. The participants from this population were diverse in tenure, experience, and age (see Table 3.2).

The 56,000-square foot automotive facility houses nine classrooms, two integrated classroom/labs/ and a main lab with 20 service bays. This college has four cohort-based internship programs with three sponsored by a major automotive manufacturer—Honda PACT, GM ASEP, and Chrysler MCAP and one comprehensive cohort supported by both the college and local independent repair shops. There are also several students who do not participate in a cohort or internship program but participate in a capstone course that includes an 8-week hands-on service operations course where the students work on customer vehicles.

The six observations I conducted at Program A lasted an average of 97 minutes each resulting in an average of 13.67 clips per participant (82 total clips). The interviews (minus clip footage) averaged 49.53 minutes per participant (Table 3.4). The observations at Program A took place in either the main laboratory or the dedicated engine lab. Once the video was edited, an IPR recall session was conducted in a small conference room with a large video projection screen. I used this room for all six interviews at Program A.

Table 3.3

Demographics of IPR Participants at Program A

Participant	Age Range	Position	Teaching Experience (yrs.)	Field Experience
Participant A1	36–40	Professor	16	5
Participant A2	36–40	Professor/Chair	12	1
Participant A3	26–30	Instructor	3	7
Participant A4	61–65	Professor	34	40
Participant A5	61–65	Professor	36	14
Participant A6	61–65	Professor	42	4

$n = 6$

Table 3.4

IPR Observation Data from Program A

Participant	Length of Observation	Length of Edited Video	# of Clips	% Identified as Improvisational
Participant A1	144	21.0	12	14.58%
Participant A2	112	17.0	18	15.18%
Participant A3	129	19.0	17	14.73%
Participant A4	74	18.0	11	24.32%
Participant A5	60	17.0	13	28.33%
Participant A6	60	12.5	11	20.83%

$n = 6$

Participant A1 Interview

Participant A1 is a full professor with 16 years teaching experience. Before teaching, he worked five years full-time as an automotive technician and specialized in engine performance, participated in an apprenticeship through a corporate sponsored program, and obtained a bachelor's degree in automotive technology. After teaching a few years, he obtained a master's degree in higher education administration. He currently teaches a variety of courses but specializes in engine performance, hybrid systems, and manual transmissions and drivelines. He is also the coordinator of an apprenticeship program.

The classroom observation for Participant A1 took place in the central laboratory. Participant A1 was teaching an automatic transmission class. He had three vehicles on lifts and the task for that day was to remove and replace automatic transmissions. This class was small in comparison to others with two groups of three and one group of two. The class had a mixed student population of both GMASEP and MCAP students. All the students in this class were in their last semester before graduating. This class was intended to be completely lock-step, with the students following the procedures outlined in the service manual, and for the most part, they

did. This is the reason why I conducted the observation for 144 minutes in order to collect 12 clips for the interview. The overall time identified as off script was 21 minutes.

Participant A2 Interview

Participant A2 is a full professor and department chair with 12 years of teaching experience and between one and two years of professional experience. He holds a bachelor's degree in automotive technology and a master's degree in educational leadership. His specialty areas are HVAC, Electrical, and Brakes. I observed Participant A2 as he taught a brakes class where he was monitoring the students as they were disassembling and reassembling drum brakes. There were 14 students working on six cars, with two lab technicians assisting. Servicing drum brakes is a straightforward procedure with the students following the procedures outlined in the service information. However, adjusting the drum brakes is a complex task that requires a substantial amount of feel for the adjustment. I conducted the observation for 112 minutes to collect 18 clips for the interview. The overall time identified as off script was 17 minutes.

Participant A3 Interview

Participant A3 is an instructor in his third year of teaching after seven years of professional experience at a new car dealership service center. Participant A3 is an alumnus of Program A and participated in a corporate-sponsored internship program during his academic career. Participant A3 specialized in manual transmissions and engine performance (i.e., fuel and ignition systems, drivability concerns, and emission systems), and teaches classes in engine performance, manual transmissions, engine systems, steering, and suspension.

I observed Participant A3's manual transmission class where they were removing transmissions to inspect and adjust clutches. The observation lasted 129 minutes, and I was able to isolate 17 clips of improvisation, lasting 19 minutes.

During the interview, participant A3 requested to stop the video quite often. This was not the case with most of the other instructors other than Participant B2, who also stopped the video multiple times to comment. I was very surprised at A3's answers to some of the questions. He provided some very complex answers and insights despite his relatively short tenure.

Participant A4 Interview

Participant A4 is a retired full professor with 34 years of teaching experience and over 40 years of experience in automotive repair in fleet maintenance, classic car restoration, and high performance. His specialty areas in both teaching and practice are engine diagnosis and repair and engine performance. He operates a fleet repair business and now teaches part-time for College A. He has a bachelor's degree in industrial education and a master's in higher education administration.

I observed A4's engine performance I class where the students were removing, inspecting, and replacing spark plugs. The observation lasted 74 minutes and resulted in 11 clips lasting 18 minutes.

Participant A5 Interview

Participant A5 worked as an automotive technician for 14 years before becoming a technical trainer for a major automotive diagnostics company and then a trainer for a major automotive manufacturer. He started working at Program A five years ago, which brought his automotive teaching experience to 36 years total. His preferred teaching topics are automatic transmissions, engines, brakes, and steering and suspension. He has an associate degree in automotive technology.

I conducted this observation in the engine laboratory. It was a corporate sponsored class where they were disassembling engines. Groups of two students were working on engines.

Participant A5 is a very experienced and capable instructor, as many of the faculty attended his training as students or technicians. However, he had a difficult time articulating his internal thoughts as they related to his observed behavior. In many cases, he would simply describe what was going on physically in the classroom, such as, "the students are working on the engine," or "he's using the wrong tool." I had a difficult time getting Participant A5 to reflect without feeling as though I was baiting or leading him to an answer. While some useful data came from the interview, he never really qualified any internal processes.

Participant A6 Interview

Participant A6 is a retired full professor with 42 years teaching experience and four years of professional automotive experience. His preferred area of expertise was automatic transmissions, and his preferred content area to teach is automotive HVAC. He has a bachelor's degree in industrial education and a master's degree in industrial education administration. He has been teaching at the same college since 1975 and served as the department chair from 1992–2014.

This observation took place in the main lab and consisted of 14 students doing two different tasks. One task was using the refrigerant identifier, and the other was connecting a gauge set to a vehicle's air conditioning service ports and taking a static pressure reading. This was by far the shortest IPR interview video; however, it yielded a long interview. He spoke a lot about "finesse" and alluded to the importance of guiding students through small incremental adjustments while giving feedback and watching body language. He did not stop the video once during the interview; however, when I stopped the video, Participant A6 just started talking without prompt. I only asked him to elaborate on a few different statements. It proved difficult to get any internal processes from A6. However, he provided good descriptions of his strategies.

He tended to shy away from internalizing any of the interactions and mostly talked about his behavior regarding prescriptive actions.

Observation at Program B

Program B employs five full-time faculty members and seven part-time faculty members, with one full-time and two part-time lab technicians, and utilizes a relatively new (10-year-old), 29,000 square foot automotive building. The building is designed like a modern automotive dealership and can accommodate 34 cars, as well as, four classroom/laboratories. Program B is NATEF accredited but do not participate in any manufacturer-sponsored programs.

The observations were conducted in either the main lab or one of the classroom labs. Since a conference room was not available, I conducted the IPR interviews of three instructors (see Table 3.5) in one of the empty classrooms.

Since Program B was a six-hour drive away, I observed three lab intense courses and conducted three interviews between Monday and Thursday of one week. I filmed and edited lab exercises on Monday and Tuesday, and interviewed participants on Wednesday and Thursday. I observed three automotive courses; an introductory course where the students were learning how to use precision measuring tools, a basic electrical class where the students were building circuits, and an engine performance class where the students were using scan tools and oscilloscopes.

The three observations I did at Program B lasted an average of 69 minutes each resulting in an average of 16 clips per participant (48 total clips). The interviews (minus clip footage) averaged 36.67 minutes per participant (see Table 3.6).

Table 3.5

Demographics of IPR Participants at Program B

Participant	Age Range	Position	Teaching Experience (yrs.)	Field Experience
Participant B1	36–40	Professor/Chair	11	10
Participant B2	36–40	Assistant Professor	7	10
Participant B3	26–30	Assistant Professor	4	10

n = 3

Table 3.6

IPR Observation Data from Program B

Participant	Length of Observation	Length of Edited Video	# of Clips	% Identified as Improvisational
Participant B1	70	22.0	16	31.43%
Participant B2	68	15.0	12	22.06%
Participant B3	68	16.0	20	23.53%

n = 3

Participant B1 Interview

Participant B1 is a full professor and chair of the automotive program. He has been teaching for 11 years. During his automotive education, he completed an internship at a new car dealership and worked ten years in the field. He was also a curriculum designer for an automotive manufacturer. In the field, he preferred working on transmissions and diesel, but his preferred areas to teach are engine performance, transmissions and drivelines, and electrical. He suggested that he would teach any subject that he needed to teach. Participant B1is an ASE master certified technician with additional ASE L1 (advanced engine performance) and L3 (light-duty hybrid technician) certifications, and Ford senior master technician. He also has an associate degree in automotive technology, a bachelor's in automotive management, and a master's degree in community college teaching and learning.

The class I observed was an engine performance class taught in both the main lab and classroom, which had a vehicle on a chassis dynamometer. Participant B1 would go back and forth between the main lab and classroom/lab to monitor students. Three activities were going on simultaneously in this class: (a) students were using a scan tool to look up engine management data related to the IAC motor, (b) students were using an oscilloscope to generate a graphic pattern to compare to the scan tool data, and (c) students were using a chassis dynamometer and scan tool to perform a volumetric efficiency test.

Instructor B2 Interview

Participant B2 is an assistant professor with seven years of experience teaching and ten years of working in the automotive repair field. His preferred content areas to teach are electrical systems, engines, steering and suspension, and engine performance. He is an ASE master technician and L1 certified. He has an associate degree in automotive technology, a bachelor's degree in vocational technical education, and a master's degree in career technical education.

I observed Participant B2 teaching an introductory electrical course where the students were working on electrical simulator boards. The boards were supplied with a fused 12-volt supply, and the students would complete various circuits on the board. In this class, the students were wiring lightbulbs in parallel and discussing parallel circuits.

Participant B2 was extremely reflective about his teaching and wanted to speak after the interview about his own research interests.

Participant B3 Interview

Participant B3 is also an assistant professor. He has been teaching automotive technology for four years after a 10-year professional experience. He prefers teaching transmissions and drivelines, HVAC, and Introduction to automotive system. He is also an ASE

master technician, L1 certified, and a Ford senior master technician. He has an associate degree in automotive technology and a bachelor's degree in automotive technology.

Observations at Program C

Program C employs six full-time instructors and between 6 and 11 adjuncts available depending on need. They have one full-time lab technician. The facility is approximately 38,000 square feet and houses eight classrooms, one lecture hall and 42 service bays. Program C is also NATEF certified and offered comprehensive courses as well as corporate sponsored programs ASEP and TTEN.

Program C, was only a two-hour drive away. I observed three instructors (see Table 3.7) navigate three lab intense courses, and I conducted three interviews between Monday and Thursday of one week. I filmed and edited on Monday and Tuesday and interviewed on Wednesday and Thursday. The first class I observed was an engine performance class conducted in the main lab, the second class was an air conditioning class conducted between the classroom/lab and main lab, and the third class was an engine class that was conducted entirely in the classroom lab.

The three observations I did at Program C lasted an average of 96 minutes each resulting in an average of 11.67 clips per participant (35 total clips). The interviews (minus clip footage) averaged 44.67 minutes per participant (see Table 3.8).

Table 3.7

Demographics of IPR Participants at Program C

Participant	Age Range	Position	Teaching Experience (yrs.)	Field Experience
Participant C1	51–55	Instructor	12	32
Participant C2	36–40	Instructor	5	10
Participant C3	56–60	Professor/Chair	28	10

n = 3

Table 3.8

IPR Observation Data from Program C

Participant	Length of Observation	Length of Edited Video	# of Clips	% Identified as Improvisational
Participant C1	94	15.0	11	15.96%
Participant C2	94	21.0	10	22.34%
Participant C3	100	16.0	14	16.00%

n = 3

Participant C1 Interview

Participant C1 has been teaching automotive technology for 12 years, either at the community college level or as a technical trainer for a manufacturer. Before teaching, he spent 32 years as a service technician specializing in climate control, steering and suspension, and engine performance. He is ASE master certified, L1, X1, and was awarded the HVAC technician of the year by the Mobil Air Conditioning Society. Participant C1 is currently working on his associate degree in automotive technology and will be pursuing a bachelor's degree after.

The course taught by Participant C1 was an engine performance course where the students were using the scan tool to investigate the different outputs from narrow and wide-band

oxygen sensors. The course was taught in the main lab with 12 students crossing between four lab vehicles.

Participant C2 Interview

Participant C2 is an instructor teaching automotive for five years after a 10-year career as either an automotive technician or an engine machinist. His preferred content areas are steering and suspension, electrical, and manual transmissions. In his automotive career, he specialized in steering, suspension, and vehicle alignment. Participant C2 is an ASE master technician, L1, L3, undercar specialist, and GM master technician. He has an associate degree in automotive technology and a bachelor's degree in business management.

The class I observed was in the engines lab/classroom. The students were GM ASEP students and were disassembling donated engines supplied by GM.

Participant C3 Interview

Participant C3 is a full professor and chair of the automotive program. He has been teaching automotive technology for 28 years. He worked in all areas of automotive repair during his ten years of professional practice. However, he prefers to teach electrical, HVAC, automatic transmissions, engine performance, engine repair, brakes, and suspension. He is ASE master certified, L1, G1, and is a Ford certified instructor. He also is the coordinator of the Toyota TTen program. He has an associate degree in automotive technology, a bachelor's degree in finance and economics, and a master's degree in human resources in higher education.

I observed Participant C3 as he worked with students in an HVAC class. The students were performing refrigerant pressure tests and conducting air conditioning performance tests. The class was structured around the Toyota TTEN curriculum.

Data Tracking

During the observations and interviews, I used several methods to keep track of my data. I created documents with participant information and kept logs of emails and phone calls to participants. I also made photocopies of all permission and consent forms. During the observations, I had two HD cameras filming and a digital recorder on the instructor with a lapel microphone. I downloaded this information onto a media laptop and created folders that contained the uncut audio and video and a separate file with the edited audio and video and stored them on an external hard drive. As I observed the class, I took field notes to identify possible off-script moments, and while editing the video, I made notes specific to why I chose the particular clip as an off-script moment. Copies of both the field notes and clip protocols were made and stored in a locked file cabinet.

During the interview, I used the digital recorder as well as a backup analog recorder to record the interview. I saved the audio files to an external hard drive and physical media in a locked file cabinet. After transcribing the audio files into Microsoft Word documents, I made two files, one anonymous and the other identifiable. I sent the anonymous files to my primary and secondary coders where they used the "insert comment" function of Microsoft Word to identify potential codes and themes. I downloaded the word documents into NVivo Pro and established my own codes and memos. Once several weeks had passed, I set up meetings with the primary and secondary coders to compare our codes and validate my own codes. Once my codes and annotations and the coding teams' codes and annotations were input into NVivo, we combined and reduced the codes and organized them into three main themes and three transitional themes.

IPR Protocol and Interview Script

The following IPR interview script and protocol were developed using suggestions from an article written by Jacob and Furgerson (2012), the methodology section of the dissertation by Lisa Graham (2010), and the IPR Video Series by Kagan (1995) as guidelines to create an appropriate approach to gathering data in the automotive classroom/laboratory.

Protocol for video observations. Through email, phone calls, or face-to-face interactions, I obtained permission and scheduled times to video record sections of automotive technology lab activities.

I completed an ethics application, and acquire approval through Antioch University's Internal Review Board (IRB) before I begin conducting research. Although I requested an expedited approval since (a) I will be interviewing adults, and (b) I was confident that this study posed minimal risk to the participants, since the probability of physical or psychological injury or discomfort is equal to or less than any harm ordinarily encountered in the daily lives of the participants, I still had to engage in negotiations for weeks to get the research approved. Mainly due to ethical concerns concerning conducting a portion of the research at my place of employment. In the end, I was required to get written and signed permission to collect data from every college and consent to conduct research form from every instructor. Additionally, I was required by College B to complete an application for ethical research and submit it to their IRB.

For this research, I was looking for specific types of laboratory activities. Specifically, lab activities in which the students are seated or standing at a workstation for at least an hour with the instructor moving from workstation to workstation assisting students in their activities. The mobility of the instructor was the main reasons that multiple cameras were needed. In this

study, I observed 15 labs, with one not meeting the requirements above, and two meeting the physical requirements but only yielding about 20 minutes of observable work.

During editing, I switched between cameras to ensure that the instructor is always on screen, and a portable audio recorder with a lapel microphone will ensure that the dialogue between the instructor and the student is consistent. In the event of a failure of either camera or the recording device, there will still be audio and video available from other sources (i.e., two cameras recording video and audio, and one digital recorder). The following is a sample of the dialogue that I used when I was looking for participants:

> *I am working on a project to help identify some practices of automotive instructors who have proven to be effective in the classroom. Since you have been teaching for XX years and have a good reputation with the students, I felt that you would be a good candidate to observe. What I am looking for is a time where you are performing bench work with the students since I will be mounting multiple cameras on tripods, I will need for the students to be relatively still and also fairly isolated from the noise present in the main auto lab. Can you think of an activity that fits this description?*

If the instructor allowed the video recording:

> *Great, I will have the video equipment set up in classroom XXX prior to the students arriving. I will have a backup audio recorder, just in case something happens with the video. I will be taking notes in the back of the classroom to be as little of a distraction as possible. As soon as I view the video, I will want to conduct a one-hour interview with you concerning certain aspects of your teaching style. It shouldn't be more than one to two days following the recording.*

At this point, I scheduled a time to observe the class and arrived early to set up the classroom by arranging the video recording equipment. Based on my experience with the pilot study, I decided to utilize two cameras—the most effective placement had proven to be the front of the room focused toward the opposite corners. However, in a few of the classes, I had to move the camera to different areas of the room in order to keep the lab activities on screen.

Sample dialogue for the students. To record the instructor in action, I also needed to record the students. Although the students will not participate in the recall process, their

participation in the recording of the exchange is critical. Before each observation, I notified the students, with the help of the instructor, to inform them of their role in the observations. I also asked if there is anyone who does not want to be included in the study and assure them that I will not intentionally record them. Furthermore, I informed the students that any accidental/incidental audio/video capture would be either blurred out, audio muted, or deleted from the video. I read a simple informational script to the students before the recording:

> *Today, we are conducting an observation of classroom activities as a pilot for future research in understanding and improving automotive class structure. The video images will not be used anywhere outside of this classroom other than observations between your instructor and me.*
>
> *I will be taking some notes in the back of the classroom and possibly move the cameras around to find a good angle for video recording a class like this.*
>
> *Please do your best to ignore the cameras and go about your work as usual. Does anyone have any questions?*

This script proved to be ambiguous enough to satisfy the students' curiosity, but also not be specific enough to influence their behavior in the classroom.

The IPR process. For the observations, I used the same two HD digital camcorders (from the pilot) on tripods placed in opposite corners of the room. To synchronize two cameras and a backup audio recorder, I started recording with all three devices and then provide a reference tone (horn honk) to synchronize all three recordings with a stopwatch I used to synchronize my handwritten notes with the recordings. Since I knew the instructor would be moving frequently and interacting with multiple students, I purchased a lapel microphone specifically designed to pick up conversations that occur between the wearer and anyone within three feet of the microphone.

Immediately after capturing the video, I would download the video and audio files onto the hard drive of a media laptop and use Adobe Premier video editing software to generate an uncut video with the two video files displaying on a split screen and an audio track from the

participant's lapel microphone. At that point, I would watch the video and make notes based on the moments that I perceived as the instructor straying from the curriculum. I would jot down the number of the isolated clip and a short description of why I isolated the clip. I experimented with the idea of using a split screen to show both camera angles, but this was found to be distracting during the pilot study, so instead, I would then choose the best quality video footage from each camera and delete the other footage. The result was a switching effect where it appeared as if the cameras were following the participant around the room; allowing me to isolate moments of the recording that show the instructor's behavior and the reaction of the students for further reflection of the instructor. The segments will begin approximately 30 seconds before the incident, extend the duration of the incident, and continue 30 seconds after the end of the incident to provide "enough footage that the participants are drawn back into the moment" (L. Graham, personal communication, September 23, 2016).

While choosing the clips, was attempting to isolate moments of an instructor displaying what could be regarded as reflection-in-action. I specifically watched for moments that indicated a change in curricular direction. Some examples included in this study were when—a student asked the instructor to repeat the information, when the student misinterpreted instruction and required an intervention, or when an instructor inserted a personal story or anecdote that was not in the established curriculum. Looking at what could be considered to be tense moments during the teaching/learning exchange prompted questions such as "What motivated you to go off-script at that moment?" or "What do you think your actions accomplished at that moment?" or "What would you have done differently if you could?" I was attempting to isolate the stimulus for the change and reflective response—specifically looking for moments where an instructor is unsuccessful at reaching a student and then changes direction. As an automotive professional,

professor, and curriculum developer, it is well within my rights as an educational researcher to choose the segments that I determine are off script. However, I intended to give the participants the option/opportunity to call out any other significant exchanges, occurrences, or situations that occurred in the lab. The ultimate goal was to interpret what the participant embeds in the language used to describe the things they feel are significant. So in order to co-construct meanings with the participant, it was critical to ask them to recall not only what is seemingly obvious from the edited video clips, but also to prompt the participant of any other occurrences I may have missed during the editing process. However, this research also involves uncovering meanings that are important to me, as well as my colleagues. Ergo, the co-construction of meaning was best understood by using IPR and thematic analysis.

Introductory script: For recall session interview. The recall sessions took place in a small conference room at Program A, an empty classroom at college B, and boardroom at college C. In every recall session, a full-size laptop computer was situated between the interviewee and me. Both the interviewer and I had access to the remote mouse to pause or restart the video clip. Although I requested a room with a projector, only one of the colleges provided access. Although I preferred the projection of the video on a large screen, I do not feel that the recall sessions were affected without the use of a large screen. Without the use of the screen, the participants and I simply used the laptop screen to view the recall videos.

I wrote the following script as a reminder of how to introduce the process to the participants. While I did not read this script word for word, I would say something very similar to the following text before every interview:

> *I want you to know how much I appreciate your agreement in letting me record your class the other day. I believe that we gathered some pretty significant data.*
>
> *Over the past five years, I have been researching effective teaching practices and curriculum specifically aimed at post-secondary automotive technology programs. This*

research will allow me to gather information that has been difficult to measure in the past. I am interested in interviewing you based on your experience and success in teaching automotive technology for the past several years.

This research looks at actual teaching practice to learn more about the strategies automotive technology teachers use. It is not meant to be an evaluation of your teaching ability, and these videos or the transcripts of these interviews or your name will never be published or made available to anyone other than my dissertation committee. If you are ready to start reviewing the video, I have attempted to isolate moments where I feel that you improvised outside of the established curriculum to make things clearer. After watching the clip, I am going to ask you a series of questions about it. Feel free to interject anything that comes to mind during the viewing and stop the clip or rewind the clip at any point if there is something you feel is significant.

If you don't have any questions, we can start the video.

Interview questions. The following questions are modified versions of samples provided by my methodology mentor during the IPR pilot (L. Graham, personal communication, September 23, 2016). These proved to be effective in prompting the interviewee to reflect on the clip without influencing the answer. I did not ask these questions at every recall session. Many times, the participant would answer the question before I had a chance to ask. If the participant did not address a particular question naturally or conversationally, I would ask the question(s) before we moved to the next clip. I would also ask for any additional information at the end of the recall session or prompt the participant to discuss anything they felt was significant. I did not take notes during the recall session; however, I did spend at least 20 minutes following each interview reflecting on the interview. Some questions that were either explicitly asked or implied included:

What motivated you to go off-script at that moment?

What do you think your actions accomplished at that moment?

What was going on for you when you went off script at that moment?

What were you thinking?

What were you feeling?

How did you know that was a good moment to go off-script?

How much did you think about going off-script before you chose to do so?

Like the introduction, I had a standard script as a guide to conclude the interview:

> *Unless you have any questions or would like to add any information or insight to what we just watched, I believe this would be a good time to conclude the interview. I will be contacting you via email or phone if there is a need to clarify information collected during this interview. I will also contact you once the research is concluded to inform you of any significant findings of this research.*

As the interviews were completed, the recorded dialogue was transcribed by both myself and three transcriptionists. Following the completion of this research, I will make the results available to the participant. In the following section, I discuss how the data were processed.

Data Processing and Analysis

As mentioned earlier, I used thematic analysis to look for emergent themes that occur through careful coding of transcribed dialogue, observations from a field journal, basic demographic information, and input from a small coding team. Therefore, the source data for this study will be the transcribed audio from the 12 recall interviews, which resulted in approximately 18 hours of transcribed audio. Once the source data are in electronic format, I will read over the transcripts multiple times, looking for any themes that emerge from the interviews. I will be using standard coding procedures outlined by Boyatzis (1998) and Guest et al. (2012) who agree that coding is a process of reducing a phenomenon down to a simple label that will allow the researcher to quickly describe and categorize emergent themes more efficiently when working with large amounts of data. Furthermore, according to Creswell and Clark (2011):

> The core feature of qualitative data analysis is the coding process. Coding is the process of grouping evidence and labeling ideas so that they reflect increasingly broader perspectives. Evidence from a database is grouped into codes, and codes are grouped into broader themes. Themes can then be grouped into even larger dimensions or perspectives, related, or compared. (p. 208)

I will generate codes from the recall sessions, along with two additional coders. I intend to work together with the coders to create valid codes that are less affected by any internal biases I may hold due to my being deeply embedded in the culture of automotive technology education. Furthermore, it will be useful to incorporate scholars from outside the automotive industry to offer an unbiased perspective, as well as, increase the likelihood of transferability. Once the codes are agreed on by the coding team, I will reach out to the research participants to get their feedback to whether or not the codes were representative of the meaning they created during the interview.

I worked closely with two coders during the initial coding of the transcriptions. The first coder is a graduate of a 2-year automotive degree program and a current Organizational Leadership student at Wright State University. She has approximately seven years as a service technician, service center manager, and a transit bus mechanic. She was my secondary coder and coded 4 of the 12 interviews. The second coder is an associate professor of automotive technology with five years of automotive experience and ten years of teaching experience. He currently holds a master's degree in higher education administration. He coded 7 of the 12 interviews and double checked my coding on the last five interviews to ensure consistency. Initially, I trained the coders on the coding process, trying to elicit original codes. After our first meeting, I looked over the codes and instructed them to try to categorize the codes they developed in three areas. Although our codes differed slightly, once they were categorized into three main categories of *classroom management, pedagogical interventions, and reflective conversation,* we saw many more similarities. This was especially true in the overwhelming category of classroom management issues. While there were fewer instances of instructor improvisation in the area of pedagogical intervention, and even fewer in the category of

reflective conversations, the data gathered was more aligned with the reflective qualities outlined in Chapter II. At another meeting, we discussed our codes and worked together to modify my original Venn diagram of the instructor's reflective modeling.

Although I was confident that my experience as both a practicing field technician and an automotive instructor would be an asset in identifying themes, I heeded the warnings of Boyatzis (1998) and Guest et al. (2012) that biases and projections could occur because of my closeness to the subject. For this reason, I relied heavily on my two additional coders and NVivo qualitative data software to assist in verifying existing codes, as well as, generating any additional codes (Creswell, 2013).

Other data gathered included a detailed research journal outlining the classroom observations, as well as, the recall sessions, and a demographic survey to understand better the experience of the participants. Questions related to years of teaching experience, professional experience, tenure at present institution, and course of study in undergraduate or graduate school, while not implying causation for an instructor's observed behavior, proved beneficial in determining areas of further study.

Credibility and Transferability

Because this dissertation is exploratory and grounded in discovery, IPR was the most effective method of collecting data relating to subjective experiences. In fact, Kagan and Kagan (1991) warned that:

> Some research claiming to be based on IPR, unfortunately, has sacrificed the real potency of IPR in order to increase the likelihood of obtaining quantifiable data. All too often, the kinds of questions asked during recall have been restricted to specific categories or parameters. Such applications of IPR limit the model's unique potential as a tool for discovery. (p. 230)

I kept this warning at the forefront of this research because I was truly interested in finding the authentic voice of the automotive instructor and explicitly looked for common experiences and

broad themes to generate insight into the observable phenomenon. I am certain that IPR as a research tool had validity because, in this study, I was able to uncover data in exactly the way Kagan described IPR. Furthermore, thematic analysis was a valid tool for analyzing the data because it served as a systematic method for organizing data and generating codes, with practical resources to assist in drawing out themes and making sense of qualitative interviews.

I strived to embed transferability into this study by utilizing interviews from multiple instructors from different areas of automotive technology, and by looking at multiple automotive programs. This study will be used to inspire other areas of career/technical education to explore what is happening during their experiential activities.

I enhanced credibility through both triangulation of data and member checking. The triangulation will be a "process of corroborating evidence from different individuals … data … or sources" (Creswell, 2002, p. 280). Therefore, 12 recall interviews, my field journal, and the video observations added validity to the study. Also, "member checking" was employed following the final stages of research to validate the accuracy of certain themes through "post analysis review" (Guest et al., 2012, p. 93). Member checking in this research involved soliciting feedback from the participants following the data analysis. This feedback was documented and used to modify or assist in confirmation of the emergent themes. Furthermore, regarding member checking, Cash et al. (1997) asserted:

> External feedback should be viewed as a method to stimulate critical thinking in the author of the research, nothing more. Validity is a property of knowledge, not methods. Although using good methods and being explicit about them, can make for better and more transparent research, ultimately it is up to a researcher's audience to determine how valid the findings of a study are. (p. 93)

If IPR is touted as the most effective method of co-constructing meaning, then emergent thematic analysis with external feedback enhanced the credibility of this study.

As the data were being transcribed, I assembled a coding team in order to provide some triangulation to the study. Once all the data were in, the transcribed interviews were made anonymous and I gave seven of my transcripts to my primary coder and four to my secondary coder. The coders provided input in word documents, which allowed us to copy/paste/combine documents. Once the team came up with some codes, we started modifying and combining codes until we reached a consensus on the validity of the codes. Once the team was familiar with the final codes, I introduced three main categories of codes, and the coding team then worked to put each code in a particular category. At times, the lines were blurred between categories. However, by simplifying the concept—for example, a student with colorblindness is a classroom management and not a pedagogical intervention—the coding team was able to agree on the main categories and transitional categories. The main point was creating the Venn diagram of the three major concepts and discussing with the group how the concepts were related. Although there were some debates over which codes belonged in which categories, simply asking the team, "which category does it best fit?", resolved much of the argument.

Summary

In conclusion, while IPR and thematic analysis have been used widely and successfully in the counseling and psychology field, its use in career/technical fields is practically nonexistent. The current method of teaching/learning assessment in automotive technology generates very little authentic data about the skill level of the teacher or the student. I firmly believe that if educational leaders want authentic answers about what goes on in a classroom, they must put aside their perspectives and ask the instructor "what is happening?" This quintessentially humanistic inquiry will produce a highly authentic view of teaching and learning in a historically and categorically dehumanized content area. Research such as this could also reveal myriad

information concerning skill acquisition, reflective practice, and the role of mentors in the development of effective automotive teachers.

Chapter IV: Results of the Study

To address my research question: What are the subjective experiences of automotive instructors as they navigate experiential learning activities in the lab?—this chapter presents the analysis of the data collected from the IPR interviews. As mentioned in Chapter III, I relied on Emergent Thematic Analysis as a method to understand the subjective experiences of my interviewees. I have divided Chapter IV into two sections. The first section involves the basic findings generated from coding the data, and the second section includes a review of the patterns, relationships, and themes that emerged from the analysis of these data.

Summary of Improvisational Activities

In Chapter III, I relied on my experience as an automotive instructor, curriculum developer, and program evaluator to determine when an instructor was going off-script. Furthermore, I would ensure that my understanding was valid by asking the participant if a particular activity was planned, scripted, or part of the curriculum. I also asked the instructors if there were any significant occurrences during the observation that I may have missed. Some incidents were obvious, such as a vehicle not starting, while some were more nuanced, such as the instructor intuitively determining which students needed to struggle through a process to enhance their learning experience.

Possibly, due to my experience with automotive curriculum development and assessment, my perceptions of when an instructor went beyond the established curriculum were extremely accurate, according to the participants. Although I had identified many visual and auditory cues in the discussion of the pilot, in Chapter III, I noticed other cues through the process. Some additional cues that emerged included the instructor's repetition of a student's question accompanied by a change in the tone of voice, a long pause following a student's answer or question, or the instructor taking extra time to assess a student's work, or physically re-setting a

station to watch the student go through the process a second time. Beyond explicit instructor cues, I could identify when a student was going the wrong direction with a lab exercise or not following instructions because I was familiar with many of the laboratory exercises. Observing student behaviors allowed me to identify preemptively when an instructor would go off script. In other words, I found that the cues that alerted me to a student or situation were very close to the cues identified by the instructors.

Although the instructors agreed with my identification of their improvisations, there were times I was surprised during the interview concerning some comments from the instructors regarding their preparation time and adherence to the established curriculum. While some instructors had every minute of the course mapped out and had to improvise only when an educative or critical intervention was necessary, others proclaimed that, although there was an established curriculum, it was absurd to think that it would play out according to the script. One instructor said that there was not a set curriculum for engine performance courses. I knew this was not true because I had physically seen the established curriculum, and when I pressed, he agreed that there was an established curriculum but trying to follow it would be like "herding cats."

This study produced 18 hours of observation, three hours identified as improvisation, and 165 individual clips among 12 instructors. Due to the variety of content and context, it would be difficult to describe every instance of improvisation, and so many of the exchanges will not be discussed in detail. However, since this study is focusing on the instructor's subjective experience as they navigate these improvisations, I will describe certain exchanges in sufficient detail to provide context to the experience. The most common improvisations have been categorized as *classroom management* issues, including dealing with lab equipment failures (53

instances), impromptu strategic monitoring of students based on prior experience (39 instances), and issues regarding student behavior (39 instances). Other educative interventions, based on student behavior (48 instances), facilitating autonomy (25 instances), or improvisational teaching (25 instances) were categorized as *pedagogical intervention*. At the heart of this study is the *reflective conversation* that the instructor has with the student as they model how they engage a problem and then coach the student through the problem—in effect, fine-tuning the student's skill. This was the least common type of improvisation, but it will be discussed in the greatest detail.

In the following section, I will describe the emergent thematic analysis of the IPR observations and interviews in three sections. First, I will describe the reflections of the instructors in regards to lower order improvisation during classroom management activities; second, I will describe the instructors' reflections of activities more aligned with technical rationality or applied pedagogy, and third, I will describe the reflections of the instructors' reflective practice as they attempted to teach higher order skills such as *finesse* or *feel*. After reviewing the observation video and using my field notes, I was able to identify an average of 14 instances of improvisation for every 90 minutes of observation.

Results of the Emergent Thematic Analysis of IPR Interviews

During the interview process, the participants were all in agreement that the clips reflected the time they were performing beyond the curriculum. The data were generated by asking the participants to reflect on their thoughts before, during, and after watching themselves improvise during laboratory activities.

This section looks at the data related to the instructors' experiences while navigating lab experiences. It will start with the basic findings and outline the most significant results; then I

will discuss the most significant themes and then some transitional themes that show how the main themes overlap.

Basic Findings

This study's basic findings uncover the types of experiences automotive instructors have during improvisations in a laboratory environment. Most instructors were aware of specific internal and external factors while improvising, although most of the instructors' behavior was not identified until the recall session. Through the IPR session, the instructors would see themselves interacting on video, and most of the instructors would display a keen awareness of both internal and external processes that informed their practice. In some cases, however, the instructor would begin the explanation by simply telling me what was going on in the clip on a surface level. It proved difficult at times to get some instructors to elaborate on anything under the surface. However, in most cases, after allowing the instructor adequate time to reflect, there were deeper underlying motives or complex systems being navigated during the improvisation. Regardless of the behavior, the instructor was improvising based on a tacit understanding of how the learning process works.

Sometimes the instructor would demonstrate awareness and purpose during improvisation immediately; other times, the instructor would need time to reflect. Sometimes the instructor would say that he did not know why he[1] did something, only to slowly explain it as the interview progressed. The instructors demonstrated that they understood, or worked to understand the context of the class and demonstrated mindfulness, as defined in Chapter II, regarding the students, other faculty, staff, administration, corporate sponsors, state and local governments, and other stakeholders (Tremmel, 1993).

[1] All instructors were male, thus use of the male pronoun throughout.

Basic finding 1: Instructors identified the most common reasons for improvisation as classroom management issues. It would be very difficult for an outsider to understand the potential impact of a failed piece of equipment during a well-planned laboratory exercise. Working within a system and adapting to real-time change within that system is where much of the improvisation occurred. The instructor, more often than not, just talked about what they did to solve the problem. Only a few instructors expressed frustration with the classroom mishap, with the majority going into a tacit "I just fixed it" mode. Many of the instructors would attempt to correct the problem, but as soon as it looked as if it was taking too much time, the instructor would source another piece of equipment (if available), move to another similar vehicle (if available), or have the students move ahead to pursue another objective while they corrected the issue.

An example was Participant C3's air conditioning course when (a) a key was missing from a vehicle he had set up for a specific lab, (b) another instructor was using a vehicle he had set up for a lab exercise, and (c) two additional vehicles set up for lab failed to start. Participant C3 did not express much frustration, but instead, managed his class in a professional manner, framed the problem to the students as something solvable, and corrected the problem by moving to vehicles that ran, and making adjustments to the curriculum to compensate for a mismatch between the available vehicles and the approved lab exercise.

Basic finding 2: ***The instructors alluded to technical rationality as an antecedent to identify a lack of finesse and the students' need to reflect in action.*** In other words, a springboard to reflective learning is the technically rational. With almost every observation, there was at least an hour of lecture to expose students to the fundamental principle. Following the lecture, the instructors would have a lab sheet with blanks, (see Appendix C). In this case,

the instructor gave the students a lab sheet with multiple components and a micrometer to have the students make precision measurements. To the casual observer, the students are merely using a tool. However, the micrometer is a perfect example of a tool that engages cognitive, spatial, and tactile skills. The students must first identify the area that needs to be measured. A good example is an engine valve stem. The students should measure the valve stem in multiple places both vertically as well as around the circumference of the stem, to check for wear and concentricity, respectively. There is a certain feel that a student must develop when using a micrometer; the student should feel a very slight drag across the component as they move the micrometer across the outside diameter of the stem. Once the student achieves the desired drag or feel—most micrometers have a small knurled ratcheting knob to assist in achieving the proper tension—they must read the micrometer in four stages to achieve a reading of increments of 0.0001." In this example, the instructors are using technical rationality to assess the student's readiness to learn. The students have been exposed to the concept; now they are practicing. The students are engaged in a reflective conversation with the component they are measuring (Schön, 1991). The instructor is monitoring this exchange and seems to know intuitively when to intervene. While obtaining the result (i.e., an accurate measurement) is the ultimate goal, the way the student gets to the result can say a lot about what the student knows. Several instructors noted the importance of letting the students struggle for what they had determined to be an appropriate time before they intervened. Some students would stop engaging, some would express frustration, some would be certain they did a good job and confidently waited for the next task—regardless of whether they did a good job or not. The instructors talked about the importance of letting the students build up discomfort as an enhancement of the learning experience:

> Participant B3: I want to see them struggle a little bit or I want to see them make the mistake. Which is, not really … a mistake, per se, but it's the trial and error kind of thing.
>
> Participant A2: I don't want them to start relying on me to assemble the work. I feel like sometimes as an instructor it's really easy to see somebody in trouble and be like oh just let me show you how to do this real quick and then they don't get to struggle with it and half of the issue is struggling with it sometimes.
>
> Participant B3: but I like to make them struggle with it. In this case, it's that – I teach you what this one pattern looks like and how to interpret it … Alright, what happens when I'm not standing there saying "this is the on and this is the off." I like to make them struggle a little bit.

The participants agreed that beyond the technically rational aspects of learning, the student needed to experience what Mezirow (1978) would call a disorienting dilemma where the students would face a problem on their own, overcome it, solve it, or receive coaching until they could.

Basic finding 3: Upon reflection, most participants expressed an awareness of the students' tendency to resist experiential activities when working on vehicles donated to the program for training purposes versus activities using a vehicle operated on public roads. One of the major selling points of automotive programs during recruitment of students as well as accreditation through associations such as NATEF has to do with the amount of newer model vehicles available for students. However, it became explicit during the interviews that there is a psychological dichotomy for students dealing with vehicles perceived as *lab cars*, or donated, laboratory use only vehicles, and *real* cars, or non-donated vehicles that are owned by a person, licensed and intended to be driven on public roads. Multiple instructors made the statement that the students are more careful and more mindful when making repairs when they are working on a real vehicle. This could be due to the likelihood of the vehicle's owner being hurt or even killed as a result of improper vehicle repair to critical components related to systems such as brakes or

steering/suspension. According to the instructors, it is sometimes difficult to bring a student wholly into an experiential exercise with a donated, laboratory use only vehicle.

An example from the interviews would be Participant A3's brakes class where he talked about the simulated experience using components off and away from the car. In this context, there are three levels of interaction with drum brakes: (a) *drum on a stick*; (b) drum on a school car; (c) student's vehicle or vehicle that will be driven on public roads.

The drum on a stick is a term used by the automotive department to describe a drum brake assembly removed from a salvaged vehicle and adapted to a square steel bar in order to be mounted to a workbench vice. They were fabricated by the faculty and staff as a means to ensure that every student would be able to disassemble and reassemble a drum brake assembly, which is a priority 1 task for NATEF accreditation. However, although the students had practiced on actual brake components when it came time to work on a school vehicle or a road vehicle, Participant A2 implied that the students did not perform as well. During the interview, Participant A3 reflected on this phenomenon:

> I personally like the cars instead of the sticks because … [the students] … have to deal with the axle flange…on the vehicle so I feel it's a little bit more 'real world.' They have to worry about … the wheel cylinder [piston] wanting to fall out … so they… have to deal with … [that] … and we can show them a trick on that. I think it works pretty well.

Furthermore, with donated vehicles, the students seem to be aware that the car will not be driven and they may not take the work as seriously. During Participant A3's interview, he stated,

> I … got into it with this student one time because … [he said that he had not] put [the car] back together [very well]. [The student said] "it doesn't matter [because] it's a school car." And … [I said,] … "no it's not, it's a real car, this is my car ... you can treat this as my car" … He just came right back [and said], "eh, still doesn't really matter though." No matter how much I pushed that it DID matter, [he kept saying], "Nah, it doesn't matter"

Additionally, if a training vehicle is in poor condition, sometimes that is enough to psychologically distance the student out of the simulation. Participant A1 proposed:

> This is my theory but, the worse a car is kept, the less they tend to care about keeping it. For instance, when door panels and things inside get torn up, they're less worried about what it looks like when they're done with it. When covers and things under the hood are either gone or broken [the students are] less likely to care about everything fitting back together nicely.

The instructors also mentioned warnings about imposing time limits. Should the students focus on speed or accuracy? Would you want your brakes repaired as quickly as the technician could possibly work? Participant A2 added:

> I know some of the other faculty like to have them [assemble a drum brake assembly] in less than five minutes, which I understand the significance of being proficient [using] a tool, but I don't know that I can do it capably in five minutes. My opinion is that most times you need linings, you need springs, and wheel cylinders so I don't want them to rush through, I don't want them to have that sense that it's just a five-minute job in the shop.

When it is a customer's vehicle or a student's vehicle, the instructor noticed that he, as well as the student, were more conscientious. The students were a little more cautious because they were more invested in the experience; the instructor was more cautious because he knew that if a student broke a part, it might take days to obtain a replacement.

Basic finding 4: Instructors are aware of the importance of body language and verbal cues. Throughout the interviews, the participants exhibited awareness of student behavior and provided detailed reflections and interpretations of the situation. Participant C2 noted:

> [H]e shrugged his shoulders … I don't know if he just gave in, or if he really understood it, I don't know.

Participant C3 discussed a student's tone of voice when answering questions:

> [W]hen I asked a question, he wasn't sure; you could tell there was a little hesitancy about the way he answered, so I asked him okay, is that what really happened or just what you wrote down? Trying to figure out, did he understand … I try to probe a little bit to see their confidence level.

Participant A3 similarly identified a student's tone of voice alerting him to intervene:

> [recreating a conversation with a student] … do you understand this?, 'yeah, yeah, yeah' ... but then you get the, 'yeah?'[confused tone].

Furthermore, multiple instructors discussed students who would say that they understood a particular concept, whether they did or not.

Participant A1 noted:

> That student is one where when he asks a question, and before you're even done explaining he's already going ooookay. It's like noo, you're not really understanding me … It's an interesting dynamic there. I could tell him something 180 off and he'd just be like 'ohhh okay', trying to act like he understands it … but I know he doesn't.

Participant C2 similarly noted:

> These guys are trying, I mean, you can tell this guy's [points to a student on the screen], you know, he doesn't really understand what's going on. You can kind of see the look on his face, [points to another student] this kid wants to try, [points to another student] this kid's trying, and [points to another student] he turned around, but he was kinda paying attention, but you see it in their eyes that it still, just, it's a little overwhelming for them yet, but at least they're engaged and trying. [Points to another student] This guy has floated off.

Participant B1 posited embarrassment or self-consciousness as a barrier to concept attainment.

He said:

> I'm hoping that he's understanding, and not just nodding [laughter] at me. "Oh, yeah, oh, yeah," Well, is it because you understand it, or, is it because, hopefully it's not embarrassment, or, you feel like, some people get like that, then they're asking for extra help, or they feel stupid, or, why is it clicking for other people and not me … I'm trying to avoid that, and I told him, I said, whatever you need, man, I'm here for you, but yeah … I'm hoping he's getting it, and not just nodding.

Other participants discussed possible actions to address this behavior:

> Participant C3: At that point, I'd asked a question, and looking at their answers, asking them about it and they're showing me their answer, so when I asked a question, he wasn't sure, you could tell there was a little hesitancy about the way he answered, so I asked him okay, is that what really happened or just what you wrote down?
>
> Participant C1: I would explain it the same way to all of the students. And then I would probably have to backslide a little more into basics if I start to see the glaze in their eyes that they didn't have a clue what I was saying.
>
> Participant A3: Just some of the body language from the different students that didn't understand, and I think that even if they were looking in there and seeing what I was

> seeing, I still don't think they would understand what was going on. That's why I felt it necessary to go to the classroom and draw out what I was referencing because I didn't feel like they were going to get it right then and there looking at it and explaining it. I think that it would've [gone] over their heads.

In some cases the instructor had to improvise based on either a perceived or informed assessment of the student; in one of the classes, it was noted that at least one student had self-identified as having a learning disability. Participant B2 explained:

> That particular student actually walked up to me on the first day and said he's got, he didn't call it OCD he called it something else but like a learning deficiency or something like that. So you're going to run into that as well. So you want them to be confident with what they are doing and not let them feel like their questions are dumb. In this particular case, it's a small class, no one else is tugging on me so I don't mind spending the time. You just don't want to be in circles.

Or when Instructor A3 said:

> Actually … that first day of class he came to me, like he doesn't read very well, and that he doesn't write very well … like, at all. Before this (I don't know if you got this or recorded this at all) even started, he was kinda inside the truck and the other students were away and he was kind of embarrassed about it.

However, sometimes an instructor was aware of certain behaviors that he was unsure about. He knew there was some sort of disability, but was not aware of the scope or nature of the disability. The student had not self-identified, and there was no official intervention from the college's disability service:

> Participant C1: Yes, he's always hoppin' and boppin' and he never sits still. I've seen him do other things, he'll sit there and get upset and start pounding on his own head … and I'm always (calm voice) "don't do that, don't get upset, it's not worth it" … Once he started to get a grasp on it, I could really hold on to him. Once he gets something he doesn't understand, he kind of shuts down. So I try to keep the rest of the class moving, right? Then grab ahold of him and try to feed him what he needs to catch up.

Sometimes a student would disclose a disability in the middle of the learning process. After arguing with the instructor about the color of a wire under the hood (in the clip, the instructor was calmly saying no, this wire is blue, then saying "well maybe it's a little faded, but its definitely blue, the student was arguing "no, its green" … finally the instructor looked up and

asked the student “are you colorblind” the student says “yes.” In the interview, Participant B1 noted:

> He’s colorblind…Which is not something you are expecting. As soon as he gets the connector up, his partner [says] “well, these look like the colors that the diagram called for”…it looks like green and white/green and yellow whatever it was…I’ve had (student name) in other classes before and was not aware of that…that he was colorblind, so I was like “huh”…that’s kind of interesting…in the memory bank for future reference.

Participant B1 immediately started reflecting on possible actions he could take with this student in the future:

> [I]n retrospect, it would have been a good spot to say, well, since you had the connector pinout, you are going to need to look where the locating tabs are, you are going to have to concentrate more on pin location versus the actual coloring … or one was a single color, and one had a tracer.

Without attributing the student’s lack of grasp of the subject to any disability or perceived disability, Participant A6 and A4 made some generalizations about automotive students:

> It can be frustrating, and I'm usually a pretty cool and calm person. I know they're learning for the first time and I've been around the industry long enough [42 years] to know that the automotive students tend to need to be shown maybe more than once or need it repeated more than once. Eventually, they will get it; you just have to be patient and work through the process and demonstrate it once, twice, maybe even three times ... and then finally they will get it ... usually. (Participant A6)

> [A]s far as understanding the content, that seems to be more of an issue [for the students]. They can find it. But as far as understanding service information … it just depends on how it’s written … just like that was a little unnecessary. All those extra steps just confuse a beginner. All they really needed to say was “get the proper size socket and remove the spark plug.” I mean really. (Participant A4)

Conversely, in some instances, the experience a student brings to class contributes to their readiness to develop artistry. Participant A1 assessed student skills as they worked in the lab:

> I guess you could say … the guys on the far left are better with a wrench, but let’s say not so much on the academic side. The group in the middle is the opposite: they study, they do their work, they just don't have as much practical hands-on [experience]. A lot of that, I think, goes back to (I think) all three in the middle group who don't get to do [anything] but oil changes at their dealership and [the group on the left get to do a variety of repairs] ... the group on the right side they do this for fun (laughing). It’s … ‘what are you guys going to do this weekend?’, ‘ oh we’re going to [student name]’s and pulling the

> transmission out of his truck, and we're going to rebuild it and put it back in.' Oh, well, okay cool … I mean that's what they do, he buys stuff, fixes it and flips it. I think I was telling you that the other day, and he's been doing it since high school. They live and breathe it.

Participant A1 also expressed a little frustration about the difference between the levels of readiness of his students:

> [W]e're not talking about someone who just started here last week; we're talking about someone who has been here for two years. So again, is it because they haven't been exposed to anything else … probably. I can tell when I'm doing a class and talking about something, and half the room is nodding their head because they've seen it before … and the rest of them, it's like the first time they've ever heard of something like that.

Other participants alluded to the background and maturity of the students as it relates to their readiness to learn. Participants C1 and B3 talked about the maturity level of certain students based on maturity:

> [These students are] definitely more mature. They … are here to learn, so they put a lot more effort into it instead of just expecting to get a good grade just for showing up. (Participant C1)

> The summer crew is, the students tend to be a cut above, if they're here in the summer, getting a head start. They're the go-getters, and they're paying more attention, and they're taking notes, they're not the ones who are dozing, you know what I mean? (Participant B3)

Participant A3 also categorized students based on skill in order to decide how to proceed with the lab assignments:

> So out of all those students there, [student who was just talking] is probably the most experienced. Just from past conversations, I know he's done a bunch of work outside of here; working on his own car and I know he's pretty experienced that he's done stuff before and even HE was unsure of what was going on. Then I was like yeah, there's a pretty good chance in the body language from some of them, that yeah ... we need to talk about this because even the guy who I thought would … be leading the charge was unsure. Sometimes a student can … teach a student if he knew what was going on and kinda show them if I wasn't there, and even he didn't know what was going on ... I knew that this … [needed to be] talked about.

Basic finding 5: Instructors were aware of student anxiety and how that may affect student performance. The instructors also picked up on student anxiety. Instructor B3 made comments about the student's eyes changing and sighing when math was involved in one of the activities. Also, Instructor B3 and A3 talked about the students creating their own anxiety by overestimating the complexity of a task. Furthermore, it seems that being able to pick up on a student's anxiety and fear was an important component. An instructor who was able to show a student that they would not be harmed by the learning process helped the students move into the learning process. Part of the artistry is being able to confidently and safely approach potentially dangerous situations and the instructor being able to demonstrate the task first and talking through it. In both Participant A5 and B1's classes, they had to demonstrate the procedure to show the student that it was safe. Participant B1's student acted surprised at what seemed to be recklessness that Participant B1 exhibited when driving a car on the chassis dynamometer:

> I think he was a little bit apprehensive, which is understandable. Most students are the first time they run the car on they dyne, and even if they … it makes some noises, and on acceleration, the car rolls up, and even though it is strapped down, it's not going anywhere, its something that is new to most of them … he is asking questions … he's curious about driving the car on the dyne … how hard do I have to hold the steering wheel? Do I need to hold the steering wheel or is it going to do its own thing? So you can tell that he is very apprehensive or not comfortable because it is something he has not done before.

After Participant B1 saw that the student did not have the correct readings, he knew that the student had not followed directions due to his apprehension about pressing the accelerator pedal to the floor. Participant B1 told the student to get in the passenger seat, and then he pressed the accelerator to the floor while the student watched. The vehicle and dynamometer made a very loud noise and the vehicle jumped violently. The student said, "I know I didn't do that!" as if he was in disbelief about the operation of the dynamometer, or he did not trust the written instructions.

Basic finding 6: The instructors are aware of students' perceptions and how they may differ or contradict service procedures. There were multiple times the students were stuck on a problem and the instructor had to walk over and simply turn a page, read the instructions aloud to the student, or rephrase the information in a different or simpler way. Participant A4 stated:

> I think that she believed that the coil and spark plug was an assembly, they were serviced as an assembly. That's what I remember her thinking. Yeah, basically what I was reading to her … what confused her was; [the service information] said … to take the coil off then blow compressed air around the sparkplug tube to get the dirt away from the spark plug, then you unscrew the spark plug. I'm not sure what she … [the service manual] made a bigger deal out of it than … needed … I think that got her … confused.

Or, in Participant C1's experience, the students misinterpreted the vacuum diagram and pulled the incorrect hose. In this case, it still provided a plausible answer for the worksheet, but it was for an unintended reason:

> [O]ne of the things you have to do is you have to drive the engine lean, so you create a vacuum leak … Well, they went ahead and tried to do it on their own, but like most people, you go ahead and grab for the biggest line you can find. Well, they didn't get a vacuum line, they got one that is the crankcase breather, going to the air snorkel, after the mass air flow. It did make it show lean on the oxygen sensors because of the false air coming in. But they didn't know that it wasn't a vacuum leak. That's why I was telling them, that's not vacuum, but it did have the effect you were looking for because the mass air flow doesn't see that air.

Participant C1 also talked about the students getting confused because they were talking about two different data points as if they were the same thing:

> [T]hey already finished the [manufacturer approved lab sheet for] the wide band. Then they went over and did the narrow band. So, the one guy, he's talking about the sheet for the narrow band, and (name), he was talking about the wide band. I was like, yeah, they kind of intermingle, but you've got to remember that it doesn't read the same. With them talking two things at once, that definitely takes (the third student in the group) and … confuses him.

Similarly, Participant B3 said:

> They don't read it all, or some of them don't read it [at] all or they just don't interpret the way that I intended … [T]hree different people read it and one of them get what [it says]

> and the other two are like … "that doesn't make sense" and … the other is like "oh, you want me to do this, right? Um, not exactly (laughs). It's the perpetual game of "this is what I heard you say" … and "that's not what I meant."

These basic findings demonstrate the importance of instructor awareness when navigating the laboratory learning environment.

Next, I will address three main areas of improvisation or themes that emerged through the analysis of this study's basic findings. The divisions range from the most basic reactions to the most complex and include (a) classroom management, (b) pedagogical intervention, and (c) reflective conversation. I will then discuss three transitional themes that emerged from the data: (a) foundational, (b) assessment and (c) experiential.

Main Themes

The basic findings above were intended to answer the question: What are the subjective experiences of automotive instructors as they navigate lab activities? Now that there are some tangible and foundational experiences confirmed, I will categorize these experiences into three major categories and three transitional categories. The main themes emerged from these data as I worked with the coding team to condense and combine the codes. Some of the codes were essentially the same or similar and were combined into a single code. To discuss the basic findings and the codes, I created a Venn diagram (see Figure 4.1.) below to illustrate the way that the main themes and the transitional themes were distributed.

I have captured the relationships in size of the different parts of the Venn diagram, with the areas having the highest number of instances warranting a larger circle in the diagram.

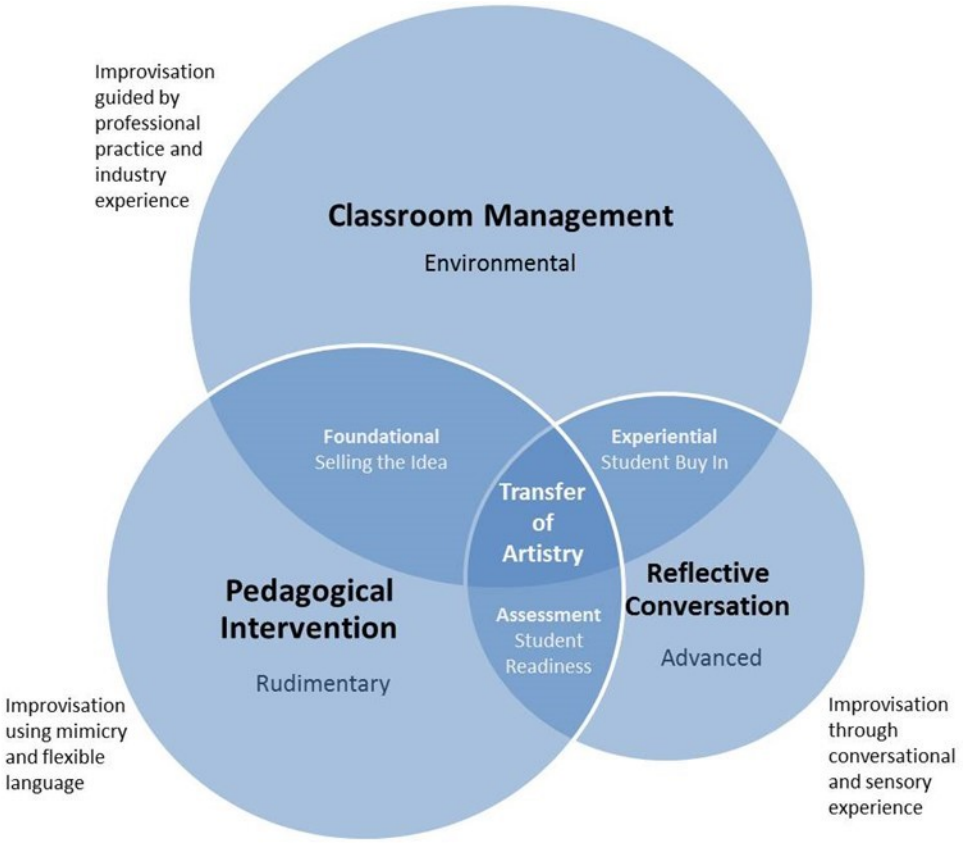

Figure 4.1. Career/Tech Reflective Practice Model illustrating the way the main themes and transitional themes were dispersed.

Classroom management

Classroom management was by far the largest sampling of data expressed by Figure 4.1. above. In Figure 4.1., classroom management was the most common theme that emerged, but also a lower order reflection, which focused on real-time improvisation related to strategic monitoring of student activity, time management, and equipment failures. There were 166 instances of classroom management interactions that ranged from improvisational equipment diagnosis to strategies in time management. In every case, upon reflection, the instructors would explain their reasoning behind some of the actions. The participants in this study were less likely to delegate issues that impeded learning and, although the instructor in every instance had access to support staff, the overwhelming majority of participants chose to solve the problem on their

own. Participant C1 attributed this improvisational problem solving to “the blue collar in us”; that is, that blue collar workers do not usually get the luxury of delegating work to other people, and ascribe value to independence. Consequently, the two instructors with the most professional experience, made it sound like a point of pride that they did not need to utilize lab technicians to manage laboratory issues. On the other hand, the instructor with the least professional experience utilized the lab technician(s) during class more than the rest of the participants combined.

Classroom management techniques, outside of macro-level guidelines such as organizational techniques, are not addressed by the teacher education programs. The instructors have learned how to orchestrate environmental issues, curricular issues, and student issues by reflecting-in-action or reflecting-on-action. My mentor and retired automotive professor said that his opinion, after reflecting on his own experience and from observing and mentoring new faculty over his 40-year career, is that it takes about eight years before an instructor is truly competent in the lab environment. What do you do when something goes wrong? What do you do to make sure you are best managing the time or attention to students? What do you do with a student who seems to lack basic information? It all requires learning by doing.

Many times, during the observation, a vehicle previously set up for the lab exercise would not be available. The instructor or lab tech had brought the vehicle in, and it was to be used as part of a particular learning module. However, in several cases, it would not run. In one case, the key was missing. In several other cases, the car would not start. The instructor had to change vehicles at the last minute. To orchestrate a believable lab experience, the instructor must familiarize himself with each vehicle during lab preparation. If the vehicle gets switched

last minute, or if student cars are used, the instructor must familiarize himself with the new vehicle—in action.

In addition, the majority of the classroom management instances forced the instructor to think on his feet, and I was impressed with the ease in which the instructors could juggle all of these different scenarios. It seemed like they have a sixth sense: where to go, what to look at, how to fix something. Although I am looking more deeply into the reflective conversations held by instructors and students and the subjective perceptions of the instructors, it is not my intention to diminish classroom management skills. If the instructor is not skilled in classroom management, the rest of the learning environment will suffer. There appears to be artistry in classroom management, and it serves as a foundation to the other themes in this study.

Pedagogical Intervention

The second largest sampling of data expressed in Figure 4.1. was Pedagogical Intervention. Pedagogical intervention refers to educative and critical interventions that reinforce prior knowledge. Pedagogical intervention assumes an appropriate use of technical rationality. In other words, the instructor is providing the student with a piece of information so that they can apply it to the learning objective. In this case, the instructors are not necessarily teaching or promoting reflection. The instructor is simply communicating that the student needs to know Concept A before they can perform Task B.

Instructors know this, they understand the importance of structure, but they also understand that there is no way a structure could create authentic learning in and of itself. Yes, procedural knowledge is one thing, but this fluid and adaptive way to navigate complex problems is something that needs to be repeatedly experienced. It could be as simple as saying, "OK, so you did this … what do you think would happen if you had done this instead?" A

simple question could help the student get into a more flexible mode of thinking. For example, during the transmission removal and replacement, the students had a very difficult time, but Participant A1 kept explaining and guiding and demonstrating until the students most likely understood. In the interview, Participant A1 noted:

> Right then I should have been like, 'okay, you guys go to break (the group that understood) … and you guys come over here (the group that did not understand). We're going to make this a topic *right now*, and we're going to get this done.'

Participant B3 offered an explanation for low foundational knowledge:

> It's different now, the students have changed quite a bit, as to previous [their] knowledge coming in. A lot of times at the college level (this is what I've been told, this was before my time) they had a lot more background in [automotive subjects] because they would grow up [repairing cars] in the driveway with Dad, they would have high school classes, they would have taken shop, they would have been exposed to a lot of this stuff before. We're getting a lot of students now that the knowledge base [is zero] when they come in the door.

Participant C2 added:

> You'll get students that have that background what they did to their car, or what [auto repairs] they did when they were young, or [with] their dad or grandad … so they bring that experience [here]. So, they can build on that, which is good for them because they see the difference and how things have changed over the years … so at least I have some context. So, when I tell them [about an automotive component] he's like "oh, that makes sense" because he has that experience, although he has never seen that style [of component], it makes sense to him versus someone who [lacks a frame of reference]. That's fine too, but it helps if they already have that background. They understand it [more easily].

Historically, many students would come from an AYES (automotive youth education system), or traditional high school automotive program or a career technical center. Many students would come to a post-secondary program with at least some background. This does not seem to be the case anymore. There is more of a mix of skill level, especially in the comprehensive program, since most of the students with work experience are recruited into the manufacturer-sponsored programs. Participant A3 talked about using students to gauge other students. Participant A3 expressed that he assessed this students' performance based on his observation and development

of a hierarchy within the class. If Participant A3 noticed the top student struggling, he would know to stop the whole class and conduct a pedagogical intervention. However, if it was a student who had a history of low performance, Participant A3 would make assumptions that they may only need an impromptu private intervention to get back on track.

Reflective Conversation

As displayed in Figure 4.1., the smallest sampling of coded data came from the area of Reflective Conversation. Reflective Conversation is the two-way communication between either the instructor and the student, the instructor, and an object or task, or the student and the object or task. It was adopted from Schön's (1991) study of designers engaging with design situations. The instructors are doing this naturally, learning through their own trials, and remembering how they were taught and modifying their behaviors based on tacit knowledge and environmental factors. Although the area of reflective conversation had the least occurrences observed, it had the closest relationship to my research question. The main point was to look at the instructor coaching students, teaching feel, fine-tuning the student's skills in a tactile and spatial way.

Many times, the instructor needs to interpret service information for the students, not because the service information is too difficult to read or understand by the students, but because it is vaguely written or overcomplicated. Most modern automobiles are not designed to be serviced easily; they are designed to be assembled efficiently and cost-effectively. For example, during the manufacturing process, a pair of transmission fluid cooler lines are assembled with the engine and transmission before the body was assembled on the car. It would be ludicrous to attempt to service the cooler lines in the reverse manner in which they were assembled from the factory. So, to create service information, the manufacturer has their in-house technician complete certain repairs, then they look at feedback and timestamps to see how other technicians

in the field are competing the task. Consequently, two significant themes that emerged from my interview with Participant A1 had to do with his improvisational techniques of getting the student to buy into the experience, and also to work with the students to understand the proper installment of transmission cooler lines and cooler line clips. This was an interesting phenomenon. In the service information, the technician is directed to simply "replace the cooler lines." However, according to Participant A1, this was the most difficult aspect of the day and (hyperbolically) stated that it took the students longer to install the cooler lines than the rest of the transmission removal and replacement. Furthermore, a somewhat exasperated Participant A1 exclaimed:

> Transmission removal and replacement is nothing; it's these damn clips! … the cooler line clips, the cooler lines in general … I wish I would've kept track of the time … but I bet they spent more time either working with the clips, talking about the clips, messing up where the clips go in, then the actual job of [removal and replacement] of the transmission. Through a good portion of that afternoon … I was always having to go and intervene with those clips.

The cooler lines, while seemingly mundane, require a certain amount of spatial intelligence and awareness of tactile feedback. The clips are small and fit into a brass fitting in the side of the transmission. The cooler lines are a custom bent pair of lines that go from the automatic transmission to a small heat exchanger in the front of the vehicle. The lines are approximately four feet in length and should not be under tension when installed. A slight bend (from rough handling) in the lines can cause alignment issues that will make the lines almost impossible to install. The lines are two different sizes and many times they are in a position under the car where they cannot easily be seen. A student must be able to feel his or her way through the process while visualizing the system and understanding the difference between the regular push–pull feel of the lines while being mindful of not bending them. Also, if he, or another

student, has bent the lines out of alignment, they must be able to see this misalignment and attempt to re-bend the lines to align with the ports on both ends.

Along the same lines, Participant B3 and Participant C2 were working with a student using precision measuring tools, such as micrometers, dial calipers, and dial indicators. During the course of the students' experience, they will need to use these tools. Precision measuring tools are delicate and require a significant amount of feel. Participant B3 rhetorically asked:

> How do you teach a feel? [H]ow do you … stand up in the front of the room … with [a component with a] diameter [of] three-quarters of an inch … what is the back-row student seeing? You're going to have to do it again, so let them fidget with it … kind of one-on-one … [and] … see what it does … I told them, okay, look at the dial. See how the dial wiggles as you wiggle the tool? [The student] could see that happening … he had the tool in his hand, and he goes, "oh, yeah, I can center this thing up and make sure that I get [the correct reading]."

Participant C2 also used micrometers as an example of this reflective conversation:

> Its really hard, to teach that feel, that drag, that "how much drag do the parts have to have against the mic, to be an accurate measurement" and you know, we take it for granted, I'm sure you see the same … I mean, when I worked at the (business name) part of my job was measuring crankshafts for 8 hours a day … so … a micrometer is like part of my hand.

Participant A5 talked about the feel of a brake pedal to inform the student of proper adjustment:

> So, I wanted [student's name] since he felt the pedal initially to then tell me what the pedal felt like after we had done the readjustment and before we would do the bleed.

Some instructors, especially those who are still active in auto repair will collect new and worn components over the course of several years. This will allow a student to feel a worn part and compare it to parts that are not worn. Instructors seem to be aware of the value of this versus photographs.

Sometimes the instructor will improvise in order to simplify a concept, and the students are distracted by the lack of lockstep instructions. One student, in particular, was distracted trying to find the schematic in the book when the Participant B2 had simply gone off script to

draw a very simple circuit on the whiteboard to simplify a more complex diagram in the workbook:

> [O]ne thing that I have noticed teaching this class with these boards … [is] the labs that we give them have very specific … steps. But when I draw a circuit on the board and just say hey, create this circuit, it's almost like they get lost. So, I try to do a little bit of both … I drew the circuit on the board and I just, without the instructions of what to put where I wanted to see if they could build that circuit and they mostly could.

Some students have difficulty going beyond the tangible curriculum. The instructor may say "this is not working" and try something else to make the same point; the student may believe that the task ends when the lab sheet is complete. This is the "this is not in the syllabus" attitude from some students. Students who are unwilling to participate in anything that is not overtly curricular also seem to fail to buy into simulations.

Transition Themes

Transition themes are themes that exist within the crossover between the main themes. It describes the area where the lines are blurred, and the two main themes have the greatest impact on each other. The transitional themes are *Foundational*, which is formed at the crossover between Classroom Management and Pedagogical Intervention; *Assessment*, which is formed at the crossover between Pedagogical Intervention and Reflective Conversation, and *Experiential*, which lies between Reflective Conversation and Classroom Management (see Figure 4.1.).

Transition theme 1: Foundational. The foundational transition theme involves pedagogical interventions that are directly affected by classroom management. These are areas where the instructor must manage the classroom in order to facilitate basic concept attainment. If the instructor is unable to manage the environmental issues such as equipment failures, vehicle issues, or even student behavior; he will not be as effective in guiding the students to basic concept attainment.

During the observations, the instructors would improvise in the midst of classroom mishaps such as vehicles not starting or the students unwittingly changing a lab station. Overall, the instructors handled these small emergencies well, turning them into a teachable moment. Some examples noted in this study included six vehicles that would not start, one missing ignition key, students recovering the refrigerant from an air conditioning system when the instructions said to take gauge readings, a transmission jack that would not release. In every case, the instructor would attempt to fix the issue immediately and if it seemed to be taking very long (usually less than 5 minutes) to fix, the instructor would either adapt the worksheet to another vehicle to fit the learning objectives, source another piece of equipment or, as a last resort, move the students to another learning objective.

One of the department chairs expanded on his expressed frustration with a lost key and a vehicle not starting, from both an instructional but also leadership perspective:

> The challenge is … on one side I'm trying to figure out okay, what's the next point on the worksheet that the student's on [in order to] get them back on task; and at the same time [I am] having a secondary conversation with myself [as to] why is this happening? Where are the holes in our boat? [W]ho's [using] these vehicles that shouldn't be [using] these vehicles, and why does nobody know what the situation is with the vehicles? So, yeah, it's a little bit tough, as a department chair, because you've got to do both, and you don't have time to do them separately sometimes.

He continued to discuss his perceived importance of the department chair also serving in an instructional role. He said it was critical in order to "get a feel" for how the department is operating.

Transition theme 2: Assessment. Assessment is the area between pedagogical intervention and reflective conversation. This is where the instructor must constantly assess whether or not the student has enough foundational knowledge to enter into the reflective discourse. This can create a feedback loop where the instructor will assess the student's level based on the instructor's perception and will loop continuously until the instructor is confident

the student is familiar with the operation. The instructor is forced to improvise because he cannot script it out. There are myriad scenarios encountered in the lab, and with the rotation of laboratory vehicles, opening a hood is, according to Participant C3, "like opening a box of Cracker Jacks, you are going to have a surprise." The instructor cannot predict what is going to happen and they will not know how long a student is going to spend on an exercise. However, I believe one of the reasons that time limits are imposed on lab activities is to generate questions to aid in the diagnostic testing of a student's readiness. Did the student actually do the work? Did it actually take the student 10 minutes? Why didn't the student finish? It's not about seeing if the student can do the task in 10 minutes, it is about how much progress one can make in 10 minutes as a diagnostic tool. The participants in this study were continuously monitoring the students to gauge their readiness for the next task Participant C1 exemplified this when he stated:

> I'll try to … listen to their thought process, and see if they [can] figure it out on their own. If they do, that's great. That's what I want, that [the students] learn on [their] own. If there's going to be any errors … I want to correct them before it gets set in their brain incorrectly.

In this case, participant C1 is trying to gauge the students' knowledge to make sure that they can fully engage in future problems. In automotive technology, there are many areas that work together as a system, and a student perceiving a task as an isolated piece of information is what the instructor is attempting to prevent. Before engaging in the reflective conversation, the student must have the appropriate vocabulary. If the student does not create certain models in their mind, they will not be able to fully participate in experiential learning.

Transition theme 3: Experiential. This theme is about getting the students to comply or *buy into* the training experience. Not all instructors identified this specifically, but most alluded to it. The students treat a live customer vehicle, a school vehicle, and their own vehicle, all differently. If the students fail to buy into the simulation, they will not necessarily approach

the instructor to have their hands-on abilities evaluated. A student needs to call to an instructor to verify his or her reading or procedure is correct, or the instructor needs to look at the student and assess whether he should intervene. If the student gets the incorrect reading, or puts the component together incorrectly or misses a damaged component during an inspection, the instructor needs to diagnose whether the student is having trouble using the tool, whether the tool is damaged or out of calibration, or whether they are actually performing the task correctly. Many times, I would see the student struggle, the instructor would ask the student if they were okay and the student would say yes, but the instructor would not believe them.

During the interviews, the instructors talked about the importance of the students seeing the component they were working on in context. In Participant A5's class, he talked about the drum on a stick, and how the students would be able to manipulate the parts and pieces on the bench but not have the same experience because of the placement on the car. It was easier and more efficient on the demo, but the students needed context. However, in Participant A3's class, when the students did not see what they needed to see on the vehicle, he took them into the classroom, drew it on the board, then had the students look at the clutch components together and use the tool out of context.

In a modern manufacturer-sponsored automotive program, students have many resources. The instructor needs to figure out how to utilize these resources to convince the students that what they are working on is real and represents what the student will see in the real world. If the student thinks it is real, they will try to go beyond the blank on the lab sheet and genuinely try to put the component together; at this point, the student will invariably become hindered with their lack of finesse because of a lack of experience. It will go together, but it won't be easy. It will

provide a reading, but it will not be accurate. The instructors in this study were able to continuously identify this struggle and coach the student through the phenomenon.

The student may have the electrical circuit board arranged in such a chaotic manner that the instructor is unable to actually see the problem with the circuit. At this point, the instructor would completely undo the student's work and have them build it from scratch, watching the student complete the task and stopping them when he sees "the mistake." If the student repeats the mistake, the correction can be made in real time. The instructor is facilitating a reflective conversation. The instructor is guiding the student to examine cause and effect.

Furthermore, there is an artistry in trying to simulate an experience. Instructors get upset when they have gone to elaborate lengths to set up a car with believable problems or symptoms (often referred to as *bugs*) installed in the vehicle, and the car is re-donated because of contractual obligations to the sponsoring manufacturer. It is not that the instructor is lazy or does not want to update the curriculum, but rather a well thought out, and reflective lab experience was created, tested and refined by the instructor; and giving the car away without consulting the instructor, or at least acknowledging the effort it took to recreate the experience, diminishes the artistry.

While experiential learning is not explicitly defined by Wurdinger and Carlson (2010), the authors outline several types of experiential learning methods (project-based, placed based, problem-based, service learning) that echo the intuitive behaviors of the automotive faculty. Often in the observations, the instructors were directing the students in applying their knowledge and conceptual understanding to real-world problems or authentic situations generated by the instructor. Wurdinger and Carlson (2010) continue by identifying "guiding principles of experiential learning" such as "promoting hands-on learning, using a problem-solving process,

addressing real-world problems, engaging in direct experience, and using multiple subjects to enhance interdisciplinary learning" (pp. 17–18).

The students need to buy into the experiential learning environment. If they do not think it is real, they will not get the most out of the experience. Solving real-world problems is the key, but it would be impossible to coordinate real-world problems in the lab. The instructor must develop a talent for simulating authentic real-world problems to increase the chances of student engagement.

Transfer of Artistry

When I discuss the transfer of artistry, I am referring to the synthesis of all the main themes and transitional themes. Transfer of artistry occurs when everything works together, and the student has both the intellectual and physical accomplishment to perform a complex task and the likelihood of transferring that skill to other contexts. As far as career/technical education is concerned the transfer of artistry is the best possible combination of factors that contribute to the desired performance. To facilitate this, the instructors are creating an environment of discovery. They are managing the learning through continuous assessment and based on their assessment of student readiness; they will engage in a reflective conversation with the student that ultimately leads to the development of artistry. As the instructors guide the students toward discovery, they are encouraging them to move to a higher developmental level.

The main goal in deconstructing these subjective experiences is to uncover some of the antecedents that facilitate the transfer of artistry, times when the instructor is going off the standard curriculum to demonstrate finesse or feel to a student—to fine tune the learning based on cues from the student and tacit knowledge of the instructor.

There was also a tacit understanding of the knowledge itself. A student asking a question and the instructor not knowing the answer is very different in a variety of contexts. Most of the instructors could answer any question that I understood. However, some students asked questions that were a little "off-the-wall," and the instructor would make all attempts to satisfy the student's curiosity without offending the student. One student was trying to ask Participant B2 questions about DC circuits, using AC circuits as an analogy within the question. It was not enough to satisfy the student's curiosity about how DC circuits worked, but also how AC circuits worked and how they were different. According to Participant B2, students are asking the "wrong question." This can be a diagnostic aid, but how does an instructor get to the point where they can address the student's ego needs as well as their professional needs? When does the ego no longer need to answer questions and say, for example, "That's not a bad question, it's just not the one you should be asking given the context." During the exchange between the student and Participant B2, Participant B2 says "he's stuck on it," meaning that the student cannot move forward until he is satisfied with the answer. At this time the Participant B2 simply says, "I don't know that much about AC," which satisfied the student enough to move ahead with the activity.

A common off curriculum theme the instructors would model was the improvisation of tools. Several classes were told that the tools were not going to always be available in the real world and the instructor would coach the student how to use universal tools to get the job done. This is off script but also sometimes necessary. Participant A4 noted:

> [S]ometimes it's just better to make it real world … that's what they are going to be working in. You don't want to have it overly prepped.

An awareness of when to interject and what level of interaction was needed was constantly being addressed in the lab. Everything was set up, but it was interesting to watch the instructor make

an observation, approach the student, assess the students through verbal cues and body language, then act accordingly, either troubleshooting the environmental barrier, solving a pedagogical problem, or engaging in a reflective exchange with the student directly transferring artistry to that student. All the instructors engaged in the environmental and pedagogical, but not all the instructors engaged in the transfer of artistry. I assert this is due to the lack of readiness from classroom management or pedagogical situations.

Although there is a curriculum in place for engine performance, one instructor, Participant A4 made the statement that it was impossible to set a curriculum for something as unpredictable as engine performance or steering and suspension. Instructor A4 noted:

> [E]ngine performance is not a set curriculum, not quite the way that engine mechanical would be, or typically the stuff that you do, you've got certain transmissions that you're going to take apart, they are going to take these measurements. Maybe air conditioning somewhat … but engine performance definitely, you never know quite what you are going to see. And steering and suspension, you have live cars, and you never know what crazy problems they are going to come in with.

I believe that students need to see and hear how instructors are thinking regarding the artistry. In other words, the instructor is modeling behavior in all three categories, and the instructor has the opportunity to talk through what he was modeling for the student. The instructors also attempted to understand what the students were thinking, Participant C3 speculated:

> I think at that point … in their mind [the students think they are] doing an exercise [and they think] "the [AC] system is working, [so] why are we doing this?" Getting them to understand that in a training environment, now is [the] time to see what normal is. You don't know what normal is until you actually physically experience normal, so once they get a feel for [normal] … they'll understand what abnormal may be.

Summary

The three themes that emerged from this study were varied in levels of reflection and frequency of occurrence. Theme 1 proposes that there is a high amount of low-level reflection or automaticity in the management of the lab. The instructors shared a common experience, and

every instructor navigated uncertainty in the lab without expressing high levels of frustration, almost as if they were accepting of the likelihood of problems in the lab. They just immediately started problem-solving while juggling the needs of the rest of the class and being mindful of time. The second theme revealed a less frequent but universal mid-level reflective practice. Instructors were continuously monitoring students to provide a pedagogical reinforcement of concepts necessary to complete the task, without focusing on the more refined aspects of practice. The third theme, which was the least frequent, involved reflection-in-action and the instructor's assessment of the student's finesse when working in the lab, creating a feedback loop between the instructor and student as they compare various sensations developed in practice. In the next chapter, I will expand on these themes and compare them to current research on reflective practice.

Chapter V: Discussion and Conclusions

Review of Research Purpose

The purpose of this research was to understand the subjective experience of automotive instructors as they navigate hands-on laboratory activities. While student-focused career/technical studies are available in the literature (Barber, 2003, 2004; Cash et al., 1997; Threeton and Walter, 2009), very few address the experience of the career-technical instructor. While some studies address instructor development and reflective teaching, this is the first study to look at the automotive instructor's experience when faced with the uncertainty inherent in an automotive laboratory. This dissertation used a unique method to collect data about these experiences that led to implications both for career/technical education and the field of automotive technology. Furthermore, this dissertation has attempted to get a better idea of the dualism that exists in career technical education between technical rationality and reflective practice—particularly, the need for balance between the approved curriculum and the instructors doing what they felt was necessary to meet the student's professional needs. In this light, I am casting doubt on Canning's (2011) assertion that Schön's (1983, 1987) dualism between reflective practice and technical rationality is no longer relevant. Although Canning said that, in modern times, many professions are more balanced between reflection and technical rationality, I challenge this statement in the context of career/technical education. In automotive training, specifically, technical rationality seems to be the only symbolic paradigm the industry stakeholders will tolerate. However, within this oversimplified context, I was able to demonstrate that the instructors practiced reflection, naturally and tacitly throughout the training experience. I contend that this behavior should be brought to light to better address the need to develop, nurture, and protect reflective practice in automotive technology programs.

Also, there is value in studying reflective practice in multiple contexts, as studies that included reflective practice in other career/technical programs would increase the tangibility and transferability of reflective practice as a holistic body of scholarship. Schön's (1987) work with architectural design students, music classes, psychoanalytic practice, and counseling assisted me in developing this study and provided much-needed academic context; he did not explicitly direct an aspiring teacher of reflective practice to any particular template. It is clear now that Schön understood that in doing so he would be participating in the very thing he was rallying against: the overreliance on technical rationality. In Chapter II, I discussed Schön's reliance on the master teacher to develop experiences for the students based on his or her own reflection of the reality of the profession. The participants in this study displayed this behavior in a very pronounced manner.

Restatement of Research Questions, With Findings

In order to move forward with the exploratory research process, in Chapter I, I proposed four research questions concerning automotive instructor behavior. These questions guided my research, although I never explicitly asked the instructors the research questions in an attempt to avoid leading the instructors to the answers. In contrast, I wanted to pull meaning from the instructor's reflections of their behavior to delineate their espoused theories versus their theories in use. In the next section, I will discuss the research questions and briefly describe the findings.

Research question 1: Is the instructor exhibiting behavior aligned with any existing educational or leadership theory? According to emergent themes from the instructor interviews, the instructors' behavior is aligned with widely accepted educational and leadership theories. Whether the instructors were aware of the theories or not, I routinely saw examples of Schön's reflective practice embedded in Deweyan pragmatism, as well as multiple examples of situational leadership theory. The instructors were creating experiences for the students,

assessing their performance, determining readiness, and giving them more coaching based on their readiness. What I saw repeatedly was a "feed them if they are hungry" approach to instruction. This was not a matter of the instructor only providing expert instruction to the higher performing students; it was the instructor giving the students what they needed on an individual basis. The instructors intuitively knew, based on observed performance, which students needed to focus on fundamentals and which students would benefit from engaging in a reflective conversation. This aligned with Hersey's (2012) statement:

> [A] situational leader is anyone, anywhere who recogni[z]es that influencing [behavior] is not an event but a process. The process entails assessing followers' performance in relation to what the leader wants to accomplish and providing the appropriate amounts of guidance and support. (ASTD ICE presentation)

Although the students were not necessarily treated equally, they were challenged appropriately. The instructors understood the folly of those who assume a homogenous student population and went against policy when they felt it was needed. Many of the instructors spoke about this circumnavigation of policy much like master automobile technicians boasting about how they found a better way than the service manual procedure to repair a vehicle.

Teaching is undoubtedly a form of leadership. Osborn, Hunt, and Jauch (2002) stated, "leadership is embedded in the context. It is socially constructed in and from a context where patterns over time must be considered and where history matters" (p. 798). The automotive instructors understand what they are asked to teach by the accrediting organizations, what they are asked to produce by the manufacturers, and the reality of what goes on at the independent repair shops and dealership service departments. Rarely do all three of these paradigms align, and the most effective instructor must decide to teach from the book, or from a place of history and experience. To provide the students with the best chance of success, the instructor must take a subjective approach to teaching based on the situation.

Thus, the most obvious connection between how an automotive instructor behaves and leadership theory was situational leadership (Hersey & Blanchard, 1977; Hersey, Blanchard, & Natemeyer, 1979) mainly because the themes of pragmatism described by the authors aligned with the findings of this study. I found that Hersey and Blanchard's (1977) work with situational leadership provides a pertinent symbol for effective leadership; it offers an explanation that alludes to some of the underlying themes that I find most interesting in my ascribed model for navigating complexity in laboratory activities. This resonated with the overall attitude among the instructors that they were willing to go against the curriculum, not because it was easy, but because it was seen as more efficient or it was in the best professional interest of the student. Hersey and Blanchard's (1977) theory of situational leadership uses constructs such as maturity, motivation, and ability to describe relationships between leaders and followers and created a chart to assist the leader in choosing the correct leadership paradigm based on his or her own awareness of themselves and the behavior of others, much like the instructors basing their action on their perceived assessment of student readiness. The accuracy of the instructor's perceptions of the student's readiness is paramount to choosing the correct leadership behavior. Furthermore, this draw to situational leadership could be based on Hersey and Blanchard's (1977) emphasis on the importance of being a diagnostician. Most of the instructors in this study performed diagnostic work based on symptoms and the understanding of automotive systems before they became involved in education. While diagnosing a fuel injection system is not directly related to diagnosing a student readiness to learn—the instructors' history of careful observation and calculated action in the field provides a template for navigating similar situations. Furthermore, as educators, they continuously evaluate and assess students to make appropriate changes in curriculum and delivery. They make impromptu value judgments concerning a student's level of

knowledge and skill and change the learning environment and their behavior to achieve the desired behavior from the student. However, utilizing leadership theories to predict behavior or to gain insight into our own thoughts and behaviors, as well as the thoughts and behaviors of others, is important when picking an arbitrary starting point for development. In one of Schön's (1983) observations, the design instructor, Quist, advised a struggling student in the architectural design lab, "you should begin with a discipline, even if it is arbitrary … you can always break it open later" (p. 93). Is this the first step toward a metacognition of the profession? Is it necessary to have some perspective (regardless if it is the right perspective) to transform that perspective into something more useful? Should all perspectives be considered disposable in a way, acting as a conduit to new meaning? Osborn et al. (2002) propose that "different models fit different circumstances, and researchers and theorists should adjust their perspectives to meet changing conditions" (p. 832). Although Situational Leadership was intuitively a good fit for my analysis, many other theories of leadership, such as relational (Graen & Uhl-Bien, 1995; Komives, Lucas, & McMahon, 1998), collaborative (Chrislip & Larson, 1994), and team leadership (Ilgen, Hollenbeck, Johnson, & Jundt, 2005) are based on observations of the behaviors of individuals, the individual's reflective perceptions of their behaviors and the behaviors of others, and how influencing these behaviors relate to performance, creating change, and realizing goals.

Research question 2: Is the instructor aware of his own thought processes during improvisational teaching moments? Under reflection, the participants in this study were aware of their thought processes during improvisational teaching moments. While they did not seem to think about the reasoning behind their actions in the moment and tended to react intuitively to stimuli presented to them in the lab, once the instructor reflected on his own behavior in the IPR session, it was obvious that, even the instructors with relatively short tenure were highly

reflective concerning their teaching practice. It was obvious that many of the behaviors were meant to correct student tendencies or classroom management issues they had experienced in the past. Also, there were markers that the instructor noticed that warranted interventions, such as body language or verbal cues from the students.

None of the instructors complained about the established curriculum or alluded to technical rationality as being restrictive. They just did what they thought was appropriate in a variety of contexts. Most of the participants in this study made remarks to the students that served as guiding or cautionary remarks about the environment the students will ultimately navigate at their workplace. This reminds me of Jarvis' (2012) juxtaposition between teachers and "human resource developers" (p. 240) which put the idea of moral and ethical education and self-efficacy into question:

> Given that teaching is regarded as essential and that it is also actually performing this mediating role, it becomes necessary to inquire whether those who are doing it are aware of the complexities of the process in which they are involved and whether they are exercising their responsibility in a way most likely to help the learners become more fully human. (p. 240)

I understood Jarvis to mean that human resource developers were assumed to treat students like commodities to be offered to the workplace, and teachers were preparing students as individuals to navigate the world as it exists from their perspective. This paradigm was evident in almost every classroom observation I conducted.

Research question 3: Does the instructor attribute improvisational or reflective skill to any particular learning event such as teacher education workshops, mentoring, or trial and error? The instructors mentioned experience, both teaching and professional practice, as being antecedent to improvisational or reflective skill. Although Threeton and Walter (2009) studied automotive students in post-secondary automotive programs, there are useful data that

may increase understanding of automotive instructors since 83% of the automotive instructors in this study started their post-secondary academic careers as students in an automotive program. If the automotive instructors are selected from the population of automotive technology students, then it would be intuitive that the majority of automotive instructors have a realistic/mechanical learning style and be comfortable teaching within the paradigm of technical rationality. Furthermore, only one instructor referenced an educational program as a means to develop skill as an instructor:

> The program, vocational–technical education is how to teach teachers how to teach CTE, so I've got both a bachelor's and a master's in that. Now, I'm going back to start an Ed.D. program … in the same subject … I really like teaching, and I really want to get good at it. There might be some redundancy … but still, there will be new techniques that have been developed since I went to school. [There are] different teachers from the school I went to, so I might get different perspectives.

Most of the other instructors touted field experience, teaching experience, and their experience as a student as the major contributor to their teaching style.

Research question 4: How does an instructor's perception of a student modify their behavior when navigating novel situations in a lab environment? The instructors in this study expressed many different assessments of students. There is no way to verify if their assessments were accurate. Even if I assessed the same students, there is no guarantee that I would be any more accurate. We are limited by our own experiences and perceptions, and that is very difficult to overcome in the lab environment. According to Thomson (1991):

> Interactions between people tend to be unique events that are very difficult to describe objectively. So, while interpersonal skills have long been recogni[z]ed as essential to many jobs, they have traditionally been given little attention by curriculum writers and even less by assessors. (p. 40)

Nevertheless, it was obvious through this study that the participants were highly aware of student behavior, and they acted accordingly to provide the students with valuable access to real-world skills.

Several of the participants would make assessments like: "[some] students are better academically than with their hands, [some] are better with mechanical manipulations." The participants even performed impromptu ability diagnosis to try to get the students the best possible outcome. The instructor would identify a student who had a perceived "disability" and work to be mindful during interactions.

Many of the participants were continuously looking at students subjectively, trying to figure out what they needed, what level of interaction, their readiness to discover. This is very similar to Dewey's (1938/2007) idea of the role of the instructor:

> It is [the educator's] business to be on the alert to see what attitudes and habitual tendencies are being created. In this direction he[sic] must, if he is an educator, be able to judge what attitudes are actually conducive to continued growth and what are detrimental. He must, in addition, have that sympathetic understanding of individuals as individuals which gives him an idea of what is actually going on in the minds of those who are learning. (p. 39)

In all, the research questions above provided insight to many areas of automotive technology lab training. However, the process of answering these questions led to an understanding of more abstract concepts of automotive teaching. These concepts are addressed in the following sections.

Key Insights

The main insight that came from this study had to do with the complex dance that led to the transfer of artistry. The industry has made assumptions about both the nature of the automotive instructor and automotive student that hinder learning. The industry believes that by preparing a student through technical rationality, they will be able to perform complex tasks and exhibit expert judgment by merely participating in lockstep array of approved activities. These activities are easy to observe and easy to measure by an outside observer. I have confirmed, through this study, that merely guiding the students follow directions to perform common tasks

is sufficient to prepare students for entry-level/lower level positions in the field, but that is not what the automotive advisory committee, the corporate stakeholders, or accrediting bodies have assigned value. The stakeholders are asking for a student to demonstrate competency in common tasks, but expecting advanced diagnostic skills. This advanced experience is only developed when the instructor is working directly with a student to develop an artistry. This was aligned with Hodkinson's (1992) assertion:

> The nature of role also depends on the context in which it is placed, including the unequal power relations between participants. Views of the role will often be contested. Not every car mechanic … recogni[z]es the descriptions of their job found in the elements of competence drawn up by lead industry bodies and it is common for employer and worker to see the same role differently. (p. 32)

Participant C3 identified several conflicting paradigms in the automotive industry. In a particularly long statement, Participant C3 noted some of the issues he had encountered in the relationship between his program, the sponsoring dealerships, and the manufacturers. His abbreviated assertions included:

- The dealers assume that the students are all going to graduate as high-level technicians.
- The dealers maintain that they do not need all employees to be high-level technicians and protest required update training imposed by the manufacturer.
- The dealers maintain that they desperately need high-level technicians.
- The students all expect to be considered high-level technicians upon completion of the program.
- 80–90% of the work the students will encounter will be repetitive low-level work.
- Most graduates will settle into a low to mid-level technician position.
- Students need to realize that it is the technician's ability to perform the 10–20% of work that requires fine and nuanced skill that will yield the higher pay levels.

All the participants could teach these fine nuanced skills and demonstrated them on call when a student was ready to receive that one-on-one interaction. However, the biggest hurdle to this interaction was preparing the students to accept the interaction. Regardless of how rigid and lockstep the curriculum is, it cannot work as designed if there is an issue with a vehicle or if

there is an issue with a piece of equipment. The participants demonstrated throughout the study that they had a keen awareness of the student's needs at a particular time. If the participant ran into a classroom management issue, they would resolve it; if they ran into a student who was having trouble with elementary concepts, the instructor would intervene; if the student was in the right place and completing the lab exercise the instructor would assess how well the student was performing the task and would reinforce and enhance the learning. I observed the participants resetting the station and having the student walk the instructor through the procedure, modeling the behavior and having the student repeat the behavior. Two participants referenced the tools as an extension of their hands. The fact that they are this comfortable with these processes forces them, as instructors, to try to communicate what they are doing naturally (often in one swift and smooth motion) into a checklist. Sometimes I will set up a lab and have multiple components, various degrees of adjustment and use the three little bears analogy, see how this one is too tight; this one is too loose, this one is just right. In my experience, many students do not understand what a slight drag on a feeler gauge is until they have something to compare.

Technical rationality in vocational education is appropriate for certain activities to promote readiness to learn artistry, and some learning outcomes can be achieved without the student experiencing it firsthand. In contrast, there is no box to check when a student is being asked to engage multiple sensory organs and a mix of abstract and concrete concepts. Even if they get the right answer, is there transferability to other areas? I assert the core finding was the impact of modeling. The students are watching the instructor deal with complex problems and all the while the process is being verbally discussed. This is closely aligned Bandura's (1977) assertion that "most human behavior is learned observationally through modeling: from observing others one forms an idea of how new behaviors are performed, and on later occasions,

this coded information serves as a guide for action" (p. 22). This observed behavior can be from any practice the instructor is engaged: classroom management, pedagogical intervention, or reflective conversation. Beyond the context, the students are seeing real problems being solved authentically by a master technician. It does not matter if the instructor is repairing a transmission jack or verbally describing a tactile process to a student, as long as the instructor is using sound logic and proper diagnostic methods, the students are learning the critical skills requested by the industry.

The instructor may say, "watch how I do this, now I'm not always going to be around, so you are going to need to deal with these things." The students are cued to pay attention because the instructor is using his credibility to infer the transferability of the activity to the job. Also, there are many times that demonstrations and verbal warnings are needed because allowing the students to learn by trial and error would be hazardous to themselves or other students, as well as damaging to expensive equipment. Bandura (1977) discussed this:

> Most of the behaviors that people display are learned, either deliberately or inadvertently, through the influence of examples. There are several reasons why modeling influences figure prominently in human learning in everyday life. When mistakes are costly or dangerous, new modes of response can be developed without needless errors by providing competent models who demonstrate how the required activities should be performed. Some complex [behaviors], of course, can be produced only through the influence of models. Under most circumstances, a good example is, therefore, a much better teacher than the consequences of unguided actions. (p. 5)

Therefore, while modeling is important in the reflective conversation between the instructor and the student, there are copious opportunities to model professional behavior to a student, in every area of practice.

Regarding Bandura's (1977) earlier statement on unguided actions, my grandfather, who started working at a Chevrolet dealership in the 1930s and operated his own service garage until the 1990s, once told me, "You can drive around in a cornfield your entire life and never learn to

drive." He understood that simply going through the motions of an activity does not transfer to practice. There is no question that trial and error is a vital component in the learning process, but so is observation, mimicry, discovery, and continuous feedback.

The paradox inherent in this study is the fact that the highly structured technically rational curriculum assumes a homogenous student body, which not only does a disservice to students who have little experience with automotive but also does a disservice to students who have experience. Although Participant C3 touted the effectiveness of the lockstep corporate curriculum, he also talked about the fact that all technicians are not going to be high performers in the dealership and identified a stratified workforce of low-skilled to high-skilled workers and equating that to earning potential. Furthermore, not all students are working at service garages and (as strange as it may sound) I have encountered some automotive students who have never driven a car. How can an instructor convey the transferable nature of the lesson to a student who does not have a frame of reference? The instructor must be flexible enough to engage students on multiple levels, but also assess their knowledge and skill in action. There were multiple times the instructor called out students as being either good with their hands, or good academically. The instructors used this as a modifier to their practice. At no point did any of the instructors reference a particular method of developing these skills, other than experience on the job.

What may appear to be the easy way of conducting automotive training is to have the students read through a laboratory worksheet, look up information, take things apart, put them back together, and check the appropriate boxes on the worksheet. It is certainly important to have the students get exposure to these activities but, beyond the curriculum, there are nuanced skills that should be developed. Jarvis (1993) discussed "institutionalization" of the learning processes, and he wrote of education institutions as going through specific phases of

habitualization moving to ritualization to objectification (p. 2). This objectification of the curriculum aligns itself with the over-reliance on technical rationality espoused by Schön (1983, 1987), Mezirow (1991), and Mayes (2005, 2007, 2010). The political and bureaucratic paradigms that exist within education, according to Jarvis, seem to be a matter of taking an easy path, a path that is easy to quantify. Jarvis (1993) singles out what he refers to as the "experiential learning movement," in regards to those who push for most of what a student learns as being best taught by being on the job:

> [T]he whole experiential learning movement is in accord with the underlying epistemology of conservatism even though it appears progressive. In contrast, expert knowledge once gained, need not be acquired experientially by others for it is a time-consuming way of learning so that that knowledge can be taught and learned in a much more traditional and anti-progressive manner. (Jarvis, 1993, p. 28)

He expands on the conservative and anti-progressive management of adult education and the dystopian society to which it contributes, making a note of the fact teachers are "…required to function within a bureaucratic framework … [and] … assume traditional or rational–legal approaches to the performance of their role" (p. 56). It is this correlation between the influences of technical rationality and the reproduction of this system within career technical education that most interest me, because of my own frustrations navigating the limitations of technical rationality in the established automotive technology curriculum.

Despite the policies above, the participants in this study eventually had to go off script, not because they did not like the script or the script was difficult to follow—they went off the script because the situation required it. I was open to the possibility of differences among the behaviors I observed across the different colleges due to policy differences, cultural differences, or leadership differences; however, this was not the case. Regardless of environmental factors, the faculty reacted to the moment and went off script when the need arose. In other words, the participants were thinking less about what the instructions say and relying on what they believe

the students needed. Based on my observations, the participants were well equipped to handle almost anything that they encountered in the laboratory. The dilemma inherent in the instructor's practice is meeting the unrealistic expectation from the automotive industry that the majority of students will graduate from an automotive program highly-skilled and ready for the workforce until a system is developed where the majority of students can be developed experientially without time restrictions.

Throughout this study, I discussed the role of maturity in reflective practice. The instructors in this study have crossed the boundaries—from an automotive student to apprentice technician to master technician to automotive instructor. They have also engaged in the study of higher education, some exploring career/technical education specifically. Many instructors share a common experience with the students and were situated professionally (sometimes decades prior) where the students currently aspire. The automotive instructors have perfected a craft and are now working to develop others. They have a feel for how to teach concepts based on how they learned the concepts, and according to some instructors in this study, teaching from a script is inauthentic.

The Career/Technical Reflective Practice Model

The model I proposed in Chapter IV (Figure 4.1.) has multiple applications for how automotive training is approached. Following Schön, I attempted to surface the complexity of automotive technology instruction, and I use the term reflective practice to describe the instructor's continuous cycle of reflection used to solve problems that arise in classroom management, pedagogical interventions, and reflective conversation. I set out to study the experiences of automotive instructors during lab instruction, using guidelines from other clinical practices in professional fields. In reference to Russell's (2005) assertion concerning the academic landscape being more concerned about conceptual value than about transferring the

skills of reflective practice to future practitioners, I intentionally looked for practical applications of reflective practice. Additionally, appropriate modeling is one of the most effective means of building up both the instructor and student's reflective practice; therefore, aligning with both Schön conceptually, as well as, Hersey and Blanchard's (1977) work with situational leadership.

At the center of the reflective practice model is the concept of transfer of artistry. This is the ultimate goal of the model. Looking at the model (Figure 4.1.) we can see that the classroom management situations far outweigh the other situations that occur in the model. This is an opportunity for the instructor to model appropriate behavior to the student. There needs to be a culture of adaptability promoted in the classroom. For example, if the instructor can model sound logic and practice in dealing with classroom management, I assert that there will be collateral learning as defined by Dewey (1938/2007), specifically, that the "formation of enduring attitudes, of likes and dislikes, may be and often is much more important than the … lesson that is learned" (p. 48). Automotive technology programs are closely tied to the industry and have a culture of problem-solving. Problem-solving is a universal skill, and being embedded in a culture of problem-solving will prime the student for a variety of contexts by developing subconscious associations (Kahneman, 2011). Watching an instructor navigate a problem in the classroom has considerable symbolic power and should not be discounted whether it is classroom management, pedagogical intervention, reflective conversation, or anything in between. If the students observe an instructor exhibit patience and logic when navigating uncertainty, they have been positively influenced by appropriate and desirable behavior.

Antecedent to basic concept attainment is the selling of the idea of the experiential learning environment. If the student is in a believable situation, the instructor can focus on the more technically rational aspects of the curriculum. At this point in the model, the students are

moving through the established curriculum, taking measurements, assembling components, and filling in blanks in preexisting lab sheets. However, multiple times during these observations, the students lacked the foundational knowledge, even though the experience was executed perfectly. If the instructor sets up a realistic air conditioner issue, and the students fail to remember the basics of the system, the instructor must engage in a loop where he will coach the student, then guide them back through the process.

Referring to the model, pedagogical intervention is the second largest area of the Venn diagram. Here the instructor is not just reviewing information with the students, but he is also looking for feedback from the student and modifying his language as he reviews. Many times the instructor would ask the student what they meant by a certain confusing phrase (one student asked "how to get the millimeter of the thingy"), or if the student made a statement that was beyond rational thought (a student showed an inside diameter measurement of a valve stem that was larger than the inside measurement of the valve guide, yet the valve moved freely in the guide) the instructor would ask the student to think about the consequences of that measurement. The instructor would need to find language that would fit the situation, and if the student did not understand, the instructor would have to modify the language or create an analogy, in the moment, to assist the student in understanding.

The least frequent interaction occurred in the area of the model labeled reflective conversation. This area symbolized the interaction between the instructor and the student where the instructor is attempting to understand the experience of the student. The instructors are trying to understand how the student is interpreting a reading or sensing the fit of a part. If a student has not been exposed to a particular component or assembly, they have no point of reference. The instructor must attempt to see what the student sees. Instructors in this study

affirmed that they take their knowledge and experience for granted at times, forgetting that what seems elementary to them is complex to the students. The instructor is relying on his vocabulary and creativeness to assist the student in understanding. This was intriguing to me as three of the instructors in this study identified the students' aversion to reading as a major hurdle in the learning process. Goldhaber (2002) correlated vocabulary level as a significant contributing factor to instructor effectiveness. The instructor and the student must possess a relatively broad vocabulary to be able to fully engage in the reflective conversation. It is tactile and spatial; it is also largely language based.

Modeling

The thread that ties all the areas of classroom management, pedagogical intervention, reflective conversation, as well as the transitional themes, was the importance of modeling the desired behavior. Modeling is paramount in establishing the instructor as a viable teacher in the mind of the student. Furthermore, the student modeling of good behavior during the pedagogical intervention serves to establish the student as a viable candidate for teaching in the mind of the instructor. In other words, the student will not be as open to the instructor if the instructor fails to maintain the illusion of control in the classroom, and the instructor will not be as invested to engage in a reflective conversation with a student if they do not seem to know (or sometimes care about) the rudiments of the concept.

This seems to connect the three main themes by showing how they interrelate, but really demonstrate how many things must align for the instructor to get to engage in the reflective conversation. Every instructor in this study displayed competence, but they didn't get the chance to perform at what could be considered an expert level for a number of reasons, mainly student readiness. The instructors were tacitly modeling behavior for the students, based on their own

experience. Participant C2 expanded on this concept when he felt that the students were trying to rely on him too much:

> [Y]ou have to adapt on the fly. It's the same thing [they will encounter at work]. I ask them, "if I wasn't here, what would you do?" They'd look at me and say "I don't know" but I'd say, "that's what you need to figure out though … because sometimes, when you come to me, I don't have a clue what to do" … "but I have to figure it out, because there's nobody else!" As a [technician], a lot of times, that's the situations you are in … something has happened, and you have to do something to get this car apart or to diagnose it, and you may not have a clue what to do … but there is no one else that does; YOU have to be the one who figures it out, either how to get that bolt out or … there is no one you can run and ask, you have to figure it out. I said, "if you guys, living in the school world, where you always come to me and I always have an answer, what you don't realize is, I don't always have an answer … I have to just dream it up on the fly … on how to fix what you have destroyed … because you don't know what to do now. This is something that you have to learn, over time, is how to fix your own mistakes. There won't be someone there to fix it for you. I'll help you here, and that's fine, but you have to remember that I'm not always there to run to—to fix everything.

While this may not be the instructor sitting down and coaching a student about a particular subject, the impact of modeling appropriate behavior while dealing with classroom management issues has the potential to enhance the students' readiness to engage in higher-order learning.

In certain cases, the students that finish on time or before time have self-identified as competent, and a quick glance will show the instructor that they can move to another task—sometimes an important but not critical task such as additional practice. The students who have not completed the task in the timed period have self-identified as someone who may need to be shown how to do something correctly, or possibly there is an equipment failure. It may be a classroom management issue, a pedagogical review, or an opportunity to teach finesse. The instructors had a tacit understanding of which one to engage.

Instructor Credibility

Regardless of activity in the lab environment, the instructor must maintain a certain attitude when dealing with classroom management, pedagogical interaction, or reflective conversation. According to Myers and Martin (2006), instructor credibility is one of the most

important variables affecting the teacher–student relationship, and "[instructors] who are viewed as being credible exert a tremendous amount of influence on their students" (p. 68). The students look for the instructor for guidance; they want to be where the instructor was—a professional automotive technician. If an instructor goes into the lab with the activities fully planned and prepared and it fails for reasons such as missing keys or an equipment malfunction, the illusion of the learning experience is shattered. The artistry of vocational teaching is not whether everything works as it should, it is how the instructor sells the learning to the students. The instructor has the option of blaming the situation, losing credibility, or capitalizing on the mishap. Many times, throughout this study, when faced with a situation where the students were losing focus because of classroom management or curricular issues the instructor would reassure the students that the situation is an opportunity to learn. For example, if the instructor tells the student to watch a pressure gauge for a certain reaction or a voltmeter for a certain reading, the students will have expectations that, if unfulfilled, will damage the instructor's credibility. The instructors' credibility is paramount to learning as asserted by several studies (Finn et al., 2009; Myers, 2001; Myers & Bryant, 2004). If the instructor is equipped to deal with complex problems, then effectively they are modeling the most critical skills the students will need at the job. I am not implying that the instructors are having a field day, which is one extreme, or conducting lab exercises completely lockstep, which is another extreme, but setting up an experience while not being entirely sure of the outcome other than its going to have a natural and genuine outcome. I am reminded of a case study of the Livonia Motech Center, a flagship individualized self-paced automotive program that received accolades throughout the 1970s for generating highly skilled auto mechanics. In an interview with a former administrator, he revealed that the instructors were all highly successful automotive engineers with practical

mechanical backgrounds and experience with professional automotive sports. These instructors were forbidden to lecture, but mainly monitor students as they navigated the curriculum (Porter, 2013). If the instructors were not allowed to teach, why was this demographic of instructor sought out? I posit that the credibility and the overall symbolic power of the instructor were being utilized to provide credibility to the program. The instructors were whom the students aspired to be, which by association gave credibility to the program.

Furthermore, the two instructors with the most shop experience both said they rarely engage in traditional modes of classroom preparation, one claiming that it can't realistically be done and the other saying that it would not be a genuine or authentic way to teach. From an outside observer's perspective, both classes looked exactly like the classes from the other observations. The two instructors with the least amount of shop experience were vocal in touting the importance of preparation, but the instructors with the most shop experience both said that it was inauthentic to teach from a script. One instructor said with trepidation:

> [M]ost of everything I do is off the cuff. I don't like to try to remember a script and have it all right, because if I'm trying to remember what somebody else tells me to say, then, there's a lot more chance of error. I'd rather just spit it out, what's coming out of my head from doing it so long, and that way I know my facts.

The instructors who said that they do not prepare have actually prepared for 32–40 years. They are masters of their craft, and they think about it and practice continuously. The attitude of the experienced instructors was very practical and mindful. They did not need anyone to tell them what to teach or how to teach it. They knew exactly what needed to be learned because they had a wealth of experience.

General Reflection in Automotive and Technical Labs

Literature that is specific to teaching reflective practice, such as Schön's *Educating the Reflective Practitioner,* is concerned with developing a "reflective practicum" that creates a

realistic environment to practice the profession (1987, p. 170). This reflective practicum goes along with Participant C2's act of developing his own method (disassembling engines from a paradigm of how they will be repaired in the field rather than a complete overhaul) outside of the established curriculum because he felt strongly that the approved lab sheets did not reflect what the students would actually be seeing in the field.

Multiple times during the interviews the instructors talked about the importance of the students actually seeing the component they were working on in context. In the brakes class, the instructor talked about the drum-on-a-stick, and how the students would be able to manipulate the parts and pieces on the bench but not have the same experience because of the placement, in context, on the car. It was easier and more efficient on the demo, but the students needed context. However, in the manual transmission class, the students did not see what they needed to see on the vehicle, so the instructor took them into the classroom, drew the components on the board, then had the students look at the clutch components together and use the tool to align the clutch on the workbench (out of context) then go back to the lab and use the tool on the live vehicle (in context). The lack of transfer was also evident in the automatic transmission class; the students had disassembled and reassembled the 4L60E transmission on the benches in the classroom for three weeks but did not recognize it installed in the car.

Mager (2012) talks about his experience with self-paced learning. One example, in particular, was the locksmith class, where the school would mail him locked locks and instructions, and he would pick the locks and return the unlocked locks for a grade. While this was a very effective way to learn, what Mager neglected was his familiarity with locks themselves, he had used locks, he had held them in his hand. Furthermore, there were two states of the locks—locked and unlocked—this was a very gratifying process, once the lock was

opened, of course. The issue in transferring this example to automotive is that the students are not always able to experience the binary. Automotive technology has countless operations such that, even if the procedure is followed in lockstep fashion, variations in quality are often undetectable by the students. It is up to the instructor to engage in reflective conversation with the student to make these nuances explicit. Using the brakes class as an example, the instructor not only coached the students through the process for adjusting drum brakes, he also had the students press the pedal in the car to get an understanding of how a properly adjusted brake pedal feels. Furthermore, when the instructor noticed that one vehicle had a low brake pedal, he gave every student the opportunity to feel the consequences of misadjusted brakes.

I believe that a goal of automotive teacher training would be to think about problems that are encountered in the field and practice coming up with procedures that steer students in the right direction. However, if the instructor does too much steering or manipulation of the environment to achieve the outcome, it would at some point cease to be realistic. Also, certain situations, like having the student do an exercise that has a negative outcome, can sometimes distract the student. In other words, in automotive technology training, identifying what is wrong with something is just as important as identifying what is right. This is not the paradigm the students are familiar with, and sometimes it can backfire. A good example of this is when Participant B2 was trying to prove a point about the differences in current flow between a hot and cold bulb filament. The student was exhibiting signs of anxiety because the mathematical calculation of amperage through the cold light bulb did not match the current flow of the bulb that was lit:

> So here is a case where … [the student is] saying "look I calculated that it should be this amperage, but I've got this dim bulb and these low amperage so I must have done something wrong" … I was trying to let [the student] know, that's the point we are going

> to make here. Give me an opportunity to make that point, but you have it right. Just be confident that it's right.

In this case, the instructor should look for opportunities to engage students in a reflective conversation, but not assume that students understand because they completed the assignment. If the students are not prepared to engage in certain activities because they lack the foundational knowledge, they are, most likely, not equipped to have the reflective conversation. Also, if the majority of students are missing a particular piece of information, a curricular change may be in order based on reflection: if none of the students understand concept X, how can we provide an experience where it can be understood?

Instructors must make the judgment—is one student not understanding? Is half the class not understanding? Is no one in the class understanding? If one student answers a question, can you move on? To be able to transfer artistry, the student must be ready to accept it, and certain antecedents must be present. The instructor needs to create or manipulate a current situation where the student can experience the phenomenon and practice the artistry. The instructor needs to build confidence in the student. The instructor needs to understand what the student knows, what the student sees, and how the student is experiencing the task.

Limitations

There are certain important limitations to be considered when interpreting this study's results. Two automotive program chairs did not respond to my email request or voicemail messages, three automotive programs that accepted my invitation to participate in this study either failed to respond to future correspondence or postponed the observations until I was forced to find other participants. It is possible that there were differences between the culture and practices of the programs that volunteered and those that did not. Also, the instructors that did not respond may have had issues with being interviewed or videotaped. They may have had a

unique perspective. Also, the small sample size of 12 faculty members from three different college automotive programs, while appropriate for a foundational study like this, is still a very small sample. Also, there was very little cultural diversity in this study of instructors. Although all of the automotive programs were in Midwestern metropolitan areas (Dayton, Indianapolis, and Chicago), there was much more student diversity in the Chicago area. Also, since all of the observation were conducted during the laboratory component of a hybrid lecture/lab course, the effectiveness of the lecture materials could have been a factor in student readiness in the lab.

Another limitation would include the potential for a student to perform a task correctly as a coincidence. The instructor could misdiagnose a student's skill level. In other words, if the student performed a procedure correctly, it could be because they naturally had the intellectual, spatial, and tactile skill to make it happen, or it could be because they just got lucky. In the pilot study of IPR, one of the instructors made the statement, "it's just as likely that the guys that got it right this time would have missed it the second time" (Pilot study instructor, personal conversation).

Another limitation is the student's readiness. Although the instructor is modeling behavior, the students may not be psychologically ready to make sense of it. The student may see classroom management issues as a way to disconnect. This happened in several observations. The instructor would interact with a problem, start to walk through a procedure, and because it did not seem to be relevant to the curriculum, students would wander off, leave the room, check their phone messages, or engage in conversations with other students. This way, the priming effect would be somewhat ineffective.

Implications for Teaching Practice

A major opportunity would be to encourage instructors to think of every area of teaching practice as an opportunity to model sound logic and proper diagnostic procedures. The instructor should be not only prepared to verbalize the process of troubleshooting a malfunctioning air conditioning recovery machine, but also be prepared to think about which actions are implicit and which actions are explicit, and involve the students at every level. I feel that mindful practice would include the intentional development of a versatile vocabulary to be able to make the diagnostic procedures clear to the students.

Also, based on my observations, instructors need to construct meaningful laboratory exercises that mimic what professional automotive technicians see in the field. If the instructor does not have a significant amount of professional experience, they could seek mentorship from faculty members with more professional experience; they could ask practicing master technicians about common problems and repairs. Also, there are opportunities to develop skills—some automotive instructors work on vehicles as a hobby or, in some cases, as a second career. Other opportunities could be volunteering at a non-profit automotive service center or even volunteering at an automotive service center or dealership service department. Two of the colleges offered professional development credits and pay incentives for volunteering or observing.

Another implication is to promote practice outside of the classroom. Multiple instructors noted that there has been a shift in the background experience of the students, and the students ready to engage in the reflective conversation are the students who bring experience to the classroom. Encouraging students to practice outside of class—interning, volunteering, starting

an automotive project at home—could be the catalyst to reach the students who clearly lack context.

Lastly, I believe that providing a solid argument for reflective teaching methods will change the way that the administration and teacher education programs look at automotive instructors. Eraut (2000) posits:

> Even though [instructors] may explicitly argue, and have personally experienced, that many teaching activities do not promote learning, this may be over-ridden by their implicit knowledge of the expected role of teachers when they are confronted by a combination of the practical need to take charge of a classroom and the psychological need to be identified as a genuine teacher. Implicit knowledge can be very powerful indeed even when, as in most teacher training, explicit knowledge is available by the bucketful. (p. 122)

More importantly, it may change the way that automotive instructors look at themselves. There is a good chance that a reflective instructor can foster reflectivity in a student. However, much of the stigma of the automotive technician must be addressed. In developing this dissertation, I encountered several negative statements concerning the automotive profession. I believe an implication for teaching would be to uplift the profession by making the artistry of automotive repair explicit.

Future Research

This was an exploratory exercise. I was not intentionally looking for any specific behaviors from the participants, but since there are no studies about the subjective experiences of career/technical instructors, as well as no studies that addressed automotive instructors specifically, I was compelled to use this study as Schön's instructor "Quist" would advise, and use this as a foundation for future studies. While I am pleased with the rich and surprising information that sprang from this research, I am even more excited at the prospect of this leading to future research that will improve and enhance the automotive educational system.

When discussing career/technical areas, it is easy to be seduced by easy answers. However, a standardized curriculum assumes a homogenous student population and overlooks one of the most valuable resources available—the rich experience and history of the instructor. Instructor quality, as well as student quality, are moving targets. The assumption in automotive technology programs is that if you standardize the curriculum, then anyone can teach, and any student will learn. Defining themes, such as classroom management, pedagogical intervention, and reflective conversation would allow instructors to reflect and refine their teaching practice. Also, if it is true that the new influx of students is not as prepared as earlier groups, how does this affect the population of incoming automotive instructors?

Future studies could include an investigation of instructor behavior based on the amount of time an instructor practiced in the field versus time spent as an educator. For example, does a certain behavior only emerge after ten years of teaching experience, or professional experience? The instructors, regardless of their experience, jumped in and dealt with the problem in real time. This willingness to improvise and overcome challenges appears to be embedded in the culture of automotive.

Three instructors even said (anonymously) that outside of getting the tools and vehicles reserved and available, they did not prepare for the actual class. They just had an idea of what they wanted the students to learn, and they just let them work and provided assistance to the students when they ran into trouble. After watching them perform, I contend that the instructors are much more prepared than they give themselves credit and do much more long-term preparation for lab instruction. I would like to see research that addresses the long-term preparation of master instructors.

Conclusion

In this chapter, I have discussed how this study of automotive technology instructors aligns with and enhances the current literature on career technical education and its implications for educational leaders and future research. This study also highlights the importance of taking a balanced view of career technical education and writing curriculum with the complexity in mind.

While this study has demonstrated that the instructor is modeling behavior to the student in every area of practice, its focus is not directly related to the students or the act of teaching as much as it is a look at the experience of instructors, and how their perceptions can lead to insights about teaching practice. After observing and exploring the levels of interactions between the faculty and students, it became clear to me that automotive technology requires just as much artistry as other fields. However, within the confines of career/technical education, what is directly observable is not always the most important. Technical rationality satiates the untrained observer, but to use a well-worn metaphor, it is only the tip of the iceberg. The biggest asset to the student is the instructor who has a tacit understanding of the gravity of his or her actions and acts accordingly. The instructors observed in this study seemed to appropriately model certain behaviors that are critical to the student's success in the field, namely being able to navigate uncertainty and use logic to solve problems, but also bending to the will of technical rationality when necessary.

My attitudes concerning teaching and learning developed throughout my academic career as I attended many different forms of education from highly technical (engine rebuilding) to highly reflective (creative writing). As I started my undergraduate work in Occupational Training and Human Resource Development, I began to see a pattern of the technical versus the reflective regarded as opposing forces. In my graduate work in Technology Enhanced Learning, I developed ideas about the purely technical aspects of teaching and learning—the instructor

engaged more as an administrator of the highly-structured curriculum. Based on this experience, technical means of education and reflective or abstract means of education are interwoven and rely on each other for meaningful education. The effective educator is one who can blend both the abstract and concrete when needed. The problem arises when this mental agility becomes the subject of quantification, and the subtleties of teaching practice are not recognized or nurtured. Through this study, I have attempted to add a different perspective to what many experts have touted as common sense, but in reality, only shows how removed they are from the nuts and bolts of teaching career/technical education.

Coda: The Influence of Schön

Donald Schön's *Reflective Practitioner* and follow up *Educating the Reflective Practitioner* are seminal works that would benefit anyone involved in career/technology education. After studying Schön and having the opportunity of working with a mentor who was a student and protégé of Schön at MIT, I can see many areas where I was able to, according to Schön's protégé, "produce truly important new insights into reflective practice as applied to a much neglected, even stigmatized area of professional practice" (N. Dale, personal communication, November 30, 2016). These new insights occurred when I discovered that, while Schön pushed for a strong divide between technical rationality and reflective practice, these two concepts are intertwined—especially when the stratification of professional skills and a non-homogenous student population are variables. A balanced curriculum is the key—if we consider educators like Robert Mager (1997) and Malcolm Knowles (1973), they are much more utilitarian and make broad generalizations about learning repeatable technical skills, which is very palatable to many educators who want to measure easily quantifiable outcomes. However, if we consider Schön's contributions, he is tapping into a learning ideology that is very difficult to quantify and does not always translate well to other areas of study. Yet, the more we study various professions through Schön's lens, the easier it will be to identify and relate to other professions.

Primarily, my work extends Schön's work through my identification of the dual role of verbalizing action in the reflective process. If an instructor verbalizes action during an activity it not only helps the instructor understand better the process of the action but also, if the students are witnessing the reflective process, it can increase the effectiveness of the modeling behavior. Schön talks about having the reflective conversation with yourself as you are engaged in action

and how this exchange increases learning, but the if the instructor involves the students, it becomes a teaching tool as well as a learning tool. I say that the lab instructors are leaving out a lot of modeling because they have not purposefully committed to practice. If the instructors are compelled to make the implicit aspects of the job explicit, I assert the student will start developing critical thinking skills. It is modeling abstract reasoning for the students, which is a necessary and highly sought skill in automotive diagnostic work. These are the skills that are being requested by the stakeholders, and I am certain that the case-specific evidence from this study will provide the argument for a unified goal of fostering this kind of diagnostic thought.

Another extension of Schön's work involves his assumption of a homogenous student population. Schön worked with design students, nursing students, psychologists, and several other professional students. These students and professional practitioners were very similar in educational background and experience, and Schön made certain assumptions about how these individuals think in action. However, in an open enrollment automotive program, a student does not need to have any specific qualifications other than a high school diploma or equivalent to be admitted to the college. An aspiring automotive technician could drop out of high school at 16 and get a job working as a professional automotive technician. Additionally, outside of a few states, there are no educational credentials or professional licensures required to perform automotive repair work. In fact, it is not unusual to have an automotive classroom with a student population consisting of high school graduates, students with GEDs, students who went to a career technical high school, students that have been working at an automotive dealership since high school. Additionally, some students were previously incarcerated, or are veterans, displaced workers, or hobbyists. When considering these different student backgrounds and experiences, it becomes clear that Schön's work does not address many of the impromptu

assessments and pedagogical interventions that are necessary to prepare diverse student populations for reflective practice.

Another extension of Schön's work deals with the symbolic power of the instructor. I was inspired by Schön's description of the architectural design instructor, Quist, who guided a student through a difficult design problem. Quist was communicating that it doesn't matter if the theory is correct. It is just a foundation to get started—something to prove or disprove. In other words, it is important in the experiential process to just start somewhere; it does not have to be correct, it just needs to be a starting place. It is this type of professional wisdom that inspires students to perform. Schön called out "the remarkable ability of humans to recognize more in the consequences of their moves than they have expected or described ahead of time" (Schön, 1991, p. 7). I believe that this can be used as a guide for the importance of transferring the skills to the students. It is reminiscent of an exchange between a former colleague and me. We were discussing a demonstration mishap, and subsequent embarrassment I encountered during a classroom demonstration. He said, "Don't ever tell the students *what* you are going to show them—just *do* the demonstration then *ask* them what just happened." He meant that an instructor will not always know if the outcome of a demonstration will work, but if he has the students watch with an element of mystery, he or she can walk the students through every step of a procedure without rigidly assuming the outcome, while preparing them to learn something new. This can also help the instructor maintain an air of credibility, which is crucial for the mentoring or coaching aspect of the student/teacher exchange. I assert that students will not be open to modeling if they think the instructor is incompetent, but the instructor also needs to balance their confidence and competence with vulnerability. The student must believe that they can achieve what the instructor has achieved in practice; otherwise the exchange is meaningless.

This work further extends Schön's work as it identifies stratified levels of reflection due to the pronounced stratification of the automotive repair industry itself. One of the instructors in this study hypothesized that 90 percent of the work that the automotive student does once they get a job in the automotive field are low-level repetitive tasks. The automotive technician will be doing the same things over and over. Even the highest performing automotive technicians will find themselves engaged in lower level tasks such as changing oil, mounting and balancing tires, or replacing worn brake pads. This type work is normally lockstep and consists of a short list of steps. However, approximately 10% of the work an automotive technician encounters is considered expert level. These are tasks dealing with microelectronics involved with fuel and emissions systems, or electronic/hydraulic systems in automatic transmission or antilock brakes/traction control systems, which are complex systems that require a high level of abstract thought to diagnose. Personally, I recall mopping floors the same day that I diagnosed complex electronics with an oscilloscope. This seems to be a unique situation when compared to other professions. However, because I have not worked in other professions, even if I immersed myself in the practice of another profession during research, I am certain I would not completely develop the tacit understandings of a different professional field. Therefore, it is important to generate specific cases for each profession and attempt to surface the tacit understandings of the artisans of the profession. While Schön studied professional practice, he did not practice design or psychotherapy. With automotive technology or similar hands-on/knowledge work it is important to think on multiple levels. A former mentor asked me, what makes a mechanic any different from a janitor? Well, the truth is—sometimes nothing. But since, more than 20 years ago, the technology in some automotive systems has surpassed the technology used to explore

space, it would also be fair to ask, what makes a mechanic any different from an aerospace technician? Again—sometimes nothing.

By offering his unique perspective, Schön has improved the canon of professional practice and educational assessment. However, the problem I have encountered throughout my automotive career is not a lack of appropriate answers from the practitioners but the inability of the outsider to ask the appropriate questions. If the focus of assessments is the right questions, then an effective assessment ideology for educational research will certainly emerge. The fact that I found scholars such as Nelsen (1997, 2010), Barber (2003, 2004), and Threeton and Walter (2009), as well as other scholars who specifically addressed the cultural and professional practices of automotive technicians, gave voice to an underrepresented group in academia. Much like the automotive students, the instructors are not as likely to improve their practice if they do not see the relevance to the training. I assert that awareness of the stratification of skill and the instructors' perceptions of student learning will draw attention to specific methods of skill development and improve the quality of automotive technology instruction.

I will continue to promote the use of the Career/Technical Reflective Practice Model with fellow practitioners to foster a fuller understanding of our own profession and practice. I hope that promoting the concept of the transfer of artistry from master automotive instructors to the students will become a cultural trend and better define the professional roles and associate those roles with the artistry within automotive technology programs. As such, an appropriate quote to end this study comes from Schön (1971): "The artist gives us new ways of looking at our experience, new ways of defining ourselves in relation to reality, and in the process, frees our awareness of phenomena incompatible with settled theory" (pp. 131–132).

Appendix

Appendix A: Recruitment Letter

4516 Pensacola Blvd
Moraine, OH 45439
May 16, 2017

Dear Professor,

My name is John Porter, and I am a Ph.D. student at Antioch University. I am conducting research aimed at understanding automotive instructors' perceptions of their own improvisational skills while navigating situations that occur during hands-on laboratory activities.

If you agree to participate in this study, *Navigating Uncertainty in Automotive Technology Instruction: The Subjective Experiences of Automotive Instructors during Laboratory Activities,* I will be video recording segments of your class and later interviewing you based on these observations. This study is not involved in evaluating your teaching methods in any way; rather it is more about your perceptions as a professional instructor as you observe your own teaching practices.

You are being asked to participate because of your position and experience as an instructor of automotive technology.

The time required as a participant includes approximately one hour of video observations in an automotive lab and a one-hour follow-up interview. You will not be required to do anything during the observation period outside of your usual teaching practice. If possible, the interview will be scheduled within 48 hours of the observation. During the interview, you will be reflecting on short video clips taken from the observation. You will also have the opportunity to reflect on any moment during the observation that you feel is significant.

In addition, you will be asked to review the results of the interview for accuracy.

This study is voluntary. If you agree to participate in this study, you will still have the option of leaving the study for any reason or at any time.

To participate in this study, or if you have any questions about the study, please feel free to call me at (xxx)xxx-xxxx or email xxxxxxx@xxxxx.edu

Kind regards,

John Porter

Appendix B: Informed Consent Form

Consent for Participation in Interview Research

I volunteer to participate in a research project conducted by Professor John Porter from Sinclair College. I understand that the project is designed to gather information about teaching practices of faculty within the automotive technology program. I will be one of approximately twelve people being interviewed.

1. My participation in this project is voluntary. I understand that I will not be paid for my participation. I may withdraw and discontinue participation at any time without penalty. If I decline to participate or withdraw from the study, no one on my campus will be told.

2. If during this research I feel uncomfortable in any way, I have the right to decline to answer any question or to end the interview.

3. Participation involves being videotaped in a live classroom interaction and then interviewed within 48 hours by the researcher, John Porter, from xxxxxxxxxx College. The video recording of the class will last approximately one hour, and the following interview will last approximately one hour. Notes will be written during the interview. A video and audio tape of the classroom interaction and an audio tape of the interview and subsequent dialogue will be made. If I do not want to be recorded, I will not be able to participate in the study.

4. I understand that the researcher will not identify me by name in any reports using information obtained from this interview and that my confidentiality as a participant in this study will remain secure. Subsequent uses of records and data will be subject to standard data use policies that protect the anonymity of individuals and institutions.

5. Faculty and administrators from my campus will neither be present at the interview nor have access to raw notes or transcripts. This precaution will prevent my individual comments from having any negative repercussions.

6. I understand that this research study has been reviewed and approved by the Institutional Review Board (IRB) for Studies Involving Human Subjects: Antioch University. For research problems or questions regarding subjects, the Institutional Review Board may be contacted through [information of the contact person at IRB office of Antioch University].

7. I have read and understand the explanation provided to me. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.

Signature_____Date _____

Printed Name _____

Signature of Investigator _____

For further information, please contact:

John M. Porter
xxxxxxxxxx College
xxxxxxxxxx Street
xxxxxxxxxxxxxxxxxxxxxxx
Email: xxxxxxxx@xxxxxxxx.edu
Phone: (xxx) xxx-xxxx

Appendix C: Precision Measurement Lab Sheet

Name:

Date:

Meeting Day and Time:

Automotive Technology 1100

Measurement Lab Activity

1. Torque the wheels on the supplied shop car to the manufacturers recommended torque spec and pattern.

   Torque Spec:

   Draw a picture of the pattern used to torque the wheels below

2. Measure the brake rotor provided.
   Measurement: _____
   Using the specifications for a 2012 Ford Fusion 4cyl rear brake rotor, can this rotor be machined? (Dial Caliper)
   Rear Brake Rotor Thickness Spec: _____

3. Measure the thickness of the stem for the valve provided. Compare this to the spec for the intake valve for a 2004 Chevy Aveo 1.6L. Based on the diameter of the stem alone, can this valve be reused?
   Measurement: _____
   Spec: _____

4. (Dial Caliper) Measure the depth of the material of the provided clutch disk to the rivets. Will this disk be reusable for a 2002 Ford Mustang GT 4.6LV8?
   Measurement:_____
   Spec:_____
5. (Dial Caliper) Measure the length (without the head) and the size of the head of the fastener provided.

   Measurement: _____

   What size wrench or socket will be used to remove this fastener?

6. (Micrometer) Measure the thickness of the cylinder head gasket

Measurement: _____

7. (Micrometer) Measure the thickness of the piston ring
   Measurement: _____

8. (Dial Caliper) Measure the height of the valve spring
   Measurement: _____

9. (Micrometer)Measure the diameter of the lifter
   Measurement: _____

10. (Dial Caliper) Measure the Height of the servo provided
    Measurement: _____

11. (Dial Caliper) Measure the inside of the connecting rod where the wrist pin would be
    Measurement: _____

12. (Micrometer) Measure the thickness of the shim
    Measurement: _____

13. (Dial Caliper) Measure the socket provided across the opening that is used to remove the fastener from the center of the flat to the center of the opposite flat.
    Measurement: _____
    Convert the size of the socket as it is labeled to decimal and find the difference between the measured and labeled size
    (Decimal equivalent) _____ - (measured) _____ = _____

References

Adams, R. S., Turns, J., & Atman, C. J. (2003). Educating effective engineering designers: The role of reflective practice. *Design Studies*, *24*(3), 275–294. https://doi.org/10.1016/S0142-694X(02)00056-X

Argyris, C., & Schön, D. A. (1974). *Theory in practice: Increasing professional effectiveness.* San Francisco, CA: Jossey-Bass.

Bain, K. (2004). *What the best college teachers do.* Cambridge, MA: Harvard University Press.

Bandura, A. (1977). *Social learning theory.* New York, NY: General Learning Press.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive.* Englewood Cliffs, NJ: Prentice Hall.

Barber, J. (2003). The informally trained mechanic: Skill acquisition. *Journal of Vocational Education and Training*, *55*(2), 133–348. https://doi.org/10.1080/13636820300200222

Barber, J. (2004). Skill upgrading within informal training: Lessons from the Indian auto mechanic. *International Journal of Training and Development*, *8*(2), 128–39. https://doi.org/10.1111/j.1468-2419.2004.00202.x

Bauder, H. (2001). 'You're good with your hands, why don't you become an auto mechanic': Neighborhood context, institutions and career development. *International Journal of Urban and Regional Research*, *25*(3), 593–608. https://doi.org/10.1111/1468-2427.00331

Beck, A., Kerschbamer, R., Qiu, J., Sutter, M. (2013). Car mechanics in the lab: Investigating the behavior of real experts on experimental markets for credence goods. *Working Papers in Economics and Statistics*, No. 2014-02. https://doi.org/10.1016/j.jebo.2014.09.008

Benner, P. (1982). From Novice to Expert. *The American Journal of Nursing, 82*(3), 402–407. https://doi.org/10.2307/3462928

Berk, R. A. (2005). Survey of 12 strategies to measure teaching effectiveness. *International Journal of Teaching and Learning in Higher Education*, *17*(1), 48–62. Retrieved from http://www.physics.emory.edu/faculty/weeks/journal/berk-ijtlhe05.pdf

Berry, A. (2009). Professional self-understanding as expertise in teaching about teaching. *Teachers and Teaching: Theory and Practice*, *15*(2), 305–318. https://doi.org/10.1080/13540600902875365

Blackwell, A., Bowes, L., Harvey, L., Hesketh, A. J., & Knight, P. T. (2001). Transforming work experience in higher education. *British Educational Research Journal*, *27*(3), 269–285. https://doi.org/10.1080/01411920120048304

Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development.* Los Angeles, CA: Sage.

Brock, S. E. (2009). Measuring the importance of precursor steps to transformative learning. *Adult Education Quarterly*, *60*(2), 122–142. https://doi.org/10.1177/0741713609333084

Brookfield, S. D. (1995). *Becoming a critically reflective teacher.* San Francisco, CA: Jossey-Bass.

Brookfield, S. D. (2000). Transformative learning as ideology critique. In J. Mezirow & Associates (Eds.), *Learning as transformation: Critical perspectives on a theory in progress* (pp. 125–148). San Francisco, CA: Jossey-Bass.

Bull, C. N., & Whittle, J. (2014). Supporting reflective practice in software engineering education through a studio-based approach. *IEEE Software*, *31*(4), 44–50. https://doi.org/10.1109/MS.2014.52

Campbell, J. (1968). *The hero with a thousand faces.* Princeton, NJ: Princeton University Press.

Canning, R. (2011). Reflecting on the reflective practitioner: Vocational initial teacher education in Scotland. *Journal of Vocational Education & Training*, *63*(4), 609–617. https://doi.org/10.1080/13636820.2011.560391

Carson, F. (2008). Utilizing video to facilitate reflective practice: Developing sports coaches. *International Journal of Sports Science & Coaching*, *3*(3), 381–390. https://doi.org/10.1260/174795408786238515

Cash, J. R., Behrmann, M. B., Stadt, R. W., & Daniels, H. M. (1997). Effectiveness of cognitive apprenticeship instructional methods in college automotive technology classrooms. *Journal of Industrial Teacher Education, 34*(2), 29–49. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=eft&AN=507551661&site=ehost-live&scope=site

Charette, R. N. (2009). This car runs on code. *IEEE Spectrum*, *46*(3), 3. Retrieved from http://www.real-programmer.com/interesting_things/ieee%20spectrumthiscarrunsoncode.pdf

Chrislip, D. D., & Larson, C. E. (1994). *Collaborative leadership*. San Francisco: Jossey-Bass.

Crawford, M. B. (2009). *Shop class as soulcraft: An inquiry into the value of work.* New York, NY: Penguin.

Creswell, J. W. (2002). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research.* Upper Saddle River, NJ: Prentice Hall.

Creswell, J. W. (2013). *Research design: Qualitative, quantitative, and mixed methods approaches.* Los Angeles, CA: Sage.

Creswell, J. W., & Clark, V. L. P. (2011). *Designing and conducting mixed methods research.* (2nd ed.). Los Angeles, CA: Sage.

Crow, J., & Smith, L. (2005). Co-teaching in higher education: Reflective conversation on shared experience as continued professional development for lecturers and health and social care students. *Reflective Practice*, *6*(4), 491–506. https://doi.org/10.1080/14623940500300582

Dant, T., & Bowles, D. (2003). Dealing with dirt: Servicing and repairing cars. *Sociological Research Online*, *8*(2). Retrieved from http://www.socresonline.org.uk/8/2/dant.html

Dawes, L. (1999). Enhancing reflection with audiovisual playback and trained inquirer. *Studies in Continuing Education*, *21*(2), 197–215. https://doi.org/10.1080/0158037990210204

Dewey, J. (1916). *Democracy and education: An introduction to the philosophy of education*. New York, NY: Macmillan.

Dewey, J. (1931). *Philosophy and civilization.* New York, NY: Minton Balch.

Dewey, J. (2005). *Art as experience*. New York, NY: Penguin. (Original work published 1934).

Dewey, J. (2007). *Experience and education.* New York, NY: Simon and Schuster. (Original work published 1938).

Dreyfus, S. E., & Dreyfus, H. L. (1980). A five-stage model of the mental activities involved in directed skill acquisition (No. ORC-80-2). California University Berkeley Operations Research Center. Retrieved from http://www.dtic.mil/get-tr-doc/pdf

Edwards, G., & Thomas, G. (2010). Can reflective practice be taught? *Educational Studies*, *36*(4), 403–414. https://doi.org/10.1080/03055690903424790

Egger-Biniores, D. (2007). The alchemy of training. *Journal of Analytical Psychology*, *52*(2), 143–155. https://doi.org/10.1111/j.1468-5922.2007.00649.x

Eraut, M. (2000). Non-formal learning and tacit knowledge in professional work. *British Journal of Educational Psychology, 70*(1), 113–136. https://doi.org/10.1348/000709900158001

Ergas, O. (2014). Mindfulness in education at the intersection of science, religion, and healing. *Critical Studies in Education*, *55*(1), 58–72. https://doi.org/10.1080/17508487.2014.858643

Finn, A. N., Schrodt, P., Witt, P. L., Elledge, N., Jernberg, K. A., & Larson, L. M. (2009). A meta-analytical review of teacher credibility and its associations with teacher behaviors and student outcomes. *Communication Education*, *58*(4), 516–537. https://doi.org/10.1080/03634520903131154

Flyvbjerg, B. (2001). *Making social science matter: Why social inquiry fails and how it can succeed again.* Cambridge, MA: Cambridge University Press.

Goldhaber, D. (2002). The mystery of good teaching: Surveying the evidence on student achievement and teachers' characteristics. *Education Next*, *2*(1), 1–7. Retrieved from http://www.nuatc.org/articles/pdf/mystery_goodteaching.pdf

Goldhaber, D., & Anthony, E. (2007). Can teacher quality be effectively assessed? National board certification as a signal of effective teaching. *The Review of Economics and Statistics*, *89*(1), 134–150. https://doi.org/10.1162/rest.89.1.134

Graen, G. B., & Uhl-Bien, M. (1995). Relationship-based approach to leadership: Development of leader-member exchange (LMX) theory of leadership over 25 years: Applying a multi-level multi-domain perspective. *Leadership Quarterly, 6*(2), 219–247. https://doi.org/10.1016/1048-9843(95)90036-5

Graham, L. G. (2010). *What is it like to be funny? The spontaneous humor producer's subjective experience* (Doctoral dissertation, Antioch University). Retrieved from http://rave.ohiolink.edu/etdc/view?acc_num=antioch1275056868

Granger, D. A. (2006). *John Dewey, Robert Pirsig, and the art of living: Revisioning aesthetic education.* New York, NY: Palgrave Macmillian.

Grimmett, P. P. (1989). A Commentary on Schon's View of Reflection. *Journal of Curriculum and Supervision*, *5*(1), 19–28. Retrieved from http://antioch.idm.oclc.org/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=ehh&AN=48151161&site=ehost-live&scope=site

Guest, G., MacQueen, K. M., & Namey, E. E. (2012). *Applied thematic analysis.* Los Angeles, CA: Sage.

Hanh, T. N. (2011). *Anger: Buddhist wisdom for cooling the flames.* New York, NY: Random House.

Hanson, J. (2001). Morphology and design: Reconciling intellect, intuition, and ethics in the reflective practice of architecture. *Proceedings of the 3rd International Space Syntax Symposium. Seoul, South Korea:* Space Syntax Network. Retrieved from http://discovery.ucl.ac.uk/1024/1/hanson-2001-morph.pdf

Hersey, P., & Blanchard, K. H. (1977). *Management of organizational behavior*. Englewood Cliffs, NJ: Prentice-Hall.

Hersey, P., Blanchard, K. H., & Natemeyer, W. E. (1979). Situational leadership, perception, and the impact of power. *Group & Organization Management, 4*(4), 418–428. https://doi.org/10.1177/105960117900400404

Heyman, G. A., & Daly, E. R. (1992). Teaching critical thinking in vocational–technical and occupational classes. In C. A. Barnes (Ed.), *Critical thinking: Educational imperative, New directions for community colleges,* No. 77 (pp. 103–108). San Francisco, CA: Jossey-Bass.

Hobbs, V. (2007). Faking it or hating it: Can reflective practice be forced? *Reflective Practice*, *8*(3), 405–417. https://doi.org/10.1080/14623940701425063

Hodkinson, P. (1992). Alternative models of competence in vocational education and training. *Journal of Further and Higher Education*, *16*(2), 30–39. https://doi.org/10.1080/0309877920160204

Hughes, E. C. (1958). *Men and their work.* Toronto, Canada: Collier-Macmillan.

Hyslop-Margison, E. J., & Armstrong, J. L. (2004). Critical thinking in career education: The democratic importance of foundational rationality. *Journal of Career & Technical Education*, *21*(1), 39–49. Retrieved from https://files.eric.ed.gov/fulltext/EJ1069498.pdf

Ilgen, D. R., Hollenbeck, J. R., Johnson, M., & Jundt, D. (2005). Teams in organizations: From input-process-output models to IMOI models. *Annual Review of Psychology, 56*(1), 517–543. https://doi.org/10.1146/annurev.psych.56.091103.070250

Ixer, G. (1999). There's no such thing as reflection. *The British Journal of Social Work*, *29*(4), 513–527. https://doi.org/10.1093/bjsw/29.4.513

Jackson, P., & Chang, D. (2013). The influence of transformation in effective training: Perspectives from trainers in the field. *Conference Proceedings From Adult Education Research Conference 2013.* St. Louis, MO: Kansas State University.

Jacob, S. A., & Furgerson, S. P. (2012). Writing interview protocols and conducting interviews: Tips for students new to the field of qualitative research. *The Qualitative Report*, *17*(42), 1–10. Retrieved from http://nsuworks.nova.edu/tqr/vol17/iss42/3

Jarvis, P. (1993). *Adult education and the state: Towards a politics of adult education*. York, England: Urban Media.

Jarvis, P. (1995). *Adult and continuing education: Theory and practice*. Hove, England: Psychology Press.

Jarvis, P. (2012). *Paradoxes of learning: On becoming an individual in society*. London, England: Routledge.

Jung, C. G. (1969). Archetypes and the collective unconscious. In H. Read, M. Fordham, G. Adler, & W. McGuire (Eds.), *The collected works of C.G. Jung*. Vol. 9. Princeton, NJ: Princeton University Press.

Jung, C. G. (1971). Psychological types, In H. Read, M. Fordham, G. Adler, & W. McGuire (Eds.), *The collected works of C.G. Jung*. Vol. 6. Princeton, NJ: Princeton University Press.

Kagan, N. I. (1995) *Interpersonal Process Recall Series.* [Video Series]. Alexandria, VA: Microtraining Associates. Retrieved from https://www.academicvideostore.com/video-collection/interpersonal-process-recall-series-full

Kagan, N. I., & Kagan, H. (1990). IPR: A validated model for the 1990s and beyond. *The Counseling Psychologist*, *18*(3), 436–440. https://doi.org/10.1177/0011000090183004

Kagan, N. I., & Kagan, H. (1991). *Interpersonal process recall*. Hoboken, NJ: John Wiley & Sons.

Kagan, N., Krathwohl, D. R., & Miller, R. (1963). Stimulated recall in therapy using videotape–A case study. *Journal of Counseling Psychology, 10*(3), 237–243. https://doi.org/10.1037/h0045497

Kahneman, D. (2011). *Thinking, fast and slow.* New York, NY: Farrar, Straus, and Giroux.

Kelchtermans, G. (2009). Who I am in how I teach is the message: Self-understanding, vulnerability and reflection. *Teachers and Teaching: Theory and Practice*, *15*(2), 257–272. https://doi.org/10.1080/13540600902875332

Kincheloe, J. L. (2006). A critical complex epistemology of practice. *Taboo*, *10*(2), 85–98. Retrieved from http://freireproject.org/wp-content/journals/taboo/TabooVolume10 Number2.pdf#page=86

Knowles, M. (1973). *The adult learner: A neglected species*. Houston, TX: Gulf Publishing.

Knowles, Z., Gilbourne, D., Borrie, A., & Nevill, A. (2001). Developing the reflective sports coach: A study exploring the processes of reflective practice within a higher education coaching programme. *Reflective Practice*, *2*(2), 185–207. https://doi.org/10.1080/14623940120071370

Komives, S., Lucas, N., & McMahon, T. (1998). *Exploring leadership for college students who want to make a difference.* San Francisco, CA: Jossey-Bass.

Ladany, N., & Inman, A. G. (2012). Training and supervision. In E. Altmaier & J. Hansen (Eds.), *Oxford handbook of counseling psychology,* (pp. 79–207). New York, NY: Oxford University Press.

Lewis, M. V., & Gill, L. (1995). The effects of standards on learning in automotive repair programs. *A third-party summative evaluation of the standards established by the national institute for automotive service excellence.* Columbus, OH: Ohio State University Center on Education and Training for Employment.

Mager, R. F. (1997). *Making instruction work or skillbloomers: A step-by-step guide to designing and developing instruction that works.* Atlanta, GA: The Center for Effective Performance.

Mager, R. F. (2012). *Life in the pinball machine: Careening from there to here.* Carefree, AZ: Mager Associates.

Markus, H., & Nurius, P. (1986). Possible selves. *American Psychologist*, *41*(9), 954–969. https://doi.org/10.1037/0003-066X.41.9.954

Mayes, C. (2005). *Jung and education: Elements of an archetypal pedagogy*. Lanham, MD: Roman and Littlefield.

Mayes, C. (2007). *Inside education: Depth psychology in teaching and learning*. Madison, WI: Atwood Publishing.

Mayes, C. (2010). *The archetypal hero's journey in teaching and learning: A study in Jungian pedagogy*. Madison, WI: Atwood Publishing.

McGowan, W. R., & Graham, C. R. (2009). Factors contributing to improved teaching performance. *Innovative Higher Education*, *34*(3), 161–171. https://doi.org/10.1007/s10755-009-9103-6

Merriam, S. B. (2004). The role of cognitive development in Mezirow's transformational learning theory. *Adult Education Quarterly*, *55*(1), 60–68. https://doi.org/10.1177/0741713604268891

Mezirow, J. (1978). Perspective transformation. *Adult Education Quarterly*, *28*(2), 100–110. https://doi.org/10.1177/074171367802800202

Mezirow, J. (1990). How critical reflection triggers transformative learning. In J. Mezirow and Associates (Eds.), *Fostering critical reflection in adulthood*, 1–20. San Francisco, CA: Jossey-Bass.

Mezirow, J. (1991). *Transformative dimensions of adult learning*. San Francisco, CA: Jossey-Bass.

Miller, D. (1996). A fire in the mind: An evaluation of Joseph Campbell's creative and intellectual influence. In J. Young (Ed.), *Saga: Best new writings on mythology*, 55–67. Ashland, OR: White Cloud Press.

Mortari, L. (2012). Learning thoughtful reflection in teacher education. *Teachers and Teaching*, *18*(5), 525–545. https://doi.org/10.1080/13540602.2012.709729

Myers, S. A. (2001). Perceived instructor credibility and verbal aggressiveness in the college classroom. *Communication Research Reports*, *18*(4), 354–364. https://doi.org/10.1080/08824090109384816

Myers, S. A., & Bryant, L. E. (2004). College students' perceptions of how instructors convey credibility. *Qualitative Research Reports in Communication*, *5*(1), 22–27. Retrieved from http://web.a.ebscohost.com.antioch.idm.oclc.org/ehost/pdfviewer/pdfviewer?vid=5&sid=8e65c413-2efd-40a9-a71a-e3035f8b3425%40sessionmgr4008

Myers, S. A., & Martin, M. M. (2006). Understanding the source: Teacher credibility and aggressive communication traits. *Handbook of instructional communication: Rhetorical and relational perspectives*, 67–88.

Nelsen, B. J. (1997). Should social skills be in the vocational curriculum? Evidence from the automotive repair field. In A. Lesgold, M. J. Feuer, & A. Black (Eds.), *Transitions in work and learning: Implications for assessment* (pp. 62–88). Washington, DC: National Academy Press.

Nelsen, B. J. (2010). *The cultural and social challenges of technical service work: Observations from the field of automotive repair*. Saarbruken, Germany: Lap Lambert Publishing.

Osborn, R. N., Hunt, J. G., & Jauch, L. R. (2002). Toward a contextual theory of leadership. *The Leadership Quarterly*, *13*(6), 797–837. https://doi.org/10.1016/S1048-9843(02)00154-6

Osterman, K. F., & Kottkamp, R. B. (1993). *Reflective practice for educators*. Thousand Oaks, CA: Corwin Press.

Petress, K. (2004). Critical thinking: An extended definition. *Education*, *124*(3), 461–466. Retrieved from http://antioch.idm.oclc.org/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=a9h&AN=13186516&site=ehost-live&scope=site

Pirsig, R. M. (1974). *Zen and the art of motorcycle maintenance.* New York, NY: Bantam.

Polanyi, M. (1966). *The tacit dimension.* London, UK: Routledge & Kegan Paul Ltd.

Porter, J. M. (2013). *Why good programs fail: A study of the Livonia Motech Center.* Unpublished manuscript, Graduate School of Leadership and Change, Antioch University Midwest, Yellow Springs, OH.

Powell, J. H. (1989). The reflective practitioner in nursing. *Journal of Advanced Nursing*, *14*(10), 824–832. https://doi.org/10.1111/j.1365-2648.1989.tb01467.x

Program Standards (n.d.). Retrieved from http://www.natef.org/achieving-accreditation/program-standards.aspx

Redmond, B. (2004). *Reflection in action: Developing reflective practice in health and social services*. Burlington, VT: Ashgate.

Roberts, A. (2009). Encouraging reflective practice in periods of professional workplace experience: The development of a conceptual model. *Reflective Practice*, *10*(5), 633–644. https://doi.org/10.1080/14623940903290703

Russell, T. (2005). Can reflective practice be taught? *Reflective Practice*, *6*(2), 199–204. https://doi.org/10.1080/14623940500105833

Saldaña, J. (2015). *The coding manual for qualitative researchers*. Los Angeles, CA: Sage.

Savin, S. (2007). *Autotronics: Implications for automotive related training programs standards based upon emerging technologies* (Doctoral dissertation, Oregon State University). Retrieved from https://ir.library.oregonstate.edu/downloads/zg64tp11w

Schön, D. A. (1971). *Beyond the stable state*. London, England: Temple Smith.

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. New York, NY: Basic.

Schön, D. A. (1987). *Educating the reflective practitioner*. San Francisco, CA: Jossey-Bass.

Schön, D. A. (1991). Designing as reflective conversation with the materials of a design situation. *Knowledge-Based Systems*, *5*(1), 3–14. https://doi.org/10.1016/0950-7051(92)90020-G

Schussler, D. L., Stooksberry, L. M., & Bercaw, L. A. (2010). Understanding teacher candidate dispositions: Reflecting to build self-awareness. *Journal of Teacher Education*, *61*(4), 350–363. https://doi.org/10.1177/0022487110371377

Shoemaker, B. (1989). *Report to NATEF board of trustees on certification and update training*. National Automotive Technicians Education Foundation, Herndon, VA.

Stone, I. F. (1989). *The trial of Socrates*. New York, NY: Anchor.

Thomson, P. (1991). Competency-based training: Some development and assessment issues for policy makers. *TAFE Journal of Research and Development*, *6*(2), 38–45.

Threeton, M. D., & Walter, R. A. (2009). Automotive technology student learning styles and their implications for faculty. *Journal of Industrial Teacher Education*, *46*(2), 48–74. Retrieved from https://files.eric.ed.gov/fulltext/EJ887444.pdf

Thurlow, A. (2014). Sputtering auto education leads to skills breakdown: New techs don't have training they need, service managers say. *Automotive News*, (6621), 40. Retrieved from http://www.autonews.com/article/20140519/RETAIL05/305199975/sputtering-auto-education-leads-to-skills-breakdown

Tremmel, R. (1993). Zen and the art of reflective practice in teacher education. *Harvard Educational Review*, *63*(4), 434–459. https://doi.org/10.17763/haer.63.4.m42704n778561176

Wang, V., & King, K. P. (2006). Understanding Mezirow's theory of reflectivity from Confucian perspectives: A model and perspective. *Radical Pedagogy*, *8*(1), 1–17. Retrieved from http://www.radicalpedagogy.org/radicalpedagogy94/Understanding_Mezirows_Theory_of_Reflectivity_from_Confucian_Perspectives__A_Model_and_Perspective.html

Wiblin, J. (1993). *The relationship between automotive service excellence certification and the Ohio vocational education achievement test scores.* (Doctoral Dissertation, The Ohio State University). Retrieved from https://etd.ohiolink.edu/rws_etd/document/get/osu1392025460/inline

Wurdinger, S. D., & Carlson, J. A. (2010). *Teaching for experiential learning: Five approaches that work.* Lanham, MD: Rowman & Littlefield.

Young, S., & Shaw, D. G. (1999). Profiles of effective college and university teachers. *The Journal of Higher Education*, *70*(6), 670–686. https://doi.org/10.1080/00221546.1999.11780803