ATHABASCA UNIVERSITY

TEACHING PSYCHOMOTOR SKILLS TO PARAMEDIC STUDENTS

BY

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The future of learning.

Approval of Thesis

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Abstract

Paramedic education incorporates the development of cognitive, affective and psychomotor skills. As distance education in paramedic training evolves, it is critical that we design and evaluate learning activities to ensure effective outcomes are realized in each of the above domains. This thesis represents a sequential explanatory study of the importance instructional design principles have on learning a skill through distance education. Even though, based on this study, the quantitative results did not show any statistically significant correlation between instructional design principles and improved skill transmission, the qualitative part helped explain the findings. As such, five recommendations were suggested which mainly focused on achieving better filming procedures, increasing the realism of distance education training, investigating evaluator differences, studying the connection between learning module navigation and translation of knowledge and the importance videotaped self-evaluated practice has in skill transmittal and retention.

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Chapter I: Introduction

Paramedic educational programs are presently increasing their distributive learning (DL) offerings, a trend which mimics wider instructional and demographical demands (Department of Education, Training and Youth Affairs. Higher Education Division. Australia, 2001). Distributive learning, "or learning at a distance", "takes place when: a student is primarily at a distance from the teacher, whether he/she is at home; or connected to the teachers from another learning facility" (Ministry of Education. British Columbia., n.d.).

Interviews with paramedic faculty involved in various distance education (DE) courses, found that, in prehospital education, psychomotor skill transmission, unlike cognitive or affective training, does not currently have a purely distance learning presence (Grant, 2010; Hofmann, 2010; Lemieux, 2010). As a direct result of these discussions, a specific interest in improving paramedic psychomotor skill delivery in an online environment was generated.

The present paper tried to elucidate the role instructional design principles have in offering pertinent psychomotor training through distance education. The thesis focused on comparing results obtained by students trained using a learning module built based on instructional design (ID) principles and students trained using a module built without the use of any instructional design principles (NID).

Rationale for the Present Study

Distance Education and Paramedic Training

In the recent past, distance education was based on paper and cassette correspondence. With modern advances in electronics and Internet connectivity, this mode of DE delivery has become expensive and inefficient. The e-learning institutions of today "support a learning process that is interactive, non-linear and collaborative" (Department of Education, Training and Youth Affairs. Higher Education Division. Australia, 2001). Educational interactions are done through online classrooms and course modules which support the trend of constantly connected "intelligent flexible learning" (Department of Education, Training and Youth Affairs. Higher Education Division. Australia, 2001). Even more, technologies seem to constantly evolve and now mobile learning is gaining momentum as an integral part of distance education (Gilkas & Grant, 2013; Motiwalla, 2007). Not only courses but also student services are customized for individual needs, all done through computer based modalities, in a manner which is not only physically but also fiscally appealing to student populations (Department of Education, Training and Youth Affairs. Higher Education Division. Australia, 2001). This makes online DE both convenient and affordable as an option for continuing education (Department of Education, Training and Youth Affairs. Higher Education Division. Australia, 2001).

Distance education successfully addresses the cognitive and the affective domains of training but is less prevalent in psychomotor learning (Forehand, 2005). The same holds true in paramedic DE; however the need for skill education in paramedics makes psychomotor learning a domain of interest for further research (Grant, 2010; Hofmann, 2010; Lemieux, 2010).

Paramedic Psychomotor Skills

Paramedic psychomotor skills have different degrees of complexity (Paramedic Association of Canada, 2001), which vary from splinting modalities to advanced airway manoeuvres. A previous study by Morrison (2002) showed that a simple psychomotor skill can be successfully delivered by using a distributive environment suggesting that "future research could focus around more complex psychomotor tasks, such as the starting of an intravenous, endotracheal intubation or emergency needle thoracocentesis" (Morrison, 2002).

The present study 1. is based on an expressed need, 2. comes as a natural conclusion of previous research and 3. will investigate the teaching-learning realities of distance delivery for a complex paramedic psychomotor skill. All three previously mentioned skills – intubation, venipuncture and thoracocentesis – are arguably the most complex hands-on activities in the scope of practice of Canadian paramedics (Paramedic Association of Canada, 2001). Endotracheal intubation was chosen as the complex skill to investigate in this study, since it does not require the use of sharp objects which might directly injure the students. Both venipuncture and thoracocentesis make use of needles capable of piercing the skin if inappropriately used.

Intubation – Skill Versus Procedure

Intubation has been recognized as a controlled medical act (The College of Physicians and Surgeons of Ontario, 2010) based on the inherent complexity and the delicate nature of the procedure. A clear differentiation is needed at the present time

between the skill of intubation and the procedure of intubation as the latter combines the mechanical skill with other higher order cognitive decisions (Hofmann, 2011). Deciding to intubate a patient is different than intubating a patient. As a matter a fact, one can make the decision that intubation is needed, without even having the skill to physically do it. For example, in the prehospital world, primary care crews could determine the need for a patient to be intubated and request the presence of advanced crews at a specific scene.

In order to allow the present paper to focus on psychomotor skills alone, intubation will be defined as the mechanical act of "putting an instrument […] beyond the larynx" (The College of Physicians and Surgeons of Ontario, 2010), and will not include the higher order cognitive decisions surrounding the need for intubation. The instrument in this case is an endotracheal tube which will be inserted orally with the help of a laryngoscope.

Intubation Instruction

Traditionally the psychomotor skill of intubation has been taught in a face-to-face (F2F) simulated environment. Typically an instructor takes a small group of students through a brief theoretical summary of the psychomotor skill, followed by a hands on session in which the expert demonstrates and the students replicate. Feedback is usually offered as needed and multimedia or video demonstrations are sometimes used to enhance learning. The students are offered the chance to self-practice and are then tested for competency in a simulated environment before moving on to their clinical experience,

where intubation is performed on real patients. Similar procedures are followed in other professions (Owen & Plummer, 2002).

At the present time, virtual patient scenarios involving proprietary software and hardware components are in various phases of testing throughout the world. Copyright and fiscal limitations are connected to these experiments limiting their mainstream deployment in educational institutions. Literature searches offered extensive documentation on the role of multimedia and mannequin simulation on intubation instruction; however very few published articles dealt with the use of software simulation in educating medical practitioners in intubation. Until these situations are solved, or a new psychomotor skill delivery process is deemed to be feasible, intubation education will employ face-to-face instruction (Hofmann, 2012).

Increasing Distributive Learning in Psychomotor Skills: Paramedic Intubation Education

With the expansion of Internet based training in paramedic practice, the possibility of delivering psychomotor skills through distance education would represent an invaluable asset for any educational institution. Psychomotor training in DE should combine instructional design (ID) principles, the multimedia capacities of a learning management system (LMS), digital interactions, as well as mental imaging modules (P. L. Smith & Ragan, 2005). All of these have been proven useful in other situations requiring motor skill training. Successful integration of these components in DE would create a learning module which would not only be of interest to faculty and students, but it could also increase the fiscal benefits of distance education paramedic programs as it

would help decrease the time spent in face-to-face training when dealing with psychomotor skills.

As a summary, this thesis was generated from 1. an expressed desire of paramedic educators, 2. evolved from previous research and 3. is aimed at improving paramedic psychomotor skill transmittal in an expanded distance education opportunity.

Statement of The Purpose of Study

The purpose of this study was to compare the effectiveness of two instructional approaches, the first using instructional design principles and the second not using instructional design principles, aimed at educating students in intubation through online distance education.

The two instructional approaches were incorporated in the design of two modules known as ID (Instructional Design Based Learning Module) and NID (non-Instructional Design Based Learning Module used as control group). The two modules were mainly different due to the arrangement of their constituent parts, with the exception of a small set of activities, especially mental imaging exercises, which were not seen in the NID control group module – Appendix A and Appendix B.

The Research Question

This was a sequential explanatory mixed method study (Creswell, 2009, p. 211) which addressed the transmission of information from cognitive to psychomotor in a

group of paramedic students who underwent intubation training through the two methods described above.

On one hand, the quantitative data helped answer the question: "Is there a statistically significant difference between the measured outcomes of ID training versus NID training in the performance of endotracheal intubation?"

On the other hand, the qualitative data built "on the results of the initial quantitative results" and was "used to explain and interpret quantitative results" (Creswell, 2009, p. 211).

The benefits of instructional design in distance education were thus investigated not only form the numerical point of view but also from an ideological perspective.

Limitations of the Proposal

The following were possible limitations or constraints for this work (Berman, 2007):

1. Time and budget restrictions were given limitations for the study. As a direct representation of time and budget limitations, it has to be acknowledged that most of the equipment was provided through a direct collaboration with the Paramedic Programs at Durham College (Canadian Medical Association, 2011; "Paramedic-Advanced Care (Distance Delivery Graduate Certificate)," 2010); however other time and budget restrictions influenced this study (availability of research participants, website scheduled updates, course outlines, availability of data gatherers and others).
2. Subject participation was a limitation of this study. Participants were self-selected from a pool of available students and evaluators. While this situation was generated

by and met Research Ethics Boards requirements, it is understood that, because of self-selection procedures (Koole, 2014), the student and evaluator desire to participate was a constraint for the present study.

3. Study participants were encouraged to participate in the present study by using the following means:
    a. All participants in the project will be entered in a draw for a monetary prize
        i. Odds of winning 1 in 5
        ii. Each monetary prize will have a value of 75 CDN$
    b. Participants will be issued a letter of participations thanking them for supporting this work.
4. Previous knowledge of intubation. If any of the student participants ever performed or were specifically instructed in endotracheal intubation they were not allowed to be part of the study.
5. Capability of study generalization based on the above research question. Due to the size of the population willing to participate in the study, it was not possible to generalize the results of this study to a larger population and the results were deemed to be specific for the population that was studied.
6. A voluntary constraint aimed at decreasing bias and assuring consistency in testing procedures was represented by the fact that the students underwent testing sessions which were a maximum of 10 minutes long and in which each student was only allowed one intubation attempt. Intubation attempt was defined here as one try to insert the endotracheal tube into the trachea. This was the same for both groups.

7. Research assistants were used as described in the upcoming sections. While this situation was generated by and met Research Ethics Boards requirements, it is understood that the use of Research Assistants during interviews and data collection procedures (Koole, 2014) limited the author interaction with the study participants to a scripted outline. Would the Research Assistants not have been used, a better author interaction with the study participants might have been possible; however participation in the study might have been inherently biased because of the lack of anonymity.

Delimitations of the Proposal

The following were delimitations of the thesis (Cline, n.d.), as they connected to what this study was not intending to cover:

1. This study was not meant to be an ongoing effort aimed at analyzing the generational evolution of student perceptions in regards to psychomotor skill delivery in DE, but it rather was aimed at understanding current student realities in relationship to psychomotor skill delivery in DE as presently seen in the student-paramedic population.
2. The study only compared differences between the two online learning modules when dealing with the initial teaching of a skill.
3. The study did not make use of hands-on self-practice as a means of instruction.
4. This study did not test skill retention over a certain period of time, although retention studies might be considered for future research.

5. This study was only meant to analyze the proposed study question and was not intended to cover student self-understanding of competency in the setup of learning a complex psychomotor skill at a distance.
6. This study was not meant to evaluate any specific products.
7. The involvement of mobile communication devices in distributive learning was purposefully excluded from this research, since the program that would directly benefit from the present research, the PADV ("Paramedic-Advanced Care (Distance Delivery Graduate Certificate)," 2010), does not currently mandate its students to have access to a mobile, cellular type device. These were however discussed in the recommendations section due to their applicability in future work.
8. The involvement of haptic devices and procedures in distance education was purposefully excluded from this research due to logistical and pecuniary limitations. These were however discussed in the recommendations section due to their applicability in future work.
9. Any theoretical model that is presented at the end of the thesis represents a conceptual model only and no physical objects were built at this time.

Definitions of the Terms

For clarification purposes, the following terms need to be defined:

Endotracheal intubation skill is defined as "Putting an instrument […] beyond the larynx"(The College of Physicians and Surgeons of Ontario, 2010). In this case the instrument is an endotracheal tube.

Endotracheal intubation procedure is defined as an "advanced airway procedure in which a tube is placed directly into the trachea." (Aehlert, 2007). In this case the intubation is performed orally.

Haptic Device/Interface is defined as a system "which comprise software and hardware components that concern the sense of touch" ("Haptics Laboratory," n.d.), "haptic interfaces enable person-machine communication through touch, and most commonly, in response to user movements" (Hayward, Astley, Cruz - Hernandez, Grant, & Robles - De - La - Torre, 2004).

PCP refers to a Primary Care Paramedic

ACP refers to an Advanced Care Paramedic

Mobile learning "offers modern ways to support learning process through mobile devices, such as handheld and tablet computers, MP3 players, smartphones and mobile phones" (UNESCO, n.d.).

Note: the term module will be used to describe the online learning module developed for the purposes of the present work.

Chapter II: Literature Review

Intubation and Paramedics

Endotracheal intubation has, for years, been practiced by advanced level prehospital healthcare providers. The complexity of the skill, along with the cognitive processes surrounding it, require many hours of training and retraining in the career of a paramedic.

Intubation is still considered the "golden standard" (Bernhard & Böttiger, 2011) of airway management, but the reality of skill depreciation cannot be denied (Garza, Gratton, Coontz, Noble, & Ma, 2003). Two trends have emerged based on these findings: the first one saw a move towards supraglottic airways being used in the initial management of paramedic treated patients (Central East Prehospital Care Program, 2011), while the second one explored a clear need for continuing medical education and training hours specifically dedicated to the skill of intubation (Garza et al., 2003). Current advancements in simulation training have been successfully employed in skill retention procedures and have been proven to maximize patient intubation outcomes (Hall et al., 2005; Wyatt, Fallows, & Archer, 2004).

Theory of Psychomotor Skill Transmission

Bloom's taxonomy discusses the existence of three domains of learning: "cognitive", "affective" and "psychomotor" (Forehand, 2005). Teaching a skill involves, helping a person transition from someone who is not able to perform a given skill to someone being capable of eliciting a "complex overt response" (Simpson, 1966) that is

directly connected to the physical task at hand. The Paramedic Association of Canada (PAC) generates the National Occupational Competency Profile for Canadian paramedics (NOCP) (Paramedic Association of Canada, 2001), a document where psychomotor skills are grouped under three categories of complexity: “low, medium and high complexity” (Paramedic Association of Canada, 2001).

Smith and Ragan remind us that the learning of a psychomotor skill involves “three phases: cognitive phase, associative phase and autonomous phase” (2005, p. 278). During the cognitive phase the learners “learn what they are to do and in what sequence” (P. L. Smith & Ragan, 2005, p. 278), during the associative phase the “learners begin to learn how to physically perform the skill” (P. L. Smith & Ragan, 2005, p. 278) while in the third phase “practice and feedback allow the learner to progress from the jerky or fumbling efforts of the novice to the smooth, controlled, apparently effortless actions that characterize the expert performance of a psychomotor skill” (P. L. Smith & Ragan, 2005, p. 278). The Smith & Ragan model sees instruction as having four parts: “Introduction”, “Body”, “Conclusion” and “Assessment” (2005, p. 283), each with specific subcomponents. As such, these steps are detailed in a very logical sequence in which the student is captured into the lesson, knows what to expect, instruction is based on previous experiences and employs multiple learning methods, and the student is offered the chance to test her/his newly acquired knowledge before being examined in a final format (P. L. Smith & Ragan, 2005, p. 283).

In the above model, the “cognitive phase” starts when the attention of the participant is captivated, until different learning strategies are employed to facilitate the education process. Relevant past knowledge is used to help the learner understand new

ideas and this “associative phase” continues until the participant is “remotivated” and the learning module concludes (P. L. Smith & Ragan, 2005, p. 278). Based on constructivist ideology (P. L. Smith & Ragan, 2005, p. 19), the “autonomous phase” allows the students to undergo practice sessions aimed at preparing them for independent performance through the use of feedback (P. L. Smith & Ragan, 2005, p. 278).

Throughout the ID learning module, the students underwent multiple self-assessment practice sessions in the online environment. They were offered feedback on their virtual performance before migrating the skill to the physical environment at the end of the module. Instructional design methods were employed throughout the learning module to mediate the transition from cognitive to psychomotor and formed the basis of the present work. For details on the learning object please see Appendix A and Appendix B.

Distributive Learning and Skill Transmittal Facilitation

Presently, distance education has been attempting to integrate psychomotor skill transmittal as one of its core components, based on research that is constantly discovering new valences of DE psychomotor learning (Hamza - Lup & Stanescu, 2010). Previous research has shown that the involvement of simulation and mental practice in skill education is extremely important for successful student education (Owen & Plummer, 2002; C. W. Sanders et al., 2008), especially when combined with experiential learning (Ti et al., 2009). Psychomotor skill delivery in distance education has benefitted from studies which have clearly proven that distance skill delivery can be as good as in-class lectures (Morrison, 2002) and might allow a successful move from “Imitation to

Naturalization" in paramedic distributive learning (Montellato, 2009). The skills that can be transmitted through DE are evolving from simple – traction splinting (Morrison, 2002) – to more complex – such as ligation of a bleeding vessel (Smeak, Beck, Shaffer, & Gregg, 1991) – and so are the tools used to deliver them.

Current research – not always paramedic, but mostly healthcare specific – shows that "teaching a complex motor skill with no expert instruction is possible" (Pott & Santrock, 2007), especially if the students are exposed to a method involving both theoretical knowledge delivery through a multimedia based system and hands on practice through a simulator that can be used by the students to practice their newly acquired skills on (Brydges, Carnahan, Safir, & Dubrowski, 2009; Done & Parr, 2002; Jowett, LeBlanc, Xeroulis, MacRae, & Dubrowski, 2007; Richard M. Levitan, Goldman, Bryan, Shofer, & Herlich, 2001; Mayrose & Myers, 2007; Morgan, Cleave - Hogg, McIlroy, & Devitt, 2002; Morrison, 2002; Smeak et al., 1991). Simulators could thus be combined with multimedia based instructional methods, that would result in student engagement in both multimedia based theoretical skill exploration and individual practice aimed at achieving psychomotor skill naturalization through clearly defined "process goals" (Brydges et al., 2009).

Studies of skill delivery through multimedia use alone, without the help of practice or hands-on simulation have yielded evidence of conflicting opinions, which vary not only with skill complexity but also with the different characters involved in the educational continuum – students and faculty (R. A. Smith, Cavanaugh, & Moore, n.d.). Despite the varying results, a generally accepted opinion that skill transmittal is enhanced by the involvement of multimedia models seems to transpire in the literature (Owen &

Plummer, 2002). Multimedia alone seems only to be successful in teaching a skill which requires a mechanistic approach to a specific action – such as arranging objects on a tray (MacIntyre, Lucaccini, & Podshadley, 1973), while simulators and even hands-on practice have generally been involved when dealing with more complex skills – such as patient resuscitation (Christenson et al., 1998; V. R. Curran, Aziz, O'Young, & Bessell, 2004; V. Curran, n.d.).

A recent quasi-experimental (Neuman, 2006) study focusing on "Teaching psychomotor skills to beginning nursing students using a web-enhanced approach" found that "although students in the web enhanced sections were provided with more time to learn the skills and did perform better on the final psychomotor skills exam, they did not perform significantly better" (Salyers, 2007). These results could thus be seen as a promising beginning for the presently proposed work, especially as they seem to connect with another study focused on physiotherapy students which evaluated "Teaching Pre-cursor Clinical Skills Using an Online Audio-visual Tool" (Coffee & Hillier, 2008). The positive results obtained from using alternative delivery methods, including different degrees of guided skill practice for students in health related programs open the door for further studies focused on allied health programs which have not been evaluated so far.

As online learning is extended beyond the cognitive and affective domains, principles from sport education and psychotherapy are currently combined with multimedia based training in order to mediate psychomotor skill development through distance education. Studies have shown that mental visualization improves performance in a given field (C. W. Sanders et al., 2008), a trend which has also been observed by Smith and Ragan when they discussed the need for "visualization of performance"

(2005, p. 283) as one of the "key events for psychomotor learning" (2005, p. 283). Generally, when mental visualization is utilized for psychomotor training, it uses guided relaxation techniques to induce a subject into a positive state of mind, followed by task focusing and mental repetition in regards to the specific skill (Sonal et al., 2011).

The use of mental visualization either as a supplement to physical training or as a substitute to physical training when hands-on activities are either impossible or impractical has been successfully used in health care related fields. Sports therapy reminds us of the mental training that athletes undergo; patient recovery uses mental images when dealing with stroke victim recovery; and medical education uses it to train surgeons in complex skills (Braun, 2010; Coffman, 1990; Sonal et al., 2011; Suinn, 1997; Whetstone, 1995).

Logistics of Multimedia Based Modules in Distance Education

As the present work made use of an interactive multimedia module in order to train students through distributive learning, an introduction to multimedia based modules used in distance education is necessary. The current literature in regards to this topic is varied and it covers multiple aspects of teaching, not only from the perspective of potential educators, but also from the point of view of IT developers and managers.

As such, the creation of multimedia modules seems to benefit from the use of a combination of tools, all of them aimed at stimulating and engaging the students. Audio and video should thus be associated with images and text based materials as well as self-testing capabilities aimed at creating a user centric module which will "include a way for

students to self-gauge how well they mastered the learning material" (Huang, 2005). The inclusion of self-reporting modules (Rovai, Wighting, Baker, & Grooms, 2009), as well as designer generated assessments, might thus be useful tools which should be considered when developing a specific learning element.

Notwithstanding pedagogical realities, technological developments also need to be considered when developing a multimedia-based endeavour. Due to technical realities, the constant development of new computing and learning platforms, generate the need of a learning module which has to be compatible with multiple operating systems and varied learning management systems in order to maximize its user friendliness. An internationally accepted solution which allows navigation between different LMSs without changes in course content and file format is represented by the use of the Sharable Content Object Reference Model (SCORM) set of standards (Advanced Distributed Learning, n.d.; Rustici Software, n.d.). These are "produced by" Advanced Distributed Learning, "a research group sponsored by the United States Department of Defense (DoD) " (Rustici Software, n.d.), in order to "create one unified "reference model" of interrelated technical specifications and guidelines that meet DoD high-level requirements for Web-based learning content and systems" (Advanced Distributed Learning, n.d.). The adoption of such a standard would solve learning management issues and offer enhanced course portability.

Haptics in DE

Haptic feedback is a new and upcoming method of improving the realism of psychomotor skill transmittal in distance education (Hamza - Lup & Stanescu, 2010). The

research that is connected to haptic feedback in DE involves mobile learning technologies, gaming devices as well as proprietary systems which are under different stages of development throughout the world (EDUCAUSE, 2007; Hayward et al., 2004; Mayrose & Myers, 2007; Treviranus, 2003; Yoshikawa & Henmi, 2000).

At the present time, even though there are studies connecting haptic feedback and psychomotor skill transmittal, the fact that they require staff and facilities ("Haptics Laboratory," n.d.) which are above the financial means of the author, stopped the present thesis from using such modalities during the study itself. It is interesting however that the utilization of a haptic feedback device as a means of teaching intubation is one of the recommendations of this study.

Mobile Learning in DE

Mobile learning, seems to be an integral field of distance education which uses technological developments and the wide distribution of smartphones to bring education to more and more people (UNESCO, n.d.). The literature connected to mobile learning is increasing on a daily basis; however, due to the delimitations of the present study, mobile devices were not evaluated in this paper.

It is again interesting to note that, as in the previous section, even though mobile learning devices were not used this time, recommendations for further studies involving mobile learning devices and intubation training stem from this research.

Motivational Design Theory

An impressive amount of work done by John M. Keller (Keller, 2013), proves that a motivated individual is an individual who will learn and assimilate material easier than an individual who has no vested interest in a given subject matter. The importance that motivation has in learning, led to the development of a series of educational approaches summarized by the ARCS model (Keller, 2013). As such, instructors should capture the "Attention" (Keller, 2013) of the students, emphasize the "Relevance" (Keller, 2013) of the studied material, inspire student "Confidence" (Keller, 2013) in their own powers and help achieve an overall higher sense of "Satisfaction" (Keller, 2013) in the pupils (Driscoll, 2005; Keller, 2013). By using such a pedagogical technique students would become motivated citizens, empowered to learn and willing to improve their knowledge.

As in the case of the above two sections, it is interesting to note that, even though the present work was based on psychomotor learning theories, the use of the ARCS (Keller, 2013) model in future work is part of the Recommendations section.

Paramedic Specific Intubation Training Modules Already in Use

Based on paramedic textbooks currently in use in Canada, skill related textbooks, as well as training possibilities the following resources were reviewed for the purposes of this paper:

Table 1

Reviewed Resources

Resource	Components
Nancy Caroline's Emergency Care in the Streets, Canadian Edition (Caroline, 2010)	- Written material - Quizzes - Skill related videos ("Caroline,

		Paramedic," n.d.)
Mosby's Paramedic Textbook and The Canadian Paramedic: An Introduction Package (M. J. Sanders & Theriault, 2010)	-	Written material
	-	Quizzes
	-	Skill related videos ("Sanders: Mosby's Paramedic Textbook, Revised 3rd Edition," n.d.)
Paramedic Care Principles and Practice, Second Edition (Bledsoe, Porter, & Cherry, n.d.)	-	Written material
	-	Quizzes
	-	Skill related video (Bledsoe et al., n.d.)
International Trauma Life Support for Prehospital Care Providers, Sixth Edition (Campbell, 2008)	-	Written material
	-	Quizzes
	-	Interactive exercises (Campbell, 2008)

The above review shows that, while the material that is available is of great importance, at the present time, there are no stand alone intubation training modules which are constructed based on instructional design principles and are able to help a paramedic student transfer her or his knowledge into the psychomotor realm at the end of the module without a face-to-face interaction with an instructor. Other resources could be reviewed, as they would become available. The present thesis used an intubation training module which was flexible and accessible enough to meet the needs of the demographics that we wanted to engage (Cleveland - Innes, 2013).

Breaking Down the Skill of Intubation

When dealing with a skill as complicated as endotracheal intubation, a structured skill instruction process is much needed. Previous work has recognized this situation and stated that "clinicians responsible for intubation should appreciate that the procedure is best understood when broken down into 3 components: (1) laryngeal exposure; (2) delivering the endotracheal tube to the glottis opening; and (3) advancing the tube into the trachea" (R. M. Levitan, Heitz, Sweeney, & Cooper, 2011). Therefore the following

steps should be applied by anyone interested in achieving endotracheal intubation success: “ proper positioning of the patient, opening the patient’s mouth, control of the tongue, control of the epiglottis, landmark identification [and] passage of the endotracheal tube” (Richard M. Levitan, Sather, & Ochroch, 2000).

Kirkpatrick Model of Training Evaluation

The Kirkpatrick model, a standardized learning evaluation system, is a tested method for developing surveys aimed at helping various stakeholders analyze a specific learning module. Training in this evaluation methodology is currently available from Kirkpatrick Partners (Kirkpatrick Partners, 2011) and some of their resources are available through the secured section of the website.

The model analyzes four levels – “reaction”, “learning”, “behaviour” and “results” – of a training entity in order to determine its value (Kirkpatrick & Kirkpatrick, 2006). These levels are best described by the authors in the latest rendition of their book, Evaluating Training Programs: The Four Levels (Kirkpatrick & Kirkpatrick, 2006). As a general idea, though, the model looks not only at overall student results and the amount of knowledge that they gained but also at the response of the students to the course and at their behavioural changes that took place as a result of the learning activity in which they were involved.

Due to the fact that the questions that were asked during the qualitative phase of the present study tried to explain the quantitative results, they were not specifically focused on the behavioural shifts; however behavioural traits were noted when evident.

Data Evaluation Considerations

During this thesis work, the quantitative data provided a statistical analysis of the transfer of knowledge, whereas the qualitative data helped rationalize why the results turned out the way they did (Cleveland - Innes, 2013). This mixed method approach used both quantitative and qualitative data which were collected and analyzed throughout the present experiment. The quantitative process has the advantage of data already separated in specific categories, whereas the qualitative process is a more arduous one in which transcription and data analysis see the researcher undergoing multiple reads of the material at hand (Neuman, 2006). For this thesis, statistical analysis details are offered in the Statistical Tests/Analysis section below.

Current software (Microsoft, 2010; Shulman, 2008; SPSS Inc., 2008) allows the analysis of both quantitative and qualitative data and it was used as needed throughout the present work.

Literature Review Summary and Conclusions

At the present time, the literature review shows that a multitude of valuable resources and theories are available; however, no paramedic student specific intubation-training module was found which was constructed based on instructional design principles and which would mediate the independent transmission of psychomotor skills from theory to practice.

As such, the Smith and Ragan (2005) instructional design theory was used to generate an intubation training learning module that was aimed at helping paramedic

students take psychomotor training from the online environment to the physical realm. This module was compared against a learning module built without using instructional design principles. Even though not used in the current work, haptic devices, mobile learning, motivational design principles and a more in-depth use of the Kirkpatrick principles (Kirkpatrick & Kirkpatrick, 2006) could be used in future work.

The current thesis was thus built on previous work, tried to discover ideas connected to a distributive learning model for paramedic intubation training and suggested further inquiry into this matter.

Chapter III: Research Procedures

Research Design

Purpose Statement

This was a mixed method study which addressed the transmission of information from cognitive to psychomotor in a group of paramedic students who underwent intubation training through two methods: a learning module developed based on instructional design principles and a learning module developed without using instructional design principles. A sequential explanatory strategy was used during this study (Creswell, 2009, p. 211).

The quantitative data came from the checkboxes of the score-sheets completed by paramedic evaluators and helped answer the question: “Is there a statistically significant difference between the measured outcomes of ID training versus NID training in the performance of endotracheal intubation?”

The qualitative data came from the comments offered by evaluators on the intubation scoring sheets as well as from student and evaluator interviews held after the quantitative data were collected and analyzed. The qualitative data collection built “on the results of the initial quantitative results” and was “used to explain and interpret quantitative results” (Creswell, 2009, p. 211).

Schematic Representation of the Study

Figure 1: Schematic representation of the thesis based on a sequential explanatory strategy (Creswell, 2009, p. 209)

Schematic Representation of the Quantitative Phase

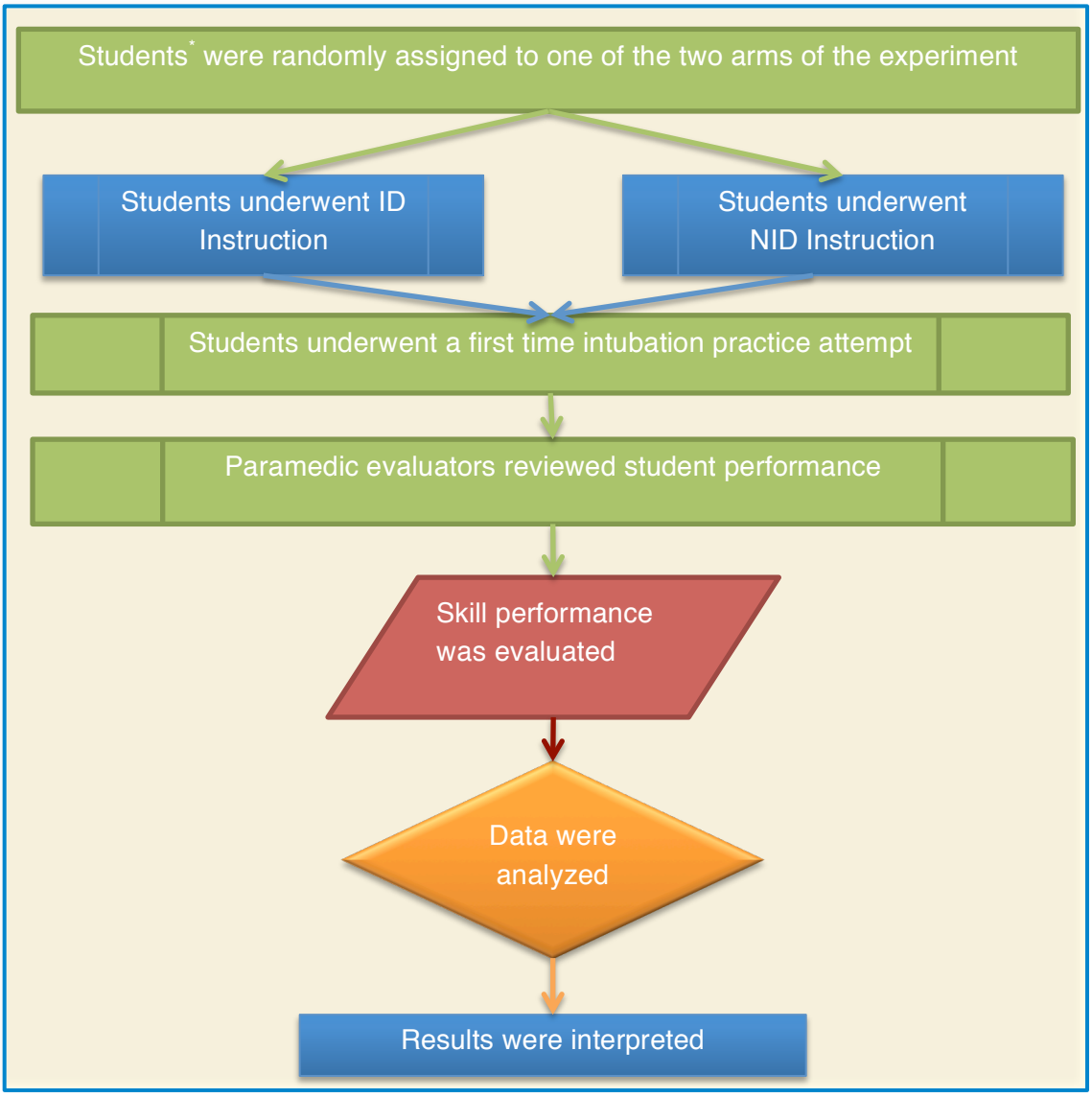

Figure 2: Schematic representation of the quantitative research phases involved in the thesis. *The students were Year 1 and Year 2 PCP students at Durham College.

Schematic Representation of the Qualitative Phase

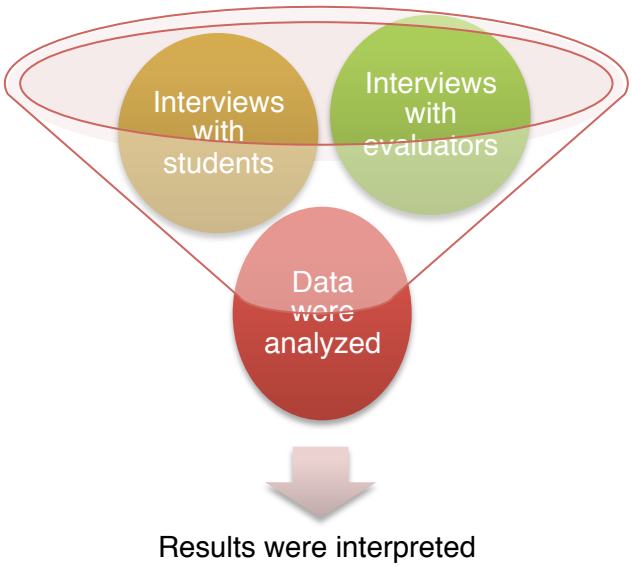

Figure 3: Qualitative phase of the thesis.

Notes:

1. The differences between the two learning modules consist in 1. the manner in which the material is presented, with the ID module adopting a more sequential delivery system, 2. the presence of a recommended visualization piece which is suggested in the ID module and 3. brief summaries of learnt procedures which are not seen in the NID arm. Appendix A presents a comparison between ID and NID.
2. Appendix B presents a detailed explanation of the learning modules along with a comparison between the different components seen by each student group.

3. Appendix D presents the intubation evaluation form used to measure student performance of the intubation skill.

Study Type

This study was a sequential explanatory strategy mixed method (Creswell, 2009, p. 211, 2010) post-test comparison of 2 study methods (ID vs. NID) (Morrison, 2002).

This study represented both experimental research because it tried "to determine if a specific treatment influences an outcome" (Creswell, 2009, p. 12) and also a post-test comparison of 2 study methods (ID vs. NID) (Morrison, 2002).

Component Groups

Quantitative

The quantitative part of the study used individuals from the Year 1 and Year 2 Primary Care Paramedic Program at Durham College. No Advanced Care Paramedic Program students were available to be part of this study since they were already taught this skill as part of their curriculum.

The students from each section were separated into 2 arms:

1. One arm of the study underwent ID and then they tried a first attempt at intubation on a mannequin ("Laerdal®Airway Management Trainer," n.d.) – experiment group.
2. One arm of the study underwent NID and then they tried a first attempt at intubation on a mannequin ("Laerdal®Airway Management Trainer," n.d.) – control group.

Qualitative

The qualitative part of the study used data obtained from:

1. the comments offered by evaluators on the evaluation check-sheets
2. interviews of students and evaluators that were already involved in the first part of the study.

These participants were selected based on the results of the quantitative part and were interviewed in order to try and explain the results obtained.

Role of Parties Involved in Study

Role of the Students

1. The students were educated in intubation through distance education based on the Durham College LMS.
2. The students accessed the Durham College LMS in an anonymous fashion.
3. The students performed a first time intubation attempt in the paramedic laboratory at Durham College.
4. Students took part in the interviews as needed.

Role of the Evaluators

1. The evaluators accessed the filmed movies for each student.
2. The evaluators completed one evaluation sheet with comments for each student.
3. The evaluators took part in interviews as needed.

Role of the Principal Researcher

The principal researcher:

1. Generated the research methodology, the participation recruitment letters and analyzed the data.
2. Created the website, which was hosted on the Durham College LMS.
3. Provided the Research Assistants with logistical support aimed at allowing them to recruit and manage participants. This includes obtaining usernames, passwords, booking rooms, obtaining equipment and other similar tasks.
    a. No specific contact details (such as names, emails or phone numbers) were provided to the Research Assistants by the principal investigator
4. Was not present at the recruitment sessions between possible participants and the Research Assistant.
5. Inputted the results of the score sheets in a database.
6. Analyzed the data and identified possible interview participants by identifying usernames only.
7. Forwarded the usernames – as used in the research study – of the possible interview participants to the Research Assistants to contact the interview participants.
8. Had access to the voice distorted recordings of the interviews.
9. Transcribed the interviews as needed.
10. Analyzed all data.
11. Did not take part in selecting the students, selecting the evaluators and generating data.
12. Did not look at the videos and did not have access to the master drive(s).

13. Will destroy the data 12 months after the end of the research study.

Role of the Research Assistants

The Research Assistants:

1. Completed the online TCPS 2 Tutorial Course on Research Ethics (CORE) (Goverment of Canada, n.d.) available at http://www.pre.ethics.gc.ca/eng/education/tutorial-didacticiel/ and submitted the Certificate of Completion to the REB before starting any work on this research study.

2. Signed a Confidentiality Agreement in regards to the present work.

3. Recruited students, managed students and gathered data.

    a. The Research Assistants obtained contact details (such as names, emails or phone numbers) from the participants themselves. These were kept confidential and the principal investigator is not aware of them. They will be destroyed 12 months after the end of the project along with the entire data as dictated by REB approval.

Procedure for Obtaining Subjects

Table 2 presents a summary of the numbers of students and evaluators that were invited and took part in the study.

Subjects for Quantitative Part

Students

Students were self-chosen from paramedic students at Durham College. Student involvement in the work was not allowed if they had previous training specifically related to endotracheal intubation. Participation in the experiment was voluntary and was extended to all students in the program. Equal opportunities were offered to any and every student that met the inclusion criteria.

The study was targeted towards paramedic students that have not yet been trained in endotracheal intubation. As such, the study was only able to use PCP students in their first and second year of training. ACP students had to be excluded since they were already trained in intubation at the time of this study.

Evaluators

Paramedic evaluators were self-chosen from paramedic laboratory instructors at Durham College. Instructor participation in the experiment was voluntary and was extended to all instructors, as long as they were able to evaluate the skill of intubation. Three instructors self identified as interested and participated in the experiment.

Subjects for Qualitative Part

After the quantitative data were collected, an initial analysis of the check-sheets was performed and outliers were invited for the interviews. These were chosen based on the small sample size, the non-parametric nature of results and the interest in opinions at the two ends of the spectrum.

Avoidance of Bias

The following represent methods used to avoid bias:

1. The principal investigator did not take part in the participant recruitment, management and data gathering processes.
2. Two research assistants:
    a) Recruited participants
    b) Distributed students in groups
    c) Completed the filming phase of data collection
    d) Prepared the video material for distribution to the evaluators
    e) Performed the interviews
    f) Prepared the audio-taped interviews for distribution to the principal researcher
    g) Performed administrative functions throughout the pre-thesis writing phase of this work
    h) Will witness the destruction of data
3. Student participants were randomly distributed in the two arms of the study, by extracting identification bracelets containing a unique username and password. This username and password followed the students throughout the research study and the principal investigator was not be able to correlate student names with study usernames. These bracelets were extracted (by the student participants) from a container which only had a hand sized opening and did not allow them to see the bracelets. One Research Assistant kept a file with the names and the identifiers of all students. This file was stored in a secured location and only the Research Assistants could access it.

4. Half of the above mentioned student usernames were enrolled in the control group (NID), and the other half were part of the instructional design (ID) group of this research study.
5. The paramedic evaluators were not aware of the teaching method used to train the students.
6. The paramedic evaluators were assigned anonymous identifiers (i.e. numbers) for the duration of the research study.
7. Students with prior intubation experience were excluded from the study. This exclusion was achieved through the initial letter of participation explaining pre-screening procedures.
8. Testing on the intubation mannequin was filmed by the Research Assistants and films were evaluated by professional paramedic instructors, using score sheets already proven and in use at Durham College
9. The same Research Assistant conducted the interview phase of the thesis.

Instrumentation that Was Used

The multimedia based learning objects were developed using Camtasia ("TechSmith | Camtasia Screen Recorder Software, Home," n.d.), video cameras and other means as presented in Appendix B. The learning object was housed on the Durham College Desire to Learn platform and other material was used as detailed in Appendix B.

Data gathering tools: video cameras, intubation mannequin ("Laerdal®Airway Management Trainer," n.d.), KingVISION^{TM} Video Laryngoscope ("King Vision Video Laryngoscope," 2010), pre-existing intubation competency checklist currently used in the

paramedic labs at Durham College – Appendix D –, audio recording device, video processing software, audio processing software, computers.

Method for Data Collection

1. Day 1: Students had access to the LMS
    a) Starting at 15:00 hours students had access to the Durham College LMS
    b) Access to the Durham College LMS was shut down at 09:30 hours in Day 2.
2. Day 2: Students came to the lab to perform a first time intubation attempt
    a) At 10:00 hours, students came to Durham College and performed a first time practical intubation on a mannequin.
    b) At 10:00 hours, all students gathered in a staging room adjacent to the lab and waited there until their practice on the mannequin.
    c) Students entered the lab room one at a time, every ten minutes, in the order that they chose.
    d) Each student was allowed only one intubation attempt during the maximum ten minutes, which they spent in the lab. This was counted as one try at inserting the endotracheal tube in the trachea and was explained to the students on entering the room.
    e) After the ten minutes or one intubation attempt performed, the students were instructed to leave the lab and the staging area.
    f) The Research Assistants recording the student performances reset the equipment.
    g) Each student underwent the same process.

h) Student interaction with the mannequin was recorded through film, through the use of two cameras and the KingVISION™ Laryngoscope ("King Vision Video Laryngoscope," 2010).

i) During the interaction that each student had with the mannequin, one camera provided a profile view of the student and the mannequin (right lateral in order to allow more clearance since intubation is a left-handed skill) and one camera provided an anterior-superior view of the student and the mannequin.

j) A capture of the vocal cords obtained with the KingVISION™ ("King Vision Video Laryngoscope," 2010) was also recorded.

k) All the above data were:

    i. Transposed on a master drive which was stored and will be disposed as described below.

    ii. Transposed to DVDs which were stored and will be disposed as described below.

    iii. The originals were kept on a master drive which was sealed in an envelope to which only the Research Assistant had access to and they will be stored in a locked cabined in room JW 210 at Durham College. This room represents the office shared by paramedic staff, hence the office is shared by the principal investigator with four other co-workers. This data storage option will be destroyed 12 months after the end of the Thesis Work.

Notes:

Each performance was evaluated by three evaluators based on the Endotracheal Intubation Evaluation – Skill Check Sheet presented in Appendix D with the following specifications:

a) The video-taped recordings allowed the evaluators to determine proper use of the intubation equipment and proper intubation procedures.

b) The KingVISION™ ("King Vision Video Laryngoscope," 2010) video allowed the evaluators to directly determine endotracheal placement of the tube.

3. Day 2: Electronic copies of each student performance were uploaded to DVDs
4. Day 3: Evaluators had access to the filmed intubation practice of the students
5. Day 3 to Day 20: Evaluators scored the student performance
   a) Evaluators obtained the DVDs from the Research Assistants
   b) Evaluators scored the videotaped student performance in a private location.
   c) Evaluators marked each intubation attempt based on the provided Endotracheal Intubation Evaluation – Skill Check Sheet presented in Appendix D making sure to clearly write their identifier on the evaluation sheet
   d) Once finished, the evaluators returned the DVDs with the evaluation sheets to the Research Assistants
   e) The Research Assistants took the DVDs and the evaluations from the Evaluators
   f) The Research Assistants gave the evaluation forms to the Principal Researcher
   g) The Research Assistants repeated the process as needed and, once all evaluations finished, stored the DVDs in a secured container box until destroyed.

6. Day 20 to Day 41: Data collected from the Endotracheal Intubation Evaluation forms was analysed by the principal researcher.
    a) The principal evaluator performed initial data analysis and identified outliers for interviews
7. Day 41: Usernames for the students and the evaluators deemed to be possible interview candidates were forwarded by the author to the Research Assistants
    a) The principal researcher gave the Research Assistants the identifiers for the participants who were to be interviewed – these were the outliers identified from the data analysis performed in the above section
8. Day 41 to Day 70: The Research Assistant performed the interviews.
    a) The same Research Assistant interviewed all the selected participants
    b) Interviews were audio taped.
    a) Interview audio taped recordings were downloaded to a master drive by the Research Assistant
    b) The interview audio taped recordings were processed for sound and the voices were distorted. These voice-distorted recordings were saved in files which were uploaded to DVDs and given to the principal researcher.
    c) A master drive will be kept with the original recordings in a sealed box in a locked cabinet in room JW 210. Only the Research Assistants will have access to this box. This will be destroyed along with all data (July 2015).
9. Day 70 onwards: Final data analysis and thesis completion.
    a) A period of further data analysis and thesis completion followed

Note: dates are adjusted based on real events.

Statistical Tests/Analysis

Data were obtained from:

1. Endotracheal Intubation Evaluation Skill Check Sheet – score sheets with comments presented in Appendix D.
2. Interviews of both students and evaluators

Endotracheal Intubation Skill Evaluation Form – Data Check-Sheet Analysis

Quantitative Data

Non-parametric analysis of entire performance

1. The student participants were only allowed one attempt at intubation as detailed above. Each student performance was scored by three evaluators.
2. Each performance was scored by the same number of evaluators. One video was not visible by all evaluators and was discarded as needed during the analysis.
3. Inter-rater reliability was reported for pairs of raters using Cohen's Kappa (Lund & Lund, 2013; Norusis, 2008, p. 431; Uebersax, 2010) – Table 3.
4. Inter-rater reliability for overall intubation score was reported using Intraclass Correlation (ICC) (Hallgren, 2012; Landers, 2011) – Table 3.

5. Data were then recoded and categorized as correct – represented by the "acceptable" section in the marking sheet – and incorrect – represented by the sum of "unacceptable" and "not seen" in the marking sheet. Inter-rater reliability was reported using intraclass correlation (ICC) (Hallgren, 2012; Uebersax, 2010) – Table 3.
6. Each performance was given a mark from 0 to 36 based on the number of acceptable scores (3 raters, 12 steps each performance).
7. A Mann-Whitney U test (Cleveland - Innes, 2012; Nachar, 2008; Ratcliffe, n.d.) was used to test the null hypothesis:

   "There is no significant difference between the scores obtained by ID module participants and the scores obtained by NID module participants when evaluating the performance of intubation, at the 0.05 significance level".
8. Any interconnected two groups (NID and ID) were analyzed based on the above.

Qualitative Data

Qualitative data obtained from both the comments section of the evaluation check-sheet and the interview were:

1. Coded and grouped in ideological themes by the principal researcher (Cleveland - Innes, 2013)
2. Analyzed using The Qualitative Data Analysis Program (QDAP) (Shulman, 2008) and word clouds ("Wordle - Beautiful Word Clouds," n.d.)
3. Interpreted in the final analysis of the results (Neuman, 2006)

Chapter IV: Results

Review of the Statement of Purpose

This was a sequential explanatory mixed method study which addressed the transmission of information from cognitive to psychomotor in a group of paramedic students who underwent intubation training through either a learning module developed based on instructional design principles or a learning module developed without using instructional design principles (Creswell, 2009, p. 211).

The quantitative data came from the evaluation of a first time intubation attempt and helped clarify the presence of statistically significant differences between ID and NID training.

The qualitative data were obtained from both, the written comments of the evaluators and the student and evaluator interviews held after the quantitative data were collected and analyzed. The qualitative data helped "explain and interpret quantitative results" (Creswell, 2009, p. 211).

Analysis

A summary of the numbers of students and evaluators that were invited and took part in the study is presented in Table 2. 34 students were distributed usernames and passwords for the LMS. From them, 25 were present in the day of filming. From these 25, 3 students informed the RA that they did not partake in the online activities. The films were evaluated by the instructors based on the evaluations forms. The evaluators had

three choices for marking a performance: 1. “acceptable”, 2. “unacceptable” and 3. “not available” – Appendix D. One of the videos did not work for two of the evaluators. The 3 students that missed the online component and the one for which video material was not visible were eliminated as needed and the quantitative analysis took part. Overall, very little agreement in between evaluators was visible, mostly when data were recoded to reflect correct and incorrect performances. No statistically significant difference was found amongst the different groups. The comments offered on the evaluation sheets, as well as the quantitative results, helped choose the interview participants. 13 interviews were held and the results were qualitatively analyzed.

Table 2

A Summary of the Numbers of Students and Evaluators which Were Invited and Took Part in the Study

Participant classes	Number of participants
Total number of evaluators invited to take part in the study	3
Total numbers of evaluators that took part in the study	3
Total numbers of evaluators invited to the interviews	2
Total numbers of evaluators interviewed	2
Total number of students invited to take part in study	34
Total number of students that took part in the study	25
Total number of ID group participants that took part in the study	10
Total number of NID group participants that took part in the study	15
Total number of Year 1 participants that took part in the study	15
Total number of Year 2 participants that took part in the study	10
Total number of students invited to the interviews	28
Total number of students that took part in the interviews	11

Note: All the students that did not partake in the online activities were from Group 2 Year 1.

Quantitative

Agreement Amongst Evaluators

Quantitative data were obtained from the check-sheets completed by the evaluators. The evaluators could have marked each subsection as "acceptable", "unacceptable" or "not available". After the initial analysis, the "acceptable" category was coded as "correct" and the "unacceptable" and "not visible" were grouped together as "incorrect". Table 3 shows the statistical tests used for each category.

Table 3

Data Provenance, Data Type and Statistical Tests Used to Determine Inter-rater Agreement

Data provenance	Data type	Statistical tests used to determine inter-rater agreement
Score sheets without any coding	Nominal ("acceptable", "unacceptable" or "not available" values per step per user per evaluator).	Cohen's κ for pairs of users (Hallgren, 2012; Lund & Lund, 2013)
Total number of successful intubation steps per user	Interval (sum of all acceptable scores per user per evaluator; could range from 0 to 12).	Intraclass Correlation (ICC) (Hallgren, 2012; Landers, 2011)
Score sheet data recoded to show correct intubation attempts	Dichotomous (the "acceptable" category was coded as "correct" and the "unacceptable" and "not visible" were grouped together as "incorrect").	Intraclass Correlation (ICC) (Uebersax, 2010)

First of all, a quantitative analysis of the evaluator check-sheets revealed that there was 100% agreement amongst all evaluators in regards to the success of intubation in the entire student population. Successful intubation was defined as the passing of the endotracheal tube through the cords and all evaluators consistently identified success and failure in the same manner. This part of the skill was easily viewable by the evaluators

through a standalone movie shot with a laryngoscope fitted with a camera ("King Vision Video Laryngoscope," 2010) which showed a clear view of the cords, oesophagus and the position of the endotracheal tube.

A Cohen's κ analysis for pairs of evaluators was performed on the score sheets without any coding being performed – Appendix E – and the results are summarized in Table 4. There seems to be a moderate agreement amongst all evaluators in regards to the last step of the intubation procedure "disconnect syringe".

Table 4

Analysis of Evaluation Sheets – No Coding

	Steps of Adult Oral Endotracheal Intubation	Cohen's κ for Evaluator 1 and Evaluator 2*	Cohen's κ for Evaluator 1 and Evaluator 3*	Cohen's κ for Evaluator 2 and Evaluator 3*
1	Establishes proper patient axis.			0.780 ($p < 0.05$)
2	Opens mouth.			0.397 ($p = 0.032$)
6	Avoids levering on teeth.		0.324 ($p = 0.036$)	
7	Uses cricoid pressure (BURP) to assist in visualization.	0.202 ($p = 0.023$)	0.751 ($p < 0.05$)	
9	Pulls stylet back as tube passes through cords.		0.484 ($p = 0.001$)	0.610 ($p = 0.001$)
10	Removes stylet.	0.378 ($p = 0.021$)	0.778 ($p < 0.05$)	
11	Inflates cuff.	0.421 ($p = 0.012$)	0.473 ($p = 0.001$)	
12	Disconnects syringe.	0.511 ($p = 0.005$)	0.678 ($p < 0.05$)	0.511 ($p = 0.005$)

*Note: Only statistically significant results are presented. Data that is not statistically significant (p is not < 0.05) is not included.

An Intraclass Correlation (ICC) (Hallgren, 2012; Landers, 2011) based on the sum of all acceptable scores per user per evaluator was performed – Appendix F – and is summarized in Table 5. Even though the intraclass correlation amongst all evaluators has a value of 0.366, the highest absolute agreement is between evaluators 2 and 3 while the agreement between evaluators 1 and 2 and the one between evaluators 1 and 3 is not even statistically significant.

Table 5

Analysis of the Sum of all Acceptable Scores per User per Evaluator (Hallgren, 2012; Landers, 2011, 2011)

ICC for Evaluator 1, Evaluator 3 and Evaluator 3*	ICC for Evaluator 1 and Evaluator 2*	ICC for Evaluator 1 and Evaluator 3*	ICC for Evaluator 2 and Evaluator 3*
0.366 ($p < 0.05$)			0.546 ($p < 0.005$)

*Note: Data that is not statistically significant (p is not < 0.05) is not included.

An Intraclass Correlation (ICC) (Uebersax, 2010) based on the recoded values was performed – Appendix G – and results are summarized in Table 6. There are only a few areas in which there is a significant amount of agreement between all evaluators. The evaluators continue to have similar opinions in regards to sub-skills which are easily visible on video, the use "of cricoid pressure (BURP) to assist in visualization" or "disconnects syringe".

Table 6.

Analysis of Recoded Data

	Steps of Adult Oral Endotracheal Intubation	ICC 1, 2 and 3*	ICC 1, 2*	ICC 1, 3*	ICC 2, 3*
1	Establishes proper patient axis.	0.364 ($p = 0.001$)			0.787 ($p < 0.05$)
2	Opens mouth.				0.369 ($p < 0.037$)

3	Introduces laryngoscope blade into right side of oropharynx.	0.218 (p = 0.022)			0.343 (p = 0.042)
6	Avoids levering on teeth.			0.359 (p = 0.034)	
7	Uses cricoid pressure (BURP) to assist in visualization.	0.863 (p < 0.05)	0.787 (p < 0.05)	1	0.787 (p < 0.05)
9	Pulls stylet back as tube passes through cords.	0.412 (p < 0.05)		0.395 (p = 0.011)	0.620 (p< 0.05)
10	Removes stylet.	0.417 (p < 0.05)	0.389 (p = 0.013)	0.785 (p < 0.05)	
11	Inflates cuff.	0.385 (p = 0.001)	0.413 (p = 0.022)	0.477 (p = 0.007)	
12	Disconnects syringe.	0.658 (p < 0.005)	0.660 (p < 0.05)	0.838 (p < 0.05)	0.522 (p = 0.002)

*Note: Data that is not statistically significant (p is not < 0.05) is not included.

Along with marking a skill on the check-boxes, the evaluators also had the chance to offer comments adjacent to each step and at the end of the evaluation sheet. The number of comments offered by each evaluator was counted and it became evident that Evaluator 1 offered the most amount of comments, followed by Evaluators 2 and 3 in a decreasing order. These results are detailed in Table 7.

Table 7

Analysis of the Amount of Comments Provided by Each Evaluator

	Number of comments per evaluator
1	Evaluator 1 offered 176 total comments
2	Evaluator 2 offered 99 total comments
3	Evaluator 3 offered 27 total comments

Differences in Group Results

Each student was given a mark equal to the sum of all intubation steps marked as successful by each evaluator:

1. There were 12 steps associated with each attempt.
2. A successful step was given a mark of 1.
3. There were three evaluators.
4. Each student could obtain a minimum mark of zero (12x0+12x0+12x0)
5. Each student could obtain a maximum mark of 36 (12x1+12x1+12x1)

Mann-Whitney U tests (Cleveland - Innes, 2012; Nachar, 2008; Ratcliffe, n.d.) were used to test for statistically significant differences between student results in regards to instruction (StatSoft, 2013); median values were compared and are presented in each test:

1. A Mann-Whitney U test indicated that there is no statistically significant difference in the scores obtained by students from Group 1 (*M = 13.00*) and students from Group 2 (*M* = 10.25), U = 45.00, z = -0.994, *p* = 0.320.
2. A Mann-Whitney U test indicated that there is no statistically significant difference in the scores obtained by students from Year 1 (*M = 13.53*) and students from Year 2 (*M* = 11.64), U = 53.500, z = -0.577, *p* = 0.564.
3. A Mann-Whitney U test indicated that there is no statistically significant difference in the scores obtained by students that partook in online activities (*M = 13.91*) and students that did not partake in online activities (*M* = 10.25), U = 13.000, z = -1.678, *p* = 0.093.
4. A Mann-Whitney U test indicated that, within Group 1, there is no statistically significant difference in the scores obtained by students from Year 1 (*M = 6.00*) and students from Year 2 (*M* = 4.33), U = 7.00, z = -0.805, *p* = 0.421.

5. A Mann-Whitney U test indicated that, within Group 2, there is no statistically significant difference in the scores obtained by students from Year 1 (*M = 7.19*) and students from Year 2 (*M* = 5.13), U = 10.500, z = -0.942, *p* = 0.346.

Other Statistically Significant Relationship

As a final note, a Mann-Whitney U test indicated that the students which were successful in intubating the mannequin "levered on the teeth" a statistically significant more times as compared to the students which were not successful in intubating the mannequin. The null hypothesis "Both the students that were successful and the students that were not successful in intubation had no difference in the amount of avoiding to lever on the teeth" was rejected due to a Mann-Whitney U test with a *p* of 0.027. None of the students who were successful in intubating avoided levering on the teeth.

Interviews

Interviewees

Based on the above analysis it was considered that Evaluator 1 and Evaluator 3, as a pair, offered the least amount of comments per area of agreement and they had the most different styles of evaluation. As a result, they were both invited for interviews. They both accepted to be interviewed and the data were processed as described in the qualitative analysis section.

In the same time, in order to assure the best student capture for the interviews, students were chosen based on the following procedures:

1. In order to assure the best student capture amongst groups, students were arranged within groups based on both mean and median values of their scores
2. In order to assure the best student capture amongst years, students were arranged within years based on both mean and median values of their scores
3. The first and the last sets of students from each section were invited for interviews and interviews were done with the ones that agreed to be interviewed.

Table 8 highlights the students that were interviewed. All students that are listed were invited.

Table 8

Students Invited to Interviews

Student affiliation	Student usernames	Selection criteria
Group 1	63, ***36***, 69	Top three students selected based on mean value of overall score arrangement.
	63, ***36***, 69	Top three students selected based on median value of overall score arrangement.
	44, ***34***	Lowest two students selected based on mean value of overall score arrangement.
	44, ***34***, ***54***	Lowest three students selected based on median value of overall score arrangement.
Group 2	64, ***05***, 67	Top three students selected based on mean value of overall score arrangement.
	05, 64, 67	Top three students selected based on median value of overall score arrangement.
	32, 57, ***46***	Lowest three students selected based on mean value of overall score arrangement.
	47, 32, ***46***	Lowest three students selected based on median value of overall score arrangement.
Year 1	63,36,05	Top three students selected based on mean value of overall score arrangement.
	63,05,36	Top three students selected based on median value of overall score arrangement.

	44,57,34	Lowest three students selected based on mean value of overall score arrangement.
	57,34,***61***	Lowest three students selected based on median value of overall score arrangement.
Year 2	***64***,08,55	Top three students selected based on mean value of overall score arrangement.
	64,08,55	Top three students selected based on median value of overall score arrangement.
	54,32,46	Lowest two students selected based on mean value of overall score arrangement.
	54,32,46	Lowest three students selected based on median value of overall score arrangement.

Note: The students ***highlighted*** were interviewed.

Note: Students 52 and 60 were also invited for the interview as they did not take part in the learning module, but they partook in the filmed practice session. Both were interviewed.

Questions Asked

The questions that formed the basis of the interview were used as indicated in Appendix H and Appendix I.

Two clarification questions were asked to the evaluators:

1. What did you do when you could not see something on the video?
2. What did you do to ensure that all students are marked based on the same criteria?

Three clarification questions were asked to the students:

1. What was your mindset going into the videotaped practice ?
2. Did you perform any mental practice or visualization ?
3. Do you think that your previous knowledge of airway management such as using the KingLT© (King Systems, 2010) helped?

Note: This last question was asked to all Group1 students and only to one Group 2 student.

No specific questions were asked in regards to the manner in which the students interacted with the learning module. This omission was purposeful, as I wanted to streamline the interview and see if the students volunteer comments related to the sequence of instruction.

Results

A total of 13 interviews (2 evaluators, 2 students that did not take part in the online learning experience, 5 students from Group 1 and 4 students from Group 2) were recorded.

The recordings were transcribed and the qualitative analysis started.

Qualitative

A process of theme discovery and coding followed an initial step of preliminary exploration of the written data. The QDAP software (Shulman, 2008) was used for coding purposes based on main themes discovered throughout the primary qualitative analysis steps. Mind maps and word clouds helped complete the sequential explanatory strategy used in this research.

Evaluator Analysis

Check-Sheets

An analysis of the check-sheets used by evaluators showed that, besides the quantitative differences between the comments offered by evaluators, there were also qualitative ones. As such the first two evaluators seemed to offer more detailed comments that described both the positive and the negative parts of a performance, whereas Evaluator 3 seemed to focus mainly on the latter. Evaluator 1 was the only one that tried to rank the students and indicated the best and the worst overall performances in her/his comments.

Besides their differences, all the evaluators seemed to agree that the following four sub-skills were not visible in the movies: “Advances blade until tip is situated in the vallecula (MacIntosh) or supporting the epiglottis (Miller), blade in midline”, “Elevates mandible with laryngoscope until vocal cords are visualized”, “Visualizes passing of endotracheal tube to proper insertion depth”, “Pulls stylet back as tube passes through cords”. The fact that one third of the sub-skills were consistently hard to see might help explain the evaluator emphasis on the need for more filming angles during their interviews.

Interviews

The following main themes were evident from the evaluator interviews:

1. Both evaluators would have liked to be able to see more camera angles when evaluating the practical student performance.

2. Both evaluators agreed that they tried to see the videos multiple times; however some sections were just not visible.
3. Both evaluators agreed that objectivism could be affected by the capacity to see a certain camera angle. Evaluator 1 even emphasized the need for a "criteria setup to what each checkbox would be considered successful" when not being able to see something.
4. Both evaluators had generally positive comments about the evaluation sheet with Evaluator 3 admitting that the evaluation was "pretty straight forward, the checkmarks were very easy to follow along with and it was not confusing and it left space for comments" and Evaluator 1 agreeing that "it is nice to have just a check sheet ".

A word cloud ("Wordle - Beautiful Word Clouds," n.d.) showing the top five words used by the evaluators during their interviews – *Figure 4* – emphasizes video angles and subjectivism.

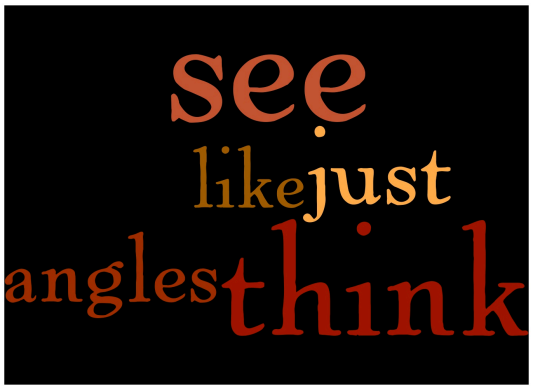

Figure 4: Top 5 words used by evaluators during their interviews.

Besides the above ideas, Evaluator 3 recognized that the video could be a useful tool for student self-evaluation, an idea which resonates with some of the themes identified during the student interviews.

Student Analysis

Group 1 and Group 2 Students

From the initial moment that the student qualitative analysis was started, it was evident that all students referred to the learning modules as "video" instead of acknowledging the modules as entities in themselves.

Multiple readings of the data were performed and 9 themes were identified as being shared amongst many users. These themes were then used as codes during the subsequent section of the qualitative analysis with special attention being paid not to duplicate data for the same student. The 9 themes, along with their explanation as well as the theme distribution within groups, are detailed in Table 9 with visual representations available in Figure 5.

Table 9

Themes, Explanations and Theme Distribution within Groups

Theme	Detail	Theme prevalence in Group 1	Theme prevalence in Group 2
Desire for pre – filming practice	Students expressed their desire to have a pre – filming practice as exemplified by comments from Student 54 who admits, "Yeah, you know what? Having the information	4 out of 5 students	3 out of 4 students

	in front of you and practical time in the same time that would kind of combine both things together" and Student 34 who says "trying to perform without practice was actually the part that I thought was harder."		
Desire for success	Participants described the fact that they were expecting to be successful. While some students do not directly answer the "were you expecting to be successful" with a yes, they do however agree based on their answer. Student 5 eloquently explains, "Ahh … having never done it before and this being the first time I would practice it I thought I would have a good chance of doing it. After watching the video it did not seem to be a difficult task so I felt fairly confident going into it."	3 out of 5 students	4 out of 4 students
Lab performance anxiety	Students were generally anxious in regards to lab performance as seen in the comments of Student 64 who admits that the lab experience "is just a little bit nerve wracking."	3 out 5 students	3 out of 4 students
Performed mental practice	Students performed some form of mental practice. Student 61 details this process by saying that "I guess you can say I did visualization. How I would do things going through a step-by-step process in my head."	4 out of 5 students	4 out of 4 students
Positive attitude towards the learning module	Students expressed a generally positive attitude towards the learning module and were happy with it. Student 64 shows enthusiasm and says "I think that it was a good experience. I think that it was a cool method to try learning. I think that it was cool that you just were watching the video in that learning environment and then see if you can do it based on theory."	4 out 5 students	3 out 4 students
Recognition of endotracheal intubation as a	All the interlocutors that were asked about their previous experience with airway management procedures,	3 out of 5 students	1 out of 1 students

specific skill	recognized the fact that endotracheal intubation is a much more complex skill than any previously attempted airway control manoeuvre. Student 52 explains this by saying: "I feel that it was entirely different. It was just a different procedure."		
Recognition of need for increased learning module availability	Students would like the video module opened for longer. This is expressed by Student 54 who says: "I believe that having it for a longer period of time […] cause me as a learner I like to read it, go away for a bit, absorb it a little bit then go back and reconfirm it."	3 out of 5 students	1 out of 4 students
Recognition of videotaped practice as important for self – evaluation	Students recognized the possibility of using this filmed event as a self – practice method. Student 61 directly admits that seeing your own videotaped performance, "gives you a scale how well you did the first time […]. You can look at your own skill, see how well you did the first time […], and maybe go back and do it the second time and maybe have a chance to reflect on what you did or did not do."	1 out of 5 students	3 out of 4 students
The intubation steps should be presented while the video was playing	Students would like more captions detailing the steps of intubation inserted in the videos. This idea seems to have a great preamble presented by Student 5, "the videos could have been done in a more step-to-step format instead of one continuous video."	1 out of 5 students	1 out of 4 students

Note: The themes identified here were used as codes during the coding section of the qualitative analysis.

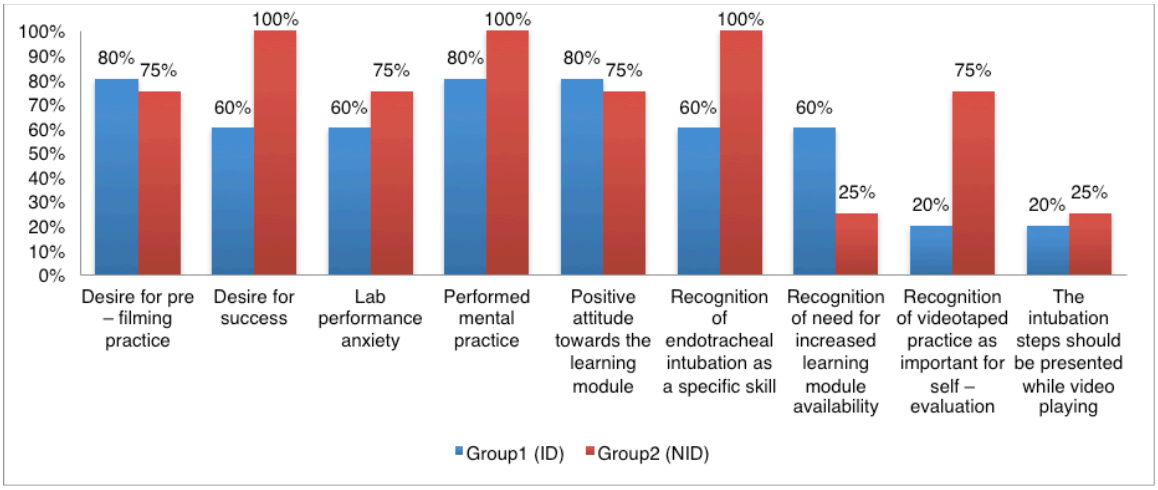

Figure 5: Coding of Group 1 (ID) and Group 2 (NID) interviews. The figure illustrates the graphical representation of theme distribution within groups. Themes follow same order as in Table 9.

A list of other themes evident during the interview analysis, but which could not be attributed to more than one person per group, is presented in Table 10. It is interesting to note that no students have ever commented on the sequence of instruction.

Table 10

Other Themes Revealed from Student Interviews

Group 1 Themes	Group 2 Themes
1. Student likes the pictures from quizzes most	1. The student believe that the steps are clearly outlined and no other explanations are needed
2. Student would like to see the videos done by EMS personnel	2. The student would like to see more patients being intubated
3. The student is a last minute learner	3. The student knew what had to be done to complete skill
4. The student would like more views focusing on the trachea during intubation	4. The student thinks that the video is moving too quickly
5. The student suggested using a GoPro (“GoPro Official Website: The World’s Most Versatile Camera,” n.d.) camera to generate videos	5. The student suggested that the video is possibly targeted at a person with prior knowledge about intubation
6. The student has thought a written test was also involved in the	6. The student thought that the write up was too long

lab practice	7. The student thought that there was a lot of information presented 8. The student thought that videos should be used in quizzes 9. The student took notes and read them over before the filmed practice 10. The student would like to be able to ask questions to someone during the participation in the learning module 11. The student would like to be offered some more details when entering the lab

Practice Only Students

Even though the first three questions presented in Appendix I did not directly apply to the students who did not take part in the online learning activities, student 60 offered her/his opinion in regards to a perfect learning module which, in her/his opinion, would consist of not only a video but also "a few descriptions […] as to what is happening".

In the same time, two themes are evident from their interviews:

1. Both students agreed that they tend to do things on a "last minute basis".
2. Both students seemed not to be stressed about the entire experience; their attitude was best described by student 52 who said: "you know what, if I do it I do it, if not then so it is."

Sample Size Effect on Study Generalization

The numbers of participants invited to be part of the study as well as the sample size of participants directly involved in the study do not provide enough power to generalize the information outside the studied sample.

Chapter V: Conclusions and Recommendations

Conclusions

This was a mixed methods research aimed at studying the translation of a complex psychomotor skill from online learning to practice. The quantitative component did not prove that, in this case, there is a statistically significant connection between the Smith and Ragan (P. L. Smith & Ragan, 2005) method of instructional design and improved skill transmission. However, the quantitative results revealed a direct association between "levering on the teeth" and success of intubation, and the qualitative part of the research helped explain the results from the point of view of both students and evaluators.

The fact that a direct predictor of successful intubation seems to be the application of pressure on the superior teeth, is by not means a surprise since such "levering" allows for a better visualization of the cords. Even though not a correct approach to intubation, this part of the skill is usually rectified during practice, when, intubation mannequins, use a haptic and auditory feedback mechanism aimed at correcting this exact mistake. The lack of such a feedback in the online environment could be easily corrected by deploying mobile learning technologies able to offer an immediate corrective output and is further discussed in the Recommendations section of this discussion.

During the quantitative evaluator score-sheet analysis it became evident that there seems to be a direct connection between not being able to see something on the video and increased evaluator disagreement. The qualitative data analysis emphasizes this fact while pointing out that there seems to be a problem not with the evaluation check-sheet

but rather with the fact that the evaluators cannot see something and are forced to estimate the correctness of the physical performance based on associated cues and not on direct observations. For example, when they cannot see the vocal cords of the patient, the evaluators can infer that the procedure was done correctly by observing the depth and angle of laryngoscope blade insertion in the mouth. However this is just a guess and not a direct observation of blade placement. This situation generated recommendations in regards to the use of better video tools and to the creation of a task force aimed at identifying whether this dichotomy of agreement is also present in the current face-to-face paramedic training reality.

At this time, I need to emphasize that all evaluators are skilled practitioners able to perform intubations in the field, under immense amounts of stress, and that their knowledge of intubation is neither commented upon nor disregarded in this discussion. In the same time all evaluators are also skilled instructors and no inference to their teaching or evaluating abilities is to be extrapolated from this study.

The lack of a statistically significant difference between the two arms of the study seems to be somewhat explained during the student interviews. When analyzing these discussions it is evident that, unanimously, the students seem to consider their online learning experience as mainly connected to watching a “video” and, no student has ever commented on the logical flow of the learning modules or on the manner in which the quizzes were interconnected with the newly presented material. Furthermore, most of the interviewed students admitted to having performed some form of mental practice or visualization before the videotaped intubation practice, even though only the first group was directly instructed to do so. As such, it could be concluded that, all the students were

mainly focused on a video and the ensuing mental practice of the skill taught by the video, thus negating the instructional design principles used throughout this research and levelling pedagogical differences between the two groups. The qualitative data helped clarify the quantitative findings and the possible influence that student behaviour has on content navigation was discovered. This finding generated recommendations about motivational theory utilization in future studies connected to increasing the student engagement in the learning activities.

Even though not speaking to the manner in which the quizzes were used, it is interesting to see that, the only student – Student 44 – that pointed out the fact "that the part that helped me out the most was the pictures in the quiz" is one of the few students who actually performed a successful endotracheal intubation. This observation was combined with the previous finding in generating recommendations.

Students recognized that intubation is a complex skill, different than any other skill that they were exposed to in their previous training. While not specifically able to differentiate between the two learning modules in which they were enrolled, the students seem to have a positive attitude towards their online experience; however they recognize that their learning experience could always be improved. As such, some would want the modules to be available for longer, some would be happy with less written and more video segments – which emphasizes the third paragraph – and they even suggest more tangible improvements such as views from a GoPro ("GoPro Official Website: The World's Most Versatile Camera," n.d.) camera, intubation movies showing paramedics rather than other healthcare professionals and the use of subtitles on videos. These ideas are incorporated into the next section of the paper.

The students seem to associate their laboratory performance anxiety with a testing situation and they do not seem to realize that the filmed part of the research is just a practice session. 1 out 5 students from the first group and 3 out 4 students from the second group voiced the need for a separate practice section and even expressed their interest in having this pre-filming performance recorded so that they can self-analyze before coming and performing the skill in the lab. Since this question was not directly asked to the students, it can only be speculated that the desire to self-evaluate might be less prevalent in the students who are instructed to undergo mental practice as compared to the students who underwent mental practice by their own choice. The possibility of using films for self – evaluation purposes was also expressed by Evaluator 3 and it generated recommendations in regards to future studies connected to the use of self-evaluated videotaped practice in student training.

Many of the students that were interviewed wanted and were even expecting success in their first time practice of the physical skill. This seems to be somewhat opposed to their lab performance anxiety and could generate many inferences in regards to the competitive nature of students, and paramedic students in special, which could develop into future studies.

An important observation is the fact that not all criteria (Cleveland - Innes, 2014) described by the Kirkpatrick Model (Kirkpatrick & Kirkpatrick, 2006) were used when interviewing the different study participants. Even though the data that was collected mainly focused on the “learning” (Kirkpatrick & Kirkpatrick, 2006) level of evaluation, the student interviews also showed that most of them possibly chose not to follow the learning modules as indicated. This important “behaviour” (Kirkpatrick & Kirkpatrick,

2006) characteristic could speak to the motivational (Keller, 2013) peculiarities of the students and might help shape the path for future research. In the same time, information in regards to the student and evaluator "reaction" (Kirkpatrick & Kirkpatrick, 2006) during their involvement in the study became available through the interviews and is presented in the above Chapter IV. Further valences and overall training "results" (Kirkpatrick & Kirkpatrick, 2006) could be better understood when and if the ideas described in this paper turn into a training program.

Based on the evaluator differences and the fact that the students appeared to consider the laboratory session as more than just practice one can only wonder whether the perception of a summative evaluation (Cleveland - Innes, 2014) affected the manner in which both groups – learners and assessors – approached this endeavour. This could have caused a stressful situation for the students and could have made the evaluators feel forced to mark a certain area even if not clearly visible. This situation has been incorporated in recommendations surrounding further investigation into evaluator differences and student behaviour.

As a final point, it is interesting to note that, even though quantitative data show no statistically significant correlation between participation in the learning modules and skill performance, the most descriptive comments are visible on the evaluation sheets of the students who did not partake in the online activities. The fact that the qualitative augments the quantitative, directly increased my interest in using mixed methods research procedures in future studies.

Recommendations

The most prevalent themes that became evident throughout this work were used to suggest five recommendations mainly focused on achieving better filming procedures, increasing the realism of DE training, investigating evaluator differences in the F2F model, studying the connection between learning module navigation and translation of knowledge and the importance videotaped self-evaluated practice has in skill transmittal and retention. It is understood that further studies should use a larger sample size which would allow for the information to be generalized to at least the paramedic student population in Ontario, calculated at the time of the studies.

A summary of the proposed recommendations, along with the findings that generated them is presented in *Figure 6*.

First of all, both students and evaluators would like to be able to have access to more camera angles. Evaluators would like more camera angles when evaluating student videos and students would like more camera angles included in the training material. As such, a series of studies aimed at identifying and/or developing improved filming and video rendering procedures is recommended. These would not only focus on obtaining a better view from outside the oral cavity but also at gathering views from the respiratory and gastrointestinal tracts as well as point-of-view shots. These would help improve the use of audio-video techniques in student evaluation and training in general. Better filming and video rendering techniques would allow a clearer view of the performance, would capture a wider array of angles and would directly increase the objectivity of the observation.

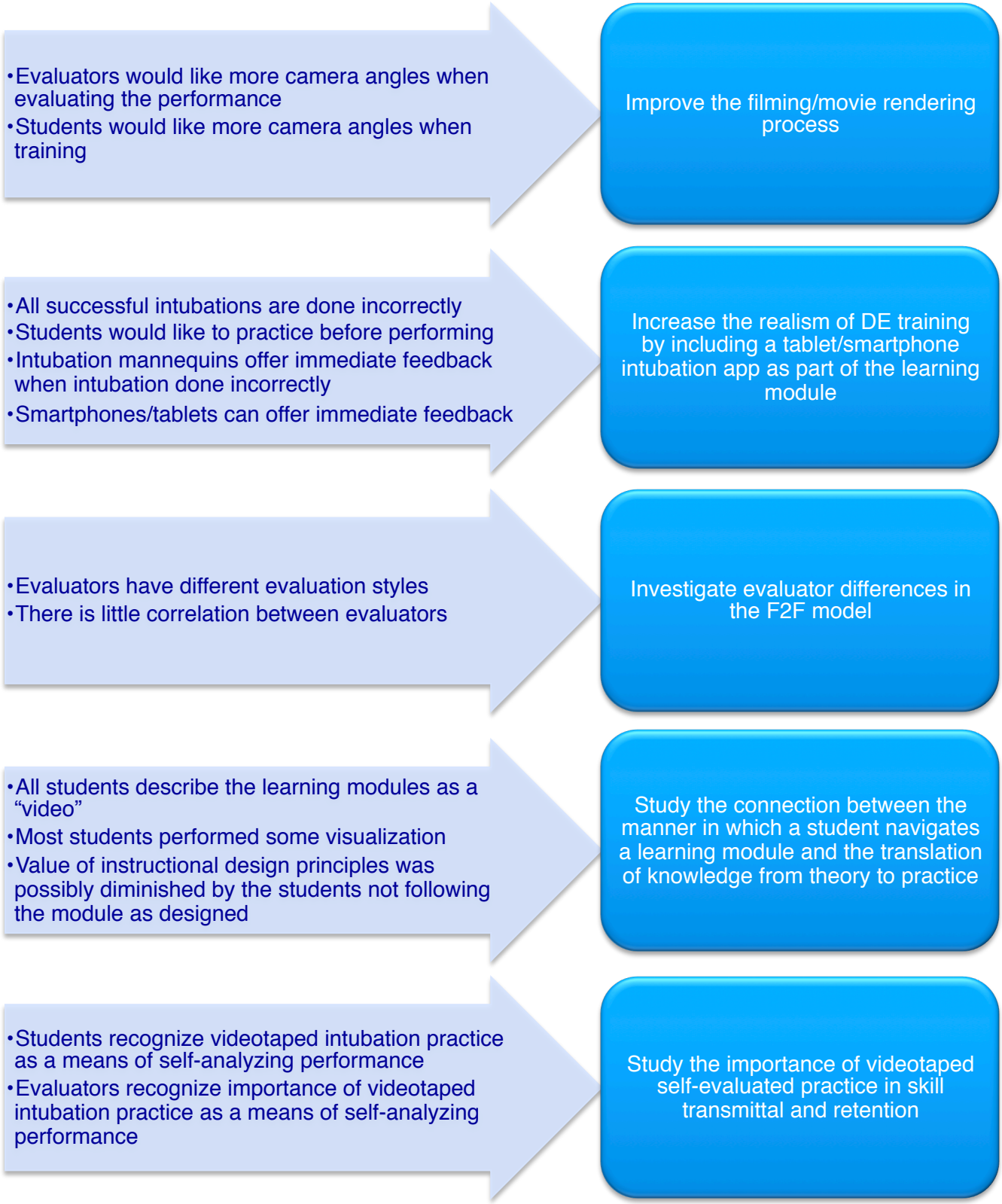

Figure 6: Proposed recommendations and the findings that generated them.

Secondly, the next recommendation is based on 1. the fact that all successful intubations are done incorrectly, 2. the expressed desire of students to practice before performing, 3. the existence of intubation mannequins which offer immediate feedback when an intubation is done incorrectly and 4. the capacity of smartphones/tablets to offer immediate feedback to a specific action. It is thus recommended to increase the realism of DE training by including a tablet or smartphone intubation app as part of the learning module.

Thirdly, the varying degrees of agreement amongst the evaluators involved in this study could also raise questions about evaluation discrepancies in the current face-to-face training model. Before any changes to the current model of training are made, I recommend the establishment of a task force aimed at further assessing the presence of inconsistencies in skill assessment amongst evaluators in the current format of student training. After determining whether these differences are currently present or not, the task force should examine the rationale for such differences and implement actions based on the discovered findings. Furthermore this task force should consist of not only full-time staff but also other than full-time staff and students. The actions of this proposed task force would not be punitive but rather educational and aimed at improving student evaluation methods.

Fourthly, a study investigating the connection between the manner in which a student navigates a learning module and the translation of knowledge from theory to practice is a direct conclusion of the present work. The need for such a study comes from the fact that it is not clear whether students followed the learning modules as they were presented to them or not. This question is raised by the fact that all interviewed students

described the learning modules as a "video" while most of them admitted to having performed a visualization exercise as part of their preparation for the filmed intubation practice. When undertaking these future studies, a motivational design perspective, as detailed in the works of John M. Keller (2013), could be applied to creating learning modules and the Kirkpatrick model (Kirkpatrick & Kirkpatrick, 2006) could be used to study their effect. This future work could also look at investigating the connection between the desire to succeed, the performance anxiety and the competitive nature of paramedic students and the influence of online testing modalities – marked online quizzes versus non-marked online self-tests – on the translation of knowledge from theory to practice.

Lastly, a study aimed at investigating the importance of videotaped self-evaluated practice in skill transmittal and retention could help improve not only initial student training but also the continuing education of practicing paramedics. This recommended study comes as a direct result of interviews, in which both students and evaluators recognized that videotaped intubation practice could be used as a means of self-analyzing performance.

As a conclusion, the above recommendations stem from the present study and are aimed at increasing our capacity to deliver better training programmes.

Summary

A sequential explanatory strategy was used to study the transmission of a complex psychomotor skill from theory to practice. The quantitative results were clarified by

qualitative data and, even though no statistical significance in regards to the main research question could be proven at the present time, this study could help shape the path for future work. As such, five recommendations were suggested which mainly focused on achieving better filming procedures, increasing the realism of DE training, investigating evaluator differences in the F2F model, studying the connection between learning module navigation and translation of knowledge and the importance videotaped self-evaluated practice has in skill transmittal and retention.

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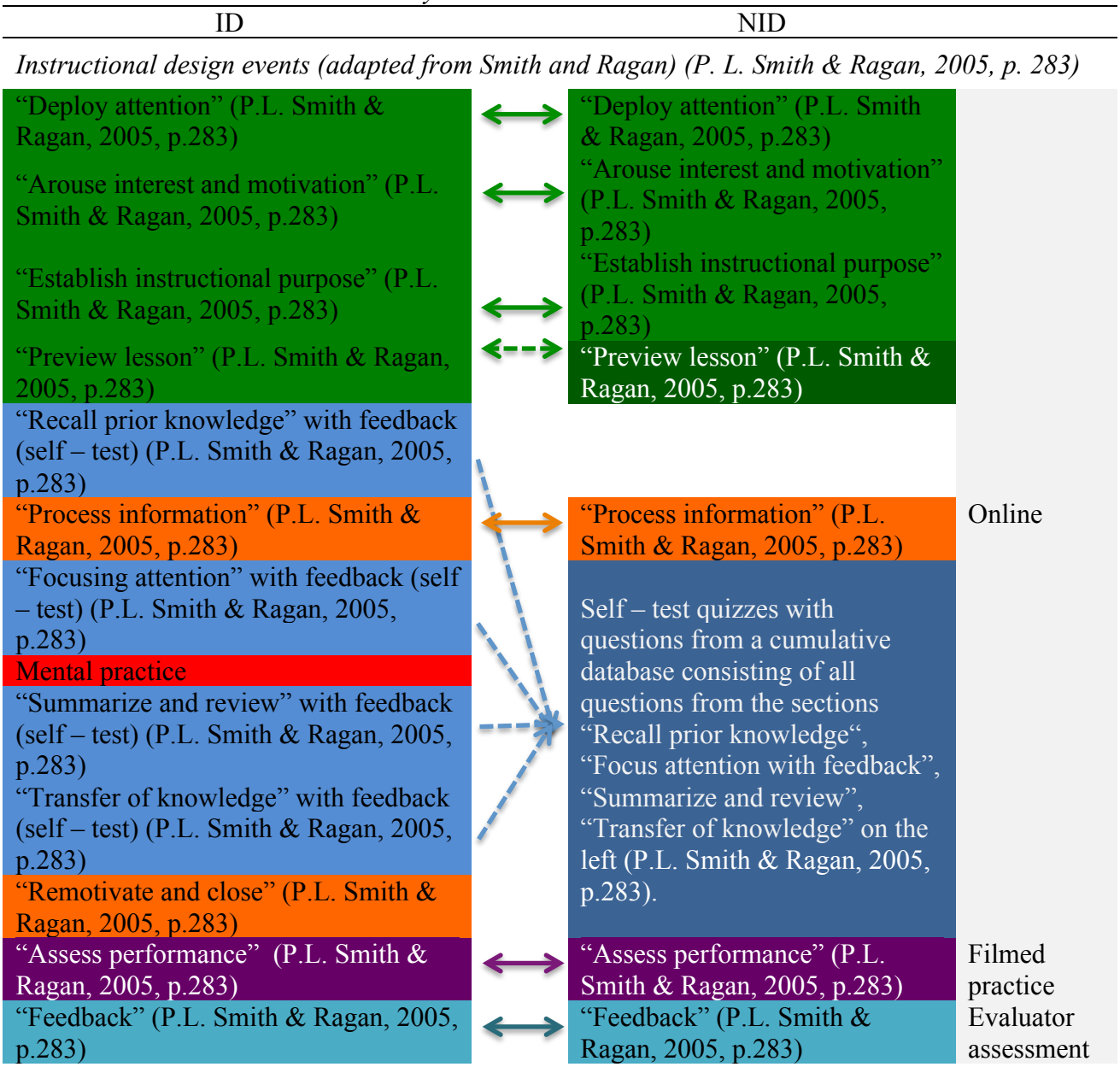
Appendix A: Differences Between the ID and the NID Learning Modules

Table 11 presents the differences between the ID and the NID learning modules.

Table 11

Clarification of the Differences between the Two Distance Education Activities in which the Students Enrolled in the Present Study Partook



Note: The ID events are presented in quotation marks as they are adapted from Smith and Ragan (2005, p. 283).

Appendix B: Detailed Presentation of Learning Modules

Following is a presentation of the learning modules, along with an explanation of the principles used to generate them:

Table 12

A Comparison of the Two Learning Modules

Learning module section	Learning module subsection	Group 1 inclusion	Group 2 inclusion	Explanation and Details
News Section				
	Welcome to this online training module !	✔	✔	An upbeat "trailer" type video introduction to the module and to the skill of intubation.
Content Part I - Overview				
	Welcome and introduction	✔	✔	This was a short video module. The students were initially thanked for their participation in the present work and then they were reminded that they are part of an interesting experiment which could benefit future generations. Presentation of the fact that intubation is a possible life saving skill which is practiced by paramedics at different levels of care followed. After that, the students were advised that online education will be used to teach the physical skill of intubation. In the end, the students were shown the skill of intubation as an example of what the final purpose of the module will be.
	Learning module overview – Group 1	✔		This section explained the manner in which their education will progress throughout the entire duration of the present

				work. Group 1 students were also told that once coming to the lab they will be filmed performing the skill of intubation. The twelve steps that they would need to successfully complete were enumerated.
	Learning module overview – Group 2		✔	This section explained the manner in which their education will progress throughout the entire duration of the present work. Group 2 students were also told that once coming to the lab they will be filmed performing the skill of intubation. The twelve steps were not enumerated.
	What do you already know about airway management?	✔		This was a self-testing quiz which allowed students to recall their previous knowledge in regards to airway management. Feedback was given throughout the quiz.
Content Part II – The skill of intubation				
	Video Intubation Module	✔	✔	This section presented a video break down of the skill of intubation along with the tools of intubation and the steps needed to successfully insert an ETT into the trachea of a patient. This section made use of the "Orotracheal intubation" movie from the New England Journal of Medicine (Kabrhel, Thomsen, Setnik, & Walls, 2007)
	Interactive Intubation Module	✔	✔	This section presented an interactive break down of the skill of intubation along with the tools of intubation and the steps needed to successfully insert an ETT into the trachea of a patient. This section made use of the "Foundation skills – tracheal intubation" learning module from

				the British Medical Journal (BMJ Learning editors, 2012)
	Practice Evaluation Form	✔	✔	This was a written explanation and direct presentation of the evaluation sheet which was used to score students based on their filmed intubation practice. This section offered an explanation of how the evaluation sheet will be used and the students had the capability to download a sample evaluation sheet from the website.
	What have you learned so far?	✔		This was a self-testing quiz which allowed the students to reinforce the new concepts that they were introduced to so far. Feedback was given throughout the quiz.
Content Part III – Review				
	Concentrate on what you learned	✔		This was a written guide for mental practice aimed at helping the students use mental visualization to help focus on the skill of intubation that was learned through the module.
	Learning module review – Group 1	✔		This was a self-testing quiz which allowed the students to review some of the new concepts that they were introduced to so far. Feedback was given throughout the quiz.
	Learning module review – Group 2		✔	This was the only quiz that was available on the Durham College LMS for the students from Group 2. Even though this module consisted of all the questions form the quizzes offered to the Group 1 students, they were not presented in a logically sequential order. Feedback was given throughout the quiz.
	Review and conclusions	✔		This was a short video review of the entire learning module. The end of the video presentation

	reminded the students that, the following day, they could participate in a first time intubation practice attempt in the Paramedic lab.

Appendix C: Examples of Material

Following are examples of relevant material and questions that were created by the author for the purposes of the learning modules:

Questions used in the question library for the learning modules:

Question 1: In the following picture, A represents:

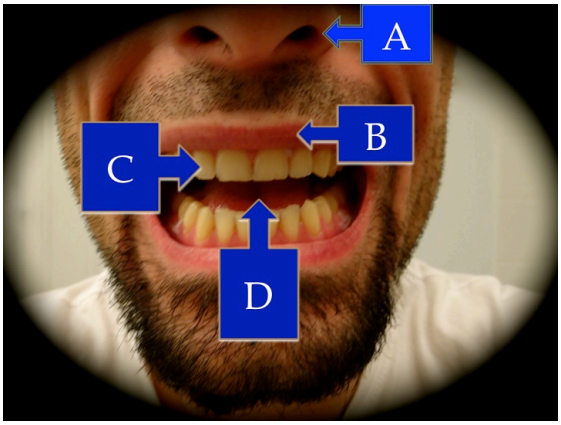


Figure 7: First example of picture used in the learning modules

A. the nose

B. the mouth

C. the tongue

D. the teeth

E. the lips

Correct answer: A

Feedback for A: Good job!

Feedback for the rest: Try Again !

Question 2: In the following picture, B represents:

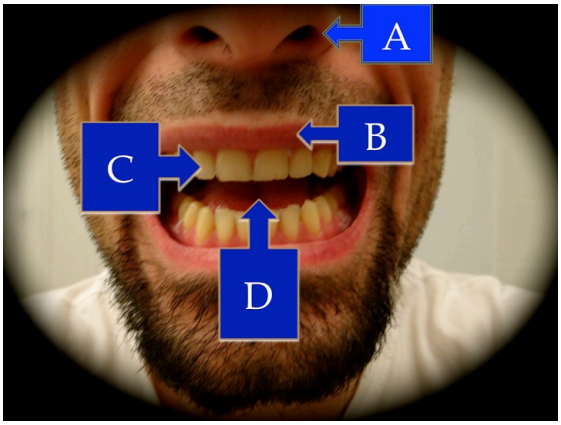


Figure 8: Second example of picture used in the learning modules.

A. the nose

B. the mouth

C. the tongue

D. the teeth

E. the upper lip

Correct answer: E

Feedback for E: Good job!

Feedback for the rest: Try Again !

Question 3: Pretend that you are sneezing. What position is your upper body more likely to adopt as all the air comes out of your airway? Why?

Figure 9: Third example of picture used in the learning modules.

A. A, because this is the anatomical position and is the best posture I can have.
B. I think it is B because it seems that all the air passages (trachea, larynx, mouth, nose) seem to align with each other. Air has the highest chance of getting out of my lungs.
C. It is definitely C, since my head is hyperflexed and all the air stays in my lungs
D. The hyperextension of my neck will allow the best passage for air. I pick this one.

Correct answer: B

Feedback for B: Good job!

Feedback for the rest: Try Again !

Question 4: In the following picture, which letter represents the uvula?

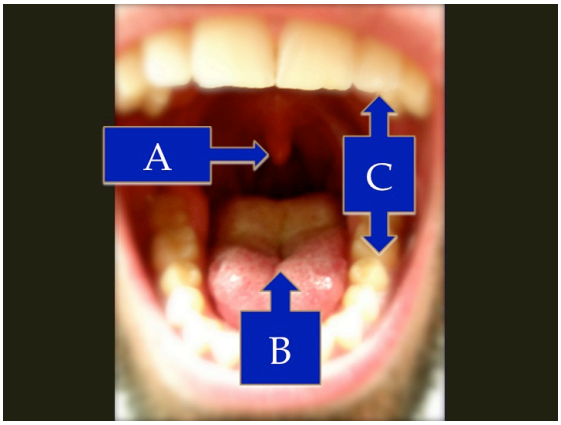


Figure 10: Fourth example of picture used in the learning modules.

A. A

B. B

C. C

Correct answer: A

Feedback for A: Good job!

Feedback for the rest: Try Again !

Question 5: In the following picture which letter represents the teeth?

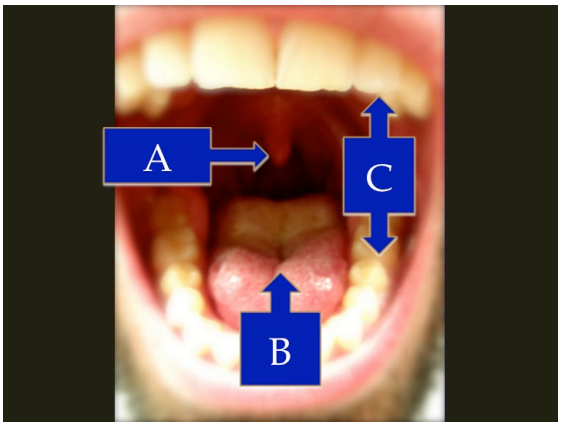


Figure 11: Fifth example of picture used in the learning modules.

A. A

B. B

C. C

Correct answer: C

Feedback for C: Good job!

Feedback for the rest: Try Again !

Script of the mental practice indications:

“Previous studies have shown a strong correlation between positive performance and the use of mental imagery or visualization techniques. In this part you will use mental visualization to help you focus on the skill that you have learned today.

Remember that there was a lot of information presented today; however the purpose of this entire module is to help you perform an oral intubation on a mannequin.

Before you begin this section, please take a break.

Walk away from the computer and come back in five minutes.

When you come back read the following section and use it as a guide for what your next activities are going to be:

Relax in a comfortable spot. Try to be away from distractions. Close your eyes if it makes you relax more.

Mentally review what you learned today.

Create a series of mental images of all the intubation procedures that come to your mind. Mentally organize the steps of intubation, until you have a good recollection of the sequential steps. If there are steps you are unsure of you may go back to the videos and the materials presented in this module so that you can clarify your questions. Repeat this exercise until you are comfortable with all the sequential steps that are part of intubation.

Now imagine yourself going through the actual process of intubation and intubating a mannequin in the lab.

For example if you imagine yourself using a curved blade laryngoscope, create an image in your mind of that event. Try to recall hand positioning and body positioning that you observed in the video, and mentally practice this positioning. Visualize placing the blade in the vallecula, revealing the cords and passing the endotracheal tube through the cords. Imagine what your hands are doing during this time. Try the same for the straight blade; however remember that this time you are lifting the epiglottis and not positioning the tip of the blade in the vallecula. Think about which one feels more comfortable to you.

Now finish your mental practice and take a break.

Go ahead and practice as instructed in the above section.

Repeat this mental exercise several times until tomorrow."

Appendix D: Intubation Evaluation Form

This part presents the tool used to confirm endotracheal intubation competency for the paramedic students at Durham College; this tool has been validated through its use in the program in the last 12 years. The present version is based on the most recent electronic copy of the tool provided by Kevin Griffin, Professor, Paramedic Program, School of Justice and Emergency Services (Griffin, 2011); the column on the left was clarified by separating sub-components on specific rows; the column on the right has been clarified with the heading "*Evaluation (acceptable/unacceptable/not available)"* in order to meet the objectives of the present work. A "Comments" section was added. Each evaluator was provided with a new form, without the capability of seeing the work done by the previous evaluators. Evaluators were instructed to check A (acceptable) if the performance was within accepted standards, U (unacceptable) if the performance was not within accepted standards and N (not available) if, due to whatever cause, the performance was not visible on video. Evaluators were instructed to insert comments in regards to the evaluated performance in the "Comments" section.

Table 13

Tool Used to Confirm Endotracheal Intubation Competency in the Paramedic Students at Durham College

Intubation: Adult Oral Endotracheal Steps	Evaluation A	U	N	Comments
Establishes proper patient axis.	☐	☐	☐	
Opens mouth.	☐	☐	☐	

Introduces laryngoscope blade into right side of oropharynx.	☐	☐	☐
Advances blade until tip is situated in the vallecula (MacIntosh) or supporting the epiglottis (Miller), blade in midline.	☐	☐	☐
Elevates mandible with laryngoscope until vocal cords are visualized.	☐	☐	☐
Avoids levering on teeth.	☐	☐	☐
Uses cricoid pressure (BURP) to assist in visualization.	☐	☐	☐
Visualizes passing of endotracheal tube to proper insertion depth.	☐	☐	☐
Pulls stylet back as tube passes through cords.	☐	☐	☐
Removes stylet.	☐	☐	☐
Inflates cuff.	☐	☐	☐
Disconnects syringe.	☐	☐	☐

Appendix E: Score-Sheet Analysis with No Coding

Analysis of score sheets without any coding:

Table 14

Analysis of Score-Sheets without any Coding

	Steps of Adult Oral Endotracheal Intubation	Cohen's κ for Evaluator 1 and Evaluator 2*	Cohen's κ for Evaluator 1 and Evaluator 3*	Cohen's κ for Evaluator 2 and Evaluator 3*
1	Establishes proper patient axis.	0.205 (p = 0.193)	0.195 (p = 0.276)	0.780 (p < 0.05)
2	Opens mouth.	0.059 (p = 0.755)	– 0.065 (p = 0.751)	0.397 (p = 0.032)
3	Introduces laryngoscope blade into right side of oropharynx.	0.089 (p = 577)	0.067 (p = 0.605)	0.294 (p = 0.086)
4	Advances blade until tip is situated in the vallecula (MacIntosh) or supporting the epiglottis (Miller), blade in midline.	– 0.114 (p = 0.295)	0.000	0.000
5	Elevates mandible with laryngoscope until vocal cords are visualized.	– 0.135 (p = 0.449)	0.000	0.000
6	Avoids levering on teeth.	– 0.067 (p = 0.532)	0.324 (p = 0.036)	– 0.077 (p = 0.390)
7	Uses cricoid pressure (BURP) to assist in visualization.	0.202 (p = 0.023)	0.751 (p < 0.05)	0.118 (p = 0.057)
8	Visualizes passing of endotracheal tube to proper insertion depth.	– 0.048 (p = 0.684)	0.000	0.000
9	Pulls stylet back as tube passes through cords.	0.233 (p = 0.125)	0.484 (p = 0.001)	0.610 (p = 0.001)
10	Removes stylet.	0.378 (p = 0.021)	0.778 (p < 0.05)	0.258 (p =

				0.065)
11	Inflates cuff.	0.421 (p = 0.012)	0.473 (p = 0.001)	0.281 (p = 0.052)
12	Disconnects syringe.	0.511 (p = 0.005)	0.678 (p < 0.05)	0.511 (p = 0.005)

*Note: Cells with data that are not statistically significant (p is not < 0.05) are shaded

(King's College London, 2014; Norwegian Social Science Data Services, 2013) .

Appendix F: Score-Sheet Analysis of the Sum of All Acceptable Scores per User per Evaluator

Analysis of the sum of all acceptable scores per user per evaluator:

Table 15

Analysis of the Sum of all Acceptable Scores per User per Evaluator (Hallgren, 2012; Landers, 2011, 2011)

ICC for Evaluator 1, Evaluator 3 and Evaluator 3*	ICC for Evaluator 1 and Evaluator 2*	ICC for Evaluator 1 and Evaluator 3*	ICC for Evaluator 2 and Evaluator 3*
0.366 ($p < 0.05$)	0.367 ($p = 0.15$)	0.120 ($p = 0.108$)	0.546 ($p < 0.005$)

*Note: Cells with data that are not statistically significant (p is not < 0.05) are shaded.

Appendix G: Score-Sheet Analysis of Recoded Values

Analysis of recoded values:

Table 16

Analysis of Recoded Data

	Steps of Adult Oral Endotracheal Intubation	ICC 1, 2 and 3*	ICC 1, 2*	ICC 1, 3*	ICC 2, 3*
1	Establishes proper patient axis.	0.364 (p = 0.001)	0.212 (p = 0.104)	0.201 (p = 0.144)	0.787 (p < 0.05)
2	Opens mouth.	0.132 (p = 0.146)	0.098 (p = 0.328)	– 0.068 (p = 0.621)	0.369 (p < 0.037)
3	Introduces laryngoscope blade into right side of oropharynx.	0.218 (p = 0.022)	0.173 (p = 0.181)	0.148 (p = 0.165)	0.343 (p = 0.042)
4	Advances blade until tip is situated in the vallecula (MacIntosh) or supporting the epiglottis (Miller), blade in midline.	– 0.036 (p = 0.612)	– 0.075 (p = 0.644)	0.000 (p = 0.500)	0.000 (p = 0.500)
5	Elevates mandible with laryngoscope until vocal cords are visualized.	– 0.066 (p = 0.715)	– 0.142 (p = 0.754)	– 0.142 (p = 0.754)	0.000 (p = 0.500)
6	Avoids levering on teeth.	0.102 (p = 0.174)	– 0.078 (p = 0.656)	0.359 (p = 0.034)	– 0.088 (p = 0.700)
7	Uses cricoid pressure (BURP) to assist in visualization.	0.863 (p < 0.05)	0.787 (p < 0.05)	1	0.787 (p < 0.05)
8	Visualizes passing of endotracheal tube to proper insertion depth.	0.000 (p = 0.482)	0.000 (p = 0.500)	0.000 (p = 0.500)	0.000 (p = 0.500)
9	Pulls stylet back as tube passes through cords.	0.412 (p < 0.05)	0.115 (p = 0.294)	0.395 (p = 0.011)	0.620 (p< 0.05)
10	Removes stylet.	0.417 (p < 0.05)	0.389 (p = 0.013)	0.785 (p < 0.05)	0.267 (p = 0.056)
11	Inflates cuff.	0.385 (p = 0.001)	0.413 (p = 0.022)	0.477 (p = 0.007)	0.290 (p = 0.063)
12	Disconnects syringe.	0.658 (p < 0.005)	0.660 (p < 0.05)	0.838 (p < 0.05)	0.522 (p = 0.002)

*Note: Cells with data that are not statistically significant (p is not < 0.05) are shaded.

Appendix H: Evaluator Interview Script

Answer the following questions to the best of your abilities:

1. “List any strengths of the” videotaped intubation practice (Chaney, 2012).
2. “List any weaknesses of the” videotaped intubation practice (Chaney, 2012).
3. “How can this” videotaped intubation practice “be improved?” (Wehrman, 2012).
4. “List any strengths of the” evaluation method (Chaney, 2012).
5. “List any weaknesses of the” evaluation method (Chaney, 2012).
6. “How can this” evaluation method “be improved?” (Wehrman, 2012).
7. “Please share any additional comments you may have” (Wehrman, 2012).
    - What did you do when you could not see something on the video ?
    - What did you do to ensure that all students are marked based on the same criteria ?

Appendix I: Student Interview Script

Answer the following questions to the best of your abilities:

1. "List any strengths of the" online learning module (Chaney, 2012).
2. "List any weaknesses of the" online learning module (Chaney, 2012).
3. "How can this" online learning module "be improved?" (Wehrman, 2012).
4. "List any strengths of the" videotaped intubation practice (Chaney, 2012).
5. "List any weaknesses of the" videotaped intubation practice (Chaney, 2012).
6. "How can this" videotaped intubation practice "be improved?" (Wehrman, 2012).
7. "Please share any additional comments you may have" (Wehrman, 2012).
    - What was your mindset before coming to the lab ?
    - Did you ever spend time mentally practicing skills that you just learned?
    - Do you think that your previous knowledge of airway management such as using the KingLT® (King Systems, 2010) helped?

Appendix J: Athabasca University Research Ethics Review Committee Approval

Athabasca University
CENTRE FOR DISTANCE EDUCATION

Research Ethics Review Committee

Memorandum

DATE: November 7, 2013

TO: Mr. Vlad Chiriac

COPY: Dr. Tom Jones, Dr. Martha Cleveland-Innes (Research Supervisors)
Alice Tieulié, Acting Secretary, Athabasca University Research Ethics Board
Dr. Vive Kumar, Chair, Athabasca University Research Ethics Board

FROM: Dr. Marguerite Koole, Chair, CDE Research Ethics Review Committee

SUBJECT: **Ethics Proposal #CDE-13-10: "*Teaching Psychomotor Skills to Paramedic Students*"**

The Centre for Distance Education (CDE) Research Ethics Review Committee, acting under authority of the Athabasca University Research Ethics Board to provide an expedited process of review for minimal risk student researcher projects, has reviewed the above-noted proposal and supporting documentation.

I am pleased to advise that this project has been awarded **APPROVAL TO PROCEED**. **Prior to starting the research, a revised application is to be submitted** showing the required changes and additional information requested below, **for file purposes only**. Please show all revisions by using yellow-highlighting additions and ~~yellow-highlighting with strikethrough~~ for deletions.

1. **Appendices F-1, F-2, F-3, F-4: Student Consent Form**
   Just to reiterate the limitations of withdrawing from the study, you may wish to reword this phrase:

   I understand that, even though I answered yes to other questions, I can withdraw from the research study at any time, without penalty, and do not have to give any reason for withdrawal.

   to:

   I understand that, even though I answered yes to other questions, I can withdraw from the research study at any time until the completion of the thesis, without penalty, and do not have to give any reason for withdrawal.

Please forward the revised application to rebsec@athabascau.ca

This approval of your application will be reported to the Athabasca University Research Ethics Board (REB) at their next monthly meeting. The REB retains the right to request further information, or to revoke the approval, at any time.

The approval for the study "as presented" is valid for a period of one year from the date of this memo. If required, an extension must be sought in writing prior to the expiry of the existing approval. **A Final Report is to be submitted when the research project is completed.** The reporting form can be found online at http://www.athabascau.ca/research/ethics/ .

As implementation of the proposal progresses, if you need to make any significant changes or modifications, please forward this information immediately to the CDE Research Ethics Review Committee via rebsec@athabascau.ca for further review.

1 University Drive, Athabasca, AB, T9S 3A3 Canada
P: 780.675.6179 | Toll-free (CAN/U.S.) 1.800.561.4650 (6179)
mde@athabascau.ca | cde.athabascau.ca | athabascau.ca

If you have any questions, please do not hesitate to contact the Committee Chair (as above), or the AU Research Ethics Administrator at rebsec@athabascau.ca .
Sincerely,

Dr. Marguerite Koole
Centre for Distance Education

Appendix K: Durham College Research Ethics Board Study Approval

DURHAM COLLEGE
SUCCESS MATTERS

Vlad Chiriac
c/o Durham College
2000 Simcoe St.
Oshawa, ON
L1H 7K4

December 20, 2013

REB application: 053-1314 Vlad Chiriac - Teaching Psychomotor Skills to Paramedic Students

Dear researcher,

The Durham College Research Ethics Board (REB) has considered your applications for ethical review of your research study and related documentation, and hereby grants approval for the above-named study. This approval is valid for a one-year period commencing on *December 20, 2013* and will expire on *December 20, 2014*. The approval is based on the following:

1. All protocols from your revised application submitted on December 5, 2013 are adhered to;
2. Any unanticipated issues that may increase risk to participants or have other ethical implications that may affect participants' welfare must be reported to the REB immediately and without delay;
3. The REB must be informed of any substantive protocol changes prior to any changes being implemented;
4. If you require an extension, a study renewal request must be submitted no less than 30 days prior to the expiry of this approval; and
5. Upon completion of the projects, a study completion report must be submitted on or before the expiry of this approval.

Forms are available on ICE for all reporting requirements *(http://ice/ResearchServices/AppliedResearch/Pages/ResearchEthics.aspx)*. Please submit all documentation and communications to reb@durhamcollege.ca.

If you have any questions, please feel free to contact me. On behalf of the REB, I'd like to wish you every success with your project.

Sincerely,

Dr. Deborah Tsagris
Acting Chair, Research Ethics Board

Oshawa Campus
2000 Simcoe Street North
Oshawa, Ontario, Canada L1H 7K4
T: 905.721.2000
www.durhamcollege.ca