Use of Instructional Videos in Remediation to Enhance Dental Hygiene Students’ Restorative Skills

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Use of Instructional Videos in Remediation to Enhance Dental Hygiene Students’ Restorative Skills

A Thesis

Presented in Partial Fulfillment of the Requirements for the Degree of Masters of Science in Dental Hygiene in the College of Graduate Studies Eastern Washington University

by Cristina Lu

Spring 2017

Major Professor:

Ann O’Kelley Wetmore
THESIS OF CRISTINA LU APPROVED BY

Ann O'Kelley Wedmore  DATE 4/5/2017
ANN O'KELLEY WEDMORE, MSDH, GRADUATE STUDY COMMITTEE

Lorie Speer  DATE 4/5/2017
LORIE SPEER, MSDH, GRADUATE STUDY COMMITTEE

Meryl R. Gersh  DATE 4/5/2017
MERYL R. GERSH, PT, PhD, GRADUATE STUDY COMMITTEE
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Date 04/18/2017
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Principal Investigator/Title/Department/Address/Phone/email
Cristina Lu, RDH, BSDH
Graduate Student
Dental Hygiene Department
10924 E. 5th Court
Spokane, WA 99206
509-768-3056
chalsl@eagles.ewu.edu

Mailing address/phone, email or fax where you can be reached
(note: only provide mailing address on original not on copies)

Title of Project
Use of Instructional Videos in Remediation to Enhance Dental Hygiene Student's Restorative Skills

For students only: Is this research being done to meet a course, thesis or other academic requirement? (please specify)
If not, why is it being done? Yes, this research is for thesis credit completion of DNYH 600

Project anticipated starting date
October 13th, 2016

Anticipated termination date
November 10th, 2016

Funding:
Non-funded

Funding status: proposal in preparation pending agency decision funded

Funding Agency (if applicable): Grant or Contract Number:

Check the type of exemption applicable to the project

1. x 2. 3. 4. 5. 6. None

Why should this project be considered exempt?
The study is examining the effectiveness of the use of the instructional videos in the restorative laboratory. There will be no consequences or retaliation for a student to decide whether or not to participate in the study. All data will be de-identified with Principal Investigator assigned unique identification number for each participant. All collected data will be kept strictly confidential and results will be reported anonymously.

Please state the purpose and methodology of the research:
The purpose of this study is to investigate whether in providing restorative remediation to dental hygiene students, the use of the instructional videos predicts improvement in their restorative skills. Remediation ensures dental hygiene students are clinically competent upon graduation, be able to uphold the standard of care, and thus readies them to successfully obtain license. Although remedial intervention have been used in assisting students' performance in dental hygiene programs (Branson & Toves, 1999; Freudenthal & Bowen, 2010; Holt, 2005), faculty's heavy workload, and faculty availability are factors posing the greatest remediation challenges (Woods et al., 2014). Common remediation methods include skill acquisition using typodonts, one-on-one faculty instruction, and additional supervised clinical practice time, with one-on-one faculty instruction being the most common method for clinical remediation (Branson & Toves, 1999; Holt, 2005). All of these methods require faculty direct supervision, and often an increased workload for the faculty (Collins, Zauske, Kenkulu, & Thompson, 2007a). Considering these challenges, this study seeks to explore the effectiveness of a specific method for restorative remediation. There are several studies in the literature on different types of instructional methods; and instructional videos have shown to enhance dental students' learning experiences in the restorative laboratory (Aragon & Zibrowski, 2008; Gadbury-Anyou, Park, Williams, & Van Ness, 2014; Patel et al., 2015).

This is a mixed method study using counterbalanced design. A timed-carving (TC) is a practical examination used to examine students’ restorative skills in the laboratory. The research design consists of gaining permission to use the timed-carving scores, self-evaluation data of a volunteer cohort of senior dental hygiene students. As a part of the restorative course, students are required to perform timed-carvings, self-evaluate their timed-carvings, and watch 2 different videos, step-by-step instructional video and evaluation video on mobile devices in restorative lab. Students will be randomly assigned to two groups. Each group will watch the videos in different orders. Group 1 will watch the video in the order of A-B, and Group 2 will watch the video in the order B-A. Quantitative data from timed carving scores prior to and after watching the videos will be gathered. The use of the instructional videos in restorative laboratory is considered the independent variable; and the dental hygiene student's restorative skills is the dependent variable. Qualitative data will be analyzed using open-ended questionnaires to assess student’s perception towards the use of videos in remediation on restorative procedures.
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Exemption Decision Aid

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(Quoted from the Code of Federal Regulations, Title 45, Part 46.101(b)(1-6))

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2. Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior, unless: (i) information obtained is recorded in such a manner that the human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or of being damaged to the subjects' financial standing, employability, or reputation.

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4. Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

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Based on both federal policy and/or University policy, exempt status may not be granted for research in the preceding six categories if any of the following conditions applies (except for certain exemptions for children).

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*Children are persons who have not attained the legal age for consent to treatments or procedures involved in the research, under the applicable law of the jurisdiction in which the research will be conducted. If subjects have the legal status of emancipated minors, or are mature minors, i.e., they may legally be treated as adult for certain purposes, they may be exempt from the restrictions applicable to children.

rev. 5/31/06
Abstract

Purpose: Performing restorative procedures is one of the scopes of practice for dental hygienists in Washington State. To ensure dental hygiene students are clinically competent with their skills upon graduation, remediation is inevitable. However, with current challenges faculty face with traditional remedial interventions such as heavy workload and faculty availability, an alternative effective method of providing restorative remediation for dental hygiene students would be beneficial. This study investigated whether the use of instructional videos in remediation enhanced dental hygiene students’ restorative skills.

Methods: This mixed-method study used a convenience sample of senior dental hygiene students. In this counterbalanced experimental design, students were randomly assigned to two groups. Each group watched the videos in different orders. Group 1 watched the videos in the order of A-B, and Group 2 watched the videos in the order B-A. Quantitative data from pre-test and post-test timed carving scores were collected. Students were required to self-evaluate their own timed carvings before turning them in using the WREB carving grading rubric. Qualitative data were gathered using open-ended questionnaires.

Results: Study results indicate an increase in students’ self-evaluation skills after watching the instructional videos. There were 36.2%, 12.5% and 6.3% increase in the percentage of agreement on Occlusal, Proximal and Margins criteria, respectively in Group 2 students and 20.1%, 0% and 6.7% increase in the percentage of agreement on Occlusal, Proximal and Margins criteria, respectively in Group 1 students. Although
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significant improvement in students’ restorative performance subsequent to the instructional videos exposure was not detected ($p > .05$), there were less failures after the exposure to both videos in both groups. Additionally, results show a direct correlation between students’ self-evaluation skills and restorative skills. Finally, data reveals students’ positive perception towards the use of the instructional videos in restorative laboratory.

**Conclusion:** In order to serve the community safely, competency upon graduation is a must. It is the responsibility of educators to provide appropriate means and support to ensure student success. Instructional videos may be used as a helpful alternative remedial intervention in providing restorative remediation for dental hygiene students who struggle with poor performance.
Acknowledgements

I would like to thank my thesis committee members, Eastern Washington University dental hygiene students and restorative faculty members for the continuous support of my Master study and research. First, I would like to express my sincere gratitude to my thesis chair Professor Ann O’Kelley Wetmore, MSDH, EWU Program Director for her guidance, encouragement and immense knowledge. Her guidance helped me in all the time of research and writing of this thesis. Next, I wish to acknowledge Professor Lorie Speer, MSDH, of EWU for her continuous support, insightful comments and showing commitment to my success. Finally, I would like to acknowledge Dr. Meryl R. Gersh, PT, Ph.D, of EWU who welcomed my research and remained a positive influence throughout the experience.
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Introduction/Literature Review

Introduction to the Research Question

In order to prepare dental hygiene students for clinical practice, they must meet specific standards of competency (Commission on Dental Accreditation [CODA], 2016). The scope of practice of a licensed dental hygienist in Washington State includes providing dental hygiene services, administering local anesthesia, and placing dental restorations (Washington State Department of Health, 2016). The Western Regional Examining Board (WREB) is one of the testing agencies in the United States that provides a reliable evaluation of dental and dental hygiene students’ clinical competency (WREB, 2011). In order to obtain dental hygiene licensure, dental hygiene students in specific geographic regions need to successfully complete WREB examinations. Results of the 2012 WREB indicate the number of candidates passing the restorative examinations was 74% compared with 96% scores for the dental hygiene clinical examination, and 89% passing scores for the local anesthesia examination (Popp, 2013). These results suggest remedial interventions during dental hygiene candidates’ educational experiences may increase passing rates for the restorative examination. In addition, remediation may ensure that upon graduation, dental hygiene students are clinically competent to uphold the standards of care and provide the best patient care for the community.

Psychomotor skills are integral to the success of dental hygiene students. Accomplishing complex skill acquisition and fulfilling competency-based curricular objectives are crucial to certify students graduate as qualified and competent oral
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healthcare providers who serve the needs of the community. Research shows skill
difficulty accounts for 56% of student attrition (Holt, 2005) and the area in the greatest
need for remediation is instrumentation technique (Wood, Villalpando, Mitchell, Holt, &
Branson, 2014). Although remedial interventions have been used in assisting students’
performance in dental hygiene programs (Branson & Toevs, 1999; Freudenthal &
Bowen, 2010; Holt, 2005), there are many barriers to conducting successful remediation
plans. According to Wood et al. (2014), faculty heavy workload, availability, and the
process of selecting the most beneficial instructional methods are factors posing the
greatest remediation challenges. When these limiting factors are taken into consideration
with the recent history of poorer restorative WREB scores, an opportunity is presented
for further research to address these issues.

Statement of the Problem

Remediation is recommended when students are unable to demonstrate adequate
basic skills or competencies. Even though remedial intervention has been used in many
academic institutions, the barriers mentioned previously pose a challenge when
attempting to implement a remediation strategy (Wood et al., 2014). Common
remediation methods include skill acquisition using typodonts, one-on-one faculty
instruction, and additional supervised clinical practice time, with one-on-one faculty
instruction being the most common method for clinical remediation (Branson & Toevs,
1999; Holt, 2005). All of these methods require faculty direct supervision, and often an
increased workload for the faculty (Collins, Zinskie, Keskula, & Thompson, 2007a).
Considering the above mentioned factors and challenges, this study explores the
effectiveness of a specific method for restorative remediation. There are several studies
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in the literature on different types of instructional methods; and instructional videos have been shown to enhance dental students' learning experiences in the dental laboratory (Aragon & Zibrowski, 2008; Gadbury-Amyot, Purk, Williams, & Van Ness, 2014; Patel et al., 2015). Therefore, in this study, the Principal Investigator (PI) attempted to answer the following questions: Does watching a step-by-step instructional video impact students’ performance in restorative procedures? Does watching a self-evaluation instructional video affect students’ ability to accurately self-assess their work? Does the order in which students watch the instructional videos affect their overall restorative performance? Finally, do students who use the videos in the restorative laboratory setting perceive that the videos enhance their learning experiences?

Overview of Research

To provide an in-depth understanding of this topic, a thorough literature review was conducted. Several subtopics are discussed in detail to assist readers in further understanding the importance of seeking a specific restorative remediation method, and the use of videos as a teaching aid in dental hygiene laboratory.

Definition of remediation in higher education. In higher education, remediation programs are intended to bolster the skills of underprepared students so they are adequately prepared for postsecondary coursework (Bailey & Cho, 2010). According to the National Conference of State Legislatures (2016), remedial education refers to “classes taken on a college campus that are below college-level” to help students improve basic skills such as mathematics, writing, and reading (What is Remedial Education? section, para. 1). This definition mainly refers to programs that assist students in preparing for college-level work. Not only helping underprepared students be successful
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in college-level coursework, remediation programs are also used in healthcare professional programs to assist students who fail to demonstrate adequate competencies (Branson & Toevs, 1999; Cleland, Mackenzie, Ross, Sinclair, & Lee, 2010; Freudenthal & Bowen, 2010; Guenzel & Knight, 1992; Sifford & McDaniel, 2007). Competency upon graduation is a must in dental hygiene programs because oral healthcare professionals are responsible for oral health of the community. For the purpose of this study, remediation refers to remedial activities that aim to strengthen the skills of under-performing students so they can increase their skills to competent level. Although this definition is not well-defined in the literature, several examples in the literature support the above definition (Branson & Toevs, 1999; Cleland et al., 2010; Freudenthal & Bowen, 2010; Guenzel & Knight, 1992; Sifford & McDaniel, 2007). In many academic institutions such as medical, nursing, dental and dental hygiene programs, remediation is required when students exhibit poor performance, and fail to demonstrate adequate competencies.

**Scope of practice of the dental hygienist.** Being competent in all dental hygiene facets ensures the quality of care for patients and readies dental hygiene students to successfully obtain licensure. In order to work as a registered dental hygienist, students must obtain a dental hygiene license. Each state enacts its own laws determining the scope of practice and level of supervision the dental hygienist is required to work under. Over four decades ago, dental hygienists in Washington State were only allowed to perform traditional dental hygiene therapy and examinations. The expansion of dental hygiene scope of practice began with the passing of legislation in Washington State in 1971 (Washington State Dental Hygienists’ Association [WSDHA], 2015). In addition to
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traditional dental hygiene duties, current practices in Washington state allow a licensed dental hygienist to “[p]erform soft-tissue curettage, [g]ive injections of a local anesthetic, [p]lace restorations into the cavity prepared by the dentist, and thereafter could carve, contour, and adjust contacts and occlusion of the restoration, [a]dminister nitrous oxide analgesia, [p]lace antimicrobials” under the dentist’s close supervision (Washington State Department of Health, 2016, para. 1). These expanded duties are supported by the dentists because they enable dental hygienists to expand specific duties to meet increasing patient care needs and facilitate office work flow (WSDHA, 2015). For example, a dental hygienist can administer local anesthesia, place or remove temporary restorations or crowns, and place amalgam and composite restorations when the dentist is not available.

Since 1971, the scope of dental hygiene practice has continued to expand across the United States. Figure 1 shows the number of states moving to expanded duties. In addition to administering local anesthesia and nitrous oxide, dental hygienists were also allowed to perform some limited restorative procedures. For the purpose of this study, only restorative expanded functions are discussed. Depending on the law of each state a dental hygienist may “[a]pply cavity liners/bases, [p]lace (and also carve and finish) amalgam restoration, [p]lace and finish composite restoration, [p]lace and/or remove temporary restoration, [p]lace and/or remove temporary crowns, [f]abricate temporary crowns” (American Dental Hygienists’ Association [ADHA], 2015, para. 2). According to ADHA (2016), 33 states allow dental hygienists to perform limited restorative procedures. However, there are currently only 15 states allowing dental hygienists to actually place, carve, and finish amalgam and composite restorations while other states
only allow dental hygienists to apply liners and bases, place and remove temporary restorations and temporary crowns. It is important to note that dental hygienist holding a restorative endorsement in Idaho can only practice in an extended access oral health care program such as community clinics (Idaho State Board of Dentistry, 2011).
### Table 1: Dental Hygiene Restorative Duties (ADHA, 2016)

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<th>State</th>
<th>Apply Cavity-Liners and Bases</th>
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<th>Place/Remove Temporary Crowns</th>
<th>Place/Carve/Finish Amalgam Restoration</th>
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*Can do services by virtue of inclusion in dental assistants’ scope of practice

**Allowed for an RDH, RDHIF, or RDISAP licensed prior to 2006

Figure 1. Dental Hygiene Restorative Duties (ADHA, 2016)
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The restorative procedures performed by a dental hygienist are mostly supportive services and require dental supervision (Washington State Department of Health, 2016). The dentist prepares a tooth for a restoration, and the dental hygienist places and finishes a restoration using amalgam or composite material. To legally perform restorative duties, dental hygienists must obtain a restorative certificate, endorsement, or permit upon the completion of a state dental board approved course. While it is optional to obtain an additional restorative certificate or endorsement to practice restorative procedures in other states, Washington State is an exception. Regardless whether dental hygiene students have a desire to practice restorative services in clinical practice or not, Washington State requires students to demonstrate their competence in restorative procedures in order to obtain a dental hygiene license (Washington State Department of Health, 2016). To ensure dental hygiene students are competent in restorative skills upon graduation, and successfully pass the restorative WREB examination, restorative courses are incorporated into the curriculum of all dental hygiene programs in Washington State. All dental hygiene students in Washington State are required to complete all of the restorative courses in the curriculum. Although there are some differences in educational training between in-state and out-of-state dental hygienists, new graduate dental hygienists relocating to Washington State are also required to demonstrate competency in restorative before they can obtain a Washington State dental hygiene license. Since new graduate dental hygienists from other states do not have previous restorative training from a CODA accredited dental hygiene curriculum, they are required to attend an additional expanded function education course, and successfully pass the WREB restorative examination in order to obtain a Washington State dental hygiene license. For
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dental hygienists who are licensed in another state and have 560 hours of clinical practice in the preceding 24 months, an initial limited license can be obtained and renewed without a restorative endorsement (WSDHA, 2016).

**Effectiveness of remediation in academic institutions.** It is a concern of many program directors to ensure dental hygiene students successfully pass regional clinical examinations, and perform as competent practitioners in clinical practice. Remediation is required when students are experiencing learning difficulties and unable to demonstrate adequate competencies. This method is effective in improving students’ performance in many academic institutions. A retrospective, observational study by Cleland et al. (2010) showed remedial intervention predicts improved performance of medical students \(N = 909\) in the subsequent examinations. Medical students at University of Aberdeen who failed one or both of the formative exams were required to attend an individual interview with two academic members. A variety of methods (extra clinical and communication skills training in simulated settings) and resources (medical/disability assistance, etc.) were recommended based on the identified problems to assist students with the remediation process. Exam performance was compared between students who received remedial intervention \(n = 198\) and those who did not \(n = 711\). These medical students’ performance increased significantly after receiving the remedial intervention \(p < .001\). Similarly, another study supports the effectiveness of remediation in nursing programs (Siffford & McDaniel, 2007). Nursing students \(N = 47\) who were identified as at risk for failure on the National Council Licensure Examination (NCLEX) (failed to achieve a passing score at an exit examination- “[a] computerized, comprehensive exit exam that uses a predictability model (HPM) to compare individual students with
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students throughout the United States…with more than 90% accurate in predicting NCLEX success and more than 96% accurate in predicting license failure”) were required to attend a two-credit hour remediation class for 15 weeks (Sifford & McDaniel, 2007, p. 35). An exit examination was re-administered following the remedial intervention. The results of this study suggest significant improvement in students’ scores following the remedial intervention (\( p < .001 \)) (Sifford & McDaniel, 2007).

Additionally, remedial intervention is also utilized in the dental and dental hygiene schools (Branson & Toevs, 1999; Guenzel & Knight, 1992). With a response rate of 80% (\( n = 181 \)), a survey of U.S. dental hygiene programs (\( N = 227 \)) conducted by Branson and Toevs suggests “remediation is an integral part of clinical skill acquisition in dental hygiene education” (1999, p. 204).

**Remediation methods.** Common remedial methods used include one-on-one faculty instruction, typodont practice, and extra clinic time under one-on-one faculty supervision or standard supervision. One-on-one faculty instruction is the most common method for clinical remediation (Branson & Toevs, 1999; Holt, 2005). In a survey of randomly selected associate degree, entry-level dental hygiene programs (\( N = 31 \)), 80% (\( n = 25 \)) reported most dental hygiene programs utilized one-on-one faculty remediation instruction (Holt, 2005). Similarly, Branson and Toevs (1999) investigated U.S. dental hygiene programs on their remediation policy, and reported one-on-one faculty instruction is the most common method for clinical remediation. Additionally, research studies demonstrate one-on-one tutoring is an effective form of instruction (Jayakumar, Albasha, & Annan, 2015; Merrill, Reiser, Merrill, & Landes, 1995). According to Jayakumar et al. (2015), students who failed in-course assessment (ICA) (\( n = 47 \))
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significantly improve their scores after receiving one-on-one peer tutoring ($p < .001$). A study conducted by Merrill et al. (1995) drew a similar conclusion about the effectiveness of one-on-one tutoring. It was found errors during problem-solving can lead to students’ confusion and frustration. Additional guidance and confirmatory feedback from tutors helps ensure students stay on track during the problem solving process and enhance their learning experiences (Merrill et al., 1995).

**Challenges of remediation.** Research studies mentioned above demonstrate one-on-one faculty instruction is an effective strategy for fostering student’s learning. However, it is a challenging remediation method to implement because of the dental hygiene faculty shortage, and the necessary increase of faculty’s devotion, time, and efforts in remedial activities.

**Shortage of dental hygiene faculty.** The number of dental hygiene educational programs in the U.S. has increased gradually over years, with 3.7%, 17.5%, 31.4%, and 55.8% increase in five years (2010-2014), 10 years (2005-2014), 15 years (1000-2014), and 20 years (1995-2014), respectively (ADHA, 2014). As the number of educational programs increase, there is a higher demand for dental hygiene educators. However, according to the U.S. Census Bureau, the baby boomers turned 65 in 2011; and as all baby boomers reach the age of 65 or above in 2029, greater than 20% of the total population in the U.S. will be over 65 years old (Colby & Ortman, 2014). As baby boomers retire from the workforce, there is a change in the United States workforce, and subsequently dental hygiene education settings because “[t]hey are not the only the largest group to enter retirement; they are also the most educated, wealthiest and most diverse generation to enter retirement” (Rhea & Bettles, 2011, p. 25). Indeed, in a survey
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(N = 781, comprising 632 dental hygiene educators and 149 program directors) conducted by Coplen (2010), greater than 90% of respondents perceived clinical, educational and technological skills were important skills in future qualified dental hygiene educators, with educational skills be paramount.

Current studies in the literature indicate half of the full-time dental hygiene faculty members are at their retirement age. With an increasing number of faculty members reaching retirement age, many dental hygiene programs are facing a shortage of experienced teaching faculty members (Carr, Ennis, & Baus, 2010; Collins et al., 2007a; Coplen, Klausner, & Taichman, 2011). The most recent survey of Allied Dental Program Directors also found that 32.5% of dental hygiene faculty range in age from 50-59 years and 19.1% are age 60 and above (American Dental Education Association [ADEA], 2015). The aging of the baby boomers remains similar in comparison to the findings from literature in 2007-2008. In a study conducted by Collins et al. (2007a), characteristics of full-time faculty (N = 167) in baccalaureate dental hygiene programs were investigated. With a response rate of 68.3% (n = 114), the study revealed the average age of faculty members was 50.2 years, with 56% of faculty age 50 or above. Out of 70 respondents 56% (n = 39) planned to retire in ten years or less, and 27% (n = 19) planned to retire in five years or less. Similarly, Coplen et al. (2011) also conducted an online survey using SurveyMonkey™ software to determine the status of current part-time and full-time dental hygiene faculty in different academic settings and qualification for future faculty. While the Collin et al.’s study focused only on full-time faculty in the baccalaureate dental hygiene programs, Coplen et al.’s study investigated both part-time and full-time dental hygiene educators across the nation. A forty-item questionnaire was
sent to dental hygiene educators ($N = 978$) in the United States with $65\%$ ($n = 631$) response rate. Reported faculty ages in this study were similar to Collins et al.’s study (2007a). On the other hand, this study reported there were only $9.5\%$ ($n = 60$) who planned to retire from the workforce at this time. This number was notably less than the results reported in Collins et al.’s study. The difference in this aspect may be due to the number of new dental hygiene educators who already filled in positions of those retired faculty, and the difference in the sample characteristics of these two studies. Additionally, although Coplen et al.’s study provided overview information regarding dental hygiene educators across the United States, the sampling technique may introduce bias into the results of this study. Unless the sample reflected the real distribution of the part-time and full-time faculty members in the dental hygiene programs, the results of this study may be skewed.

In addition to aging and retirement, compensation also contributes to the faculty shortage. Compensation difference between educational settings and private practice is one of the reasons more graduate dental hygienists prefer private practice rather than academia (Carr et al., 2010; Collins et al., 2007a). Of the 112 respondents, $14.3\%$ ($n = 16$) of full-time baccalaureate dental hygiene faculty were very satisfied with their salary, with the majority somewhat satisfied ($33%, n = 37$), somewhat dissatisfied ($32.1%, n = 36$), and very dissatisfied ($20.5%, n = 23$) (Collins et al., 2007a). Although pursuing a career in academia provides a great opportunity for professional development, retirement planning, medical insurance, extensive time off, and stable income, educational settings offer lower salaries in comparison to private practice (Majeski, 2006). Additionally, to pursue a career in academia, a dental hygienist must have at least a bachelor’s degree.
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CODA (2016) standard 3-7 indicates “[t]he full-time faculty of a dental hygiene program must possess a baccalaureate or higher degree[while] part-time faculty providing didactic instruction must have earned at least a baccalaureate degree or be currently enrolled in a baccalaureate degree program” (Faculty section, para. 3). According to American Dental Association (ADA), only 9.6% of 323 dental hygiene education programs in the U.S. offer Baccalaureate degree, while 83% offer Associate’s degree (2011). This means that in order to pursue a career as a dental hygiene educator, advanced dental hygiene education is required for many dental hygienists. The average estimated cost of tuition and fees for an associate degree in dental hygiene is $22,692, for a baccalaureate degree is $36,382 and a master’s degree is $30,421 (ADA, 2014). Lower remuneration and the indebtedness of most new entry-level students are factors that discourage many from pursuing advanced education and choosing to work in educational settings. As Coplen et al. (2011) stated, while a large percentage of dental hygienist educators will soon be replaced in the future, the number of dental hygienists enrolled in graduate programs is small in comparison with the need for qualified, credentialed, and diverse educators.

In contrast, recent surveys from both ADHA and ADEA report increases in the new dental hygiene educator workforce. The ADEA Survey of Allied Dental Program Directors reported the total number of new dental hygiene faculty in the academic year 2013-2014 was 605, with the majority (75%) in part-time positions. The total number of faculty who left was 300, with the majority (71.3%) also in part-time positions (ADEA, 2015). This difference indicates the growing of the dental hygiene profession, and increase in the dental hygiene educator workforce replacement of the aging faculty members who are at retirement age. In fact, while the retirements for the next five years
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will approximately lead to 292 vacant and lost positions in dental hygiene programs, the average enrollment in Dental Hygiene Master’s Degree program was 63-111 students per year, with 111 was the highest number of enrollment in 2010. Similarly, the average enrollment in Dental Hygiene degree completion programs was 299-573, with 573 being the highest number of enrollment in 2011 (ADHA, 2014). Out of the total number of students enrolled in the advanced dental hygiene education, over 75% are interested in teaching (ADHA, 2014). These current data indicate there is a need for new dental hygiene faculty at this time. However, since there are many students pursuing advanced education to become dental hygiene educators every year, this current shortage does not negatively impact the dental hygiene educational programs. Although it was documented by Collins et al. that there was noticeable shortage in the dental hygiene educators due to the aging and retirement of the baby boomers, this research study was conducted in 2007. Necessary strategies could have been implemented in the past to expand the dental hygiene educator workforce. Figures 2 and 3 illustrate the enrollment in Master degree and degree completion program, with the highest average of enrollment per program in 2010-2011 (ADHA, 2014).
Figure 2. Master degree Dental Hygiene enrollment (ADHA, 2014)

Figure 3. Degree completion Dental Hygiene enrollment (ADHA, 2014)
**Faculty workload.** There are a variety of academic settings offering dental hygiene programs such as universities or four-year-college, community colleges, technical colleges or institutes, vocational schools, and others (ADA, 2014). Faculty work responsibilities depends on the institution type and setting. According to Boyer (1990), full-time baccalaureate dental hygiene faculty are responsible for conducting research and clinical practice in addition to the teaching and service. In Collins et al.’s study (2007a), a 25-item survey was sent out to full-time dental hygiene educators ($N = 167$) in 29 baccalaureate dental hygiene programs in the United States to investigate their characteristics and job satisfaction. With a response rate of 68.3% ($n = 114$), this study revealed dissatisfaction of the baccalaureate full-time faculty members in some aspects such as heavy workload, and inadequate compensation. Only 26.1% ($n = 29$), 23.4% ($n = 26$), and 25.2% ($n = 28$) of faculty members were very satisfied with their available time for working with students, academic workload, and class preparation respectively. The majority (73.8%, 76.5%, 73.8%, respectively) were somewhat satisfied, somewhat dissatisfied, or very dissatisfied in these aspects. In fact, while some faculty reported having some adjustments in their clinical workload, the majority (83%, $n = 150$), of the faculty members reported they receive no additional compensation for providing clinical remediation (Branson & Toevs, 1999; Holt, 2005, Wood et al., 2014).

Similarly, Collins et al. conducted another study in 2007 to further assess the institutional responsibilities and workload of baccalaureate dental hygiene faculty. A 25-item survey was sent to 29 baccalaureate dental hygiene programs. With a response rate of 68.3% ($n = 114$), faculty members reported an average work week of 50.5 hours, which included 46.9 hours spent on paid activities (teaching, clinical service, class
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Preparation, research, administration) and 3.6 hours spent on unpaid activities. Descriptive statistics revealed faculty spent significantly more time in teaching undergraduate students, and performing institutional service while they preferred to spend more time in teaching graduate students, conducting research, professional growth, and public service. These findings further explained why the majority of faculty members were divided between somewhat satisfied and somewhat dissatisfied in regard to the availability, academic workload, and class preparation. Furthermore, it was found full-time baccalaureate dental hygiene faculty had a heavier workload than associate’s institutions due to higher research expectations, more service commitment, and clinical practice activities, and less course preparation time (Collins et al., 2007b). Heavy teaching loads, and institutional service commitment were barriers that prevented faculty members from conducting research, and professional growth activities which are factors for promotion and tenure decisions in baccalaureate programs (Collins et al., 2007b).

There is a need for a new dental hygiene educator workforce as the aging baby boomers enter retirement. However, with a recent increase in dental hygiene educators, these vacant positions will potentially be filled in the near future. Nevertheless, it is still very beneficial to develop a specific method for restorative remediation because the literature shows full-time faculty members have limited available hours due to heavy teaching workload and other academic responsibilities. In order to ensure the safety in clinical practice, and the development of clinical competence, maintaining faculty to student ratios is crucial. According to CODA (2016), one to twelve is considered the maximum faculty to student ratio for restorative laboratory sessions. To facilitate learning experiences in the laboratory, these ratios could be decreased by providing more
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clinical instructors. However, it is challenging to justify more instructors because oftentimes the program is overseen by Deans and administrators who insist on using CODA as the standard to reduce costs for clinical faculty. Therefore, in dental restorative laboratory, it is challenging to provide one-on-one instruction for every dental hygiene student who is struggling with poor performance related to limited availability of faculty members. Due to issues with additional faculty workload, faculty availability, and compensation, one-on-one faculty instruction is considered a challenge when creating a successful remediation plan. Considering this challenge and other previously mentioned factors, a specific method for restorative remediation needs may prove beneficial.

The use of videos as a teaching aid in clinical settings. As mentioned previously, providing one-on-one tutoring for each student’s poor academic performance is impractical on a large scale. To attempt to remedy this, there have been various efforts to identify alternate strategies that afford students the benefits of individualized instruction. One area of research focuses on the use of videos as a teaching aid in clinical settings. Instructional videos have been used in dental laboratory settings to enhance students’ learning experience and improve their psychomotor skills. Previous studies show the use of instructional videos is effective in improving students’ clinical performance (Aragon & Zibrowski, 2008; Nikzad, Azari, Mahgoli, & Akhoundi, 2012). In a study conducted by Aragon and Zibrowski (2008), Class of 2008 second-year dental students (N = 55) were given copies of a 35-minute video including step-by-step procedures involved in the preparation of an all-ceramic tooth restoration and provisional crown fabrication. According to the authors, instructional videos were used due to the limited field of view during live demonstrations of restorative procedures in the dental
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laboratory. Students were encouraged to watch the restorative procedures as many times as they could during the course. The class of 2008 students \((n = 55)\) with exposure to the video performed significantly better \((p < .01)\) than the previous Class of 2007 \((n = 52)\) who had no exposure to the video. Additionally, these students also significantly outperformed their own performance \((p < .01)\) on the other clinical examinations when no teaching aids were introduced. The results of this study suggest instructional video may be a useful teaching aid in the fixed prosthodontics dental laboratory.

In contrast, other studies found no statistically difference in dental students’ performance between a group exposed to instructional videos and a control group receiving no video instruction (Gadbury-Amyot et al., 2014; Patel et al., 2015). In a pilot study conducted by Gadbury-Amyot et al. (2014) a stratified random sample of preclinical dental students \((N=30)\) at University of Missouri-Kansas City were chosen to participate. The sample was obtained randomly from a list of student volunteers. This increased the bias because these volunteer students may be more favorable towards this study, and may skew the study’s results. Difficult restorative procedures perceived by the laboratory instructors such as Class II composite preparation and restoration, and anterior veneer preparations were included in the videos. The videos included ideal and non-ideal models, step-by-step procedures, and walked students through each criterion on the grading rubric. As Gadbury-Amyot et al. (2014) suggested the use of instructional videos based on the cognitive theory of multimedia learning, the design of these videos facilitated visual and auditory learners. Additionally, these videos also facilitated a self-paced learning environment that students could control the pace of the video, and replay or skip any parts as needed. Apple iPad® 2 with accompanying instructional videos were
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provided to students during open lab. Participants were exposed to the instructional videos during open lab only and their restorative work products were evaluated independently by two different instructors during laboratory examinations. Students were required to self-assess their work product using a grading rubric. Self-assessment accuracy was also a part of the students’ grades. The study found no significant improvement ($p > 0.05$) in students’ performance in restorative procedures after the exposure to the instructional videos. According to the author, the lack of the attendance policy during the open lab and limited exposure to the videos of the experimental group contributed to the results of the study (2014).

Additionally, findings from Patel et al.’s randomized control study (2015) also suggested use of instructional videos did not improve first-year dental student’s performance in the preclinical settings. A convenience sample of first-year dental students ($N = 100$) at the University of Texas School of Dentistry were chosen as participants. Students were randomly divided into two groups, control ($n = 50$) and experimental ($n = 50$) groups. Three restorative procedures including Class I amalgam preparation, Class I amalgam restoration, and Class I composite restoration on #19 were selected because these procedures were in the course curriculum. All three procedures were introduced to students for the first time. Following lecture and before attending laboratory, the experimental group watched a 20-minute video while the control group watched a “placebo” video in two separate halls. These videos were developed professionally by faculty members, had been peer-reviewed, and used in the dental school curriculum for three years. In contrast to the Gadbury-Amyot et al.’s study (2014), this study’s design did not facilitate individualized learning because students could not
control the pace of the videos. Students were also required to self-assess their work product using a grading rubric, and their work products were evaluated by two calibrated blinded examiners. This study found no difference in students’ performance between the control and experimental groups (mean values on amalgam preparation score: 77.1 vs. 77.8; amalgam restoration score: 82.7 vs. 82.8; composite restoration score: 79.7 vs. 78.0).

The results from these two current studies imply that while instructional video is used as a teaching aid in the dental laboratory, the effectiveness of the instructional videos remains unclear. Although there are some controversies about use of instructional videos to improve students’ clinical performance, in these two studies with preclinical dental students, the use of videos has been proven to increase the students’ ability to accurately self-assess their work products and comprehend the concepts of the psychomotor techniques (Gadbury-Amyot et al., 2014; Patel et al., 2015). There has not been a study to investigate the use of videos as a tool for providing remediation on restorative procedures for dental hygiene students.

**Students’ perception towards the use of instructional videos in laboratory.** In addition to the effectiveness of the use of the instructional videos, students’ perception towards the use of the instructional videos was also explored in the literature. Regardless whether the use of the instructional videos predict improvement in students’ clinical performance in dental laboratory or not, the use of the instructional videos was perceived positively by dental students in previous studies. In Gadbury-Amyot et al.’s (2014) previously mentioned study, students’ perception data ($N = 30$) was collected using short questionnaires consisting of 4 items written in Likert Scale. Researchers developed this
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short questionnaire. Students perceived the use of iPad® technology and videos in the preclinical laboratory setting allowed them to perform better and self-assess their work product more accurately following the exposure to instructional videos hosted on an iPad®. Although participants were randomly selected by the SPSS system, they were randomly selected from a list of student volunteers. This increases the bias because these volunteer students may be more favorable towards this study, and may skew the result of the study. The similar study done by Patel et al. (2015) also showed significant difference (for amalgam preparation $p < .03$, amalgam restoration $p < .001$, composite restoration $p < .001$) in students’ perception of the impact of the videos between control and experimental groups. The results indicated while the exposure to the instructional video did not affect students’ performance on preclinical restorative procedures, the instructional videos were perceived by students as useful teaching aid in preclinical settings. Similarly, an earlier study conducted by Aragon and Zibrowski (2008) found 96% ($n = 48/50$) of students indicated via course evaluations that use of videos was helpful in preparing them for the clinical examination in the dental laboratory.

In contrast, Nikzad et al. (2012) found no statistical relationship ($p > .05$) between exposure to the videos and level of stress and anxiety among participants. Dental students ($N = 80$) in a preclinical prosthodontics course at the Tehran University of Medical Sciences were chosen to participate in this study. Dental students ($n = 40$) were randomly selected to watch the instructional video, while the others ($n = 40$) were trained with live demonstration only. A 16-item Likert scale questionnaire developed by researchers based on previously published data was administered to all of the participants ($N = 80$) to determine their perceptions towards the anxiety and stress level during the
laboratory procedures, self-confidence, and their ability to prepare a crown and fabricate a provisional restoration. Although this study revealed a statistically significant improvement \((p \leq .05)\) in students’ clinical performance after the exposure to the video in comparison to the group who had not \((p > .05)\), no significant relationship was found between the exposure to the video and the stress level among participants. Limitations in this study may include the use of a foreign language in the videos, and lack of the computer access in the dormitories. Since English was the main language used in the videos, Tehran students who were not proficient in English may not fully understand the content of the video. These limitations may skew this study’s results, and imply the importance of using English in developing instructional videos because all of the dental hygiene students in this study were proficient in English.

**Cognitive theory of multimedia learning.** While Aragon and Zibrowski, (2008) and Patel et al. (2015) suggested the use of the videos in the laboratory because of the inadequate field of view during a live demonstration, Gadbury-Amyot et al. (2014) suggested the use of videos based on the cognitive theory of multimedia learning. According to this theory, students are overloaded with a continuous stream of information during a traditional lecture presentation. When students are able to control the pace of the presentation or knowledge dissemination, they have more time to analyze and comprehend the materials before moving on to the next topic of the presentation, thus increasing their learning capacity (Mayer, 2001). An experiment by R. Mayer, Dow and S. Mayer (2013) supports the cognitive theory of multimedia learning. To learn how an electric motor works, students \((N = 37)\) were divided into the control \((n = 19)\) and experimental groups \((n = 18)\). The experimental group \((n = 18)\) were exposed to an
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interactive version of a presentation where they could control the pace of the presentation, while the control group (n = 19) were exposed to a non-interactive version. There were five main parts on the computer screen, each consisting of 13 questions and answers to help students learn about electric motors. This study found students in the experimental groups significantly generated more answers on the problem-solving transfer test than students in the control group (p = .0189). This result indicated students learned better when they were able to control the pace of the presentation. Although the effectiveness of the use of videos in improving students’ performance in dental laboratory experiences remains unclear in literature, these findings imply videos have potential as a helpful teaching aid in providing remediation on restorative procedures.

Motor skills theory. Research findings reveal that skill difficulty accounts for 56% of students’ attrition in the dental hygiene programs (Holt, 2005), and the area in the greatest need for remediation is instrumentation technique (Wood et al., 2014) suggesting psychomotor skills development is crucial in dental hygiene programs. To ensure dental hygiene students possess a high level of fine psychomotor skills, it is important to incorporate research findings and learning theories in designing remedial strategies.

Besides the cognitive theory of multimedia learning, recognition skills are important for students’ performance (Feil, Guenzel, Knight & Geistfeld, 1994; Knight & Guenzel, 1990). According to D. Smith (1976) and J. Smith (1978), discrimination learning occurs when a learner is able to distinguish the critical features of a final product and explain the differences between the ideal and its variants or the non-ideal. Recognition skills result from discrimination learning. Feil et al. (1994) recommended providing recognition training for students prior to the production task. The ability to recognize the desired
outcome of a final product and distinguish what is ideal from non-ideal must occur prior to any production tasks. Without acknowledging how an acceptable product must look, students are unable to identify errors, and make appropriate adjustment to fix these errors throughout the production (Feil et al., 1994). Figure 4 demonstrates these relationships. Recognition skills are considered a prerequisite for the production process (Branson & Toevs, 1999; Guenzel & Knight, 1992; Knight & Guenzel, 1990).

Figure 4. Model of recognition skill (Branson & Toevs, 1999; Guenzel & Knight, 1992; Knight & Guenzel, 1990)

In a quasi-experimental study conducted by Knight, Guenzel, & Fitzgerald (1990) a convenience sample of enrolled first-year dental students ($N = 86$) were chosen to participate. Students were trained to develop recognition skills. A pre-test and post-test were administered to examine their product quality and recognition skills on class I amalgam restorations before and after the intervention. Five steps of developing recognition skills were utilized including:
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1. Recognition of Schema: students were given 13 sets of three drawings consisting of two ideal models and a variant of them. The first ideal model was labelled and identified. Students were asked to identify a variant model in two remaining drawings, and selected an appropriate statement to describe the variant. Answer keys were given.

2. Recognition of actual preparations: this second task was similar to the first task. However, instead of using drawings, actual class I amalgam preparations in plastic teeth were used. A laboratory instructor demonstrated how to correctly evaluate each criterion. Students were given the opportunity to compare their own evaluations with their instructor’s, verify their judgments, and resolve any differences.

3. Evaluation of Recognition Training: after performing a Class I amalgam preparation on #19, students were asked to evaluate their work and their peers’. Their evaluations were then compared with instructors.


5. Formative Evaluation of Production Training. Students were asked to compare their work to the ideal, and subsequently identified any variants, and determined appropriate steps to correct their preparations.

The ratio between recognition training and production task was 2.6 to 1 (8-hour recognition training and 3-hour production tasks). Students showed significant improvement in both recognition ($p < .03$) and production skills ($p < .0001$) from the pre-test to the post-test. The improvement in the recognition skills corresponded to the improvement in product performance for Class I cavity preparation ($R = .717$). Similarly, a quasi-experimental study by Knight and Guenzel (1990) showed the effectiveness of
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the recognition skills and self-evaluation training in improving the basic waxing skills among first-year dental students. First-year dental students ($N = 13$) who failed to adequately demonstrate their waxing skills were chosen to participate. Participants were divided into two groups. The experimental group ($n = 6$) received discrimination training on four wax projects and four handpiece projects for 13 hours, while the control group ($n = 7$) received verbal feedback with models, and one-on-one demonstration on seven wax projects for 13 hours. Five steps of developing recognition skills were also used in this study. The ratio between recognition training and production task was 2.25 to 1. Both groups were tested on their ability to perform a Class II restoration in wax material at the post-test. Interrater reliability was completed between two evaluators. All products were given a code number, and independently evaluated by two laboratory instructors. There was a significant difference ($p < .0001$) in students’ performance on class II preparation between the control and experimental groups. Although the percent of student and instructor agreement increased, no statistical significance improvement was found in students’ ability to self-assess. This could be due to the design of the discrimination training. The training focused on having students identify the gross differences between the ideal model and variants, and lacked finer discrimination between similar variants. Additionally, this study had a very small sample size and lacked randomization in its methodology.

**Self-assessment.** Recognition skills and self-assessment skills interrelate with each other. While recognition skills are important for students’ performance, self-assessment skills are integral to the development of students’ clinical skills (Gadbury-Amyot, Woldt, & Siruta-Austin, 2015; Jackson & Murff, 2011; Mould, Bray, &
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Gadbury-Amyot, 2011). Self-assessment is defined as “the involvement of students in identifying standards and/or criteria to apply to their work and making judgements about the extent to which they have met these criteria and standards” (Boud, 2003, p. 12).

According to Mould et al. (2011), accurate self-assessment is the hallmark of a competent individual, and it is the cornerstone for critical thinking skills and problem-solving skills. Without accurately self-assessing one’s own work products, it is challenging for students to identify gaps in their skills, and determine appropriate strategies to improve their skills. Self-assessment is also an integral component of quality assurance. Since self-assessment of knowledge and skill is crucial for the continuing education of the practicing healthcare professionals, inaccurate self-assessment may render suboptimal quality of care for patients (Fitzgerald, White, & Gruppen, 2003; Mould et al., 2011).

Due to the benefits of self-assessment, CODA (2016) recommended incorporation of self-assessment skills in the dental hygiene curriculum. Standard 2-21 CODA (2016) states graduates must demonstrate ability to self-assess their learning needs throughout their career as an oral health care professional. The intent is to prepare students with lifelong learning skills to “maintain competency and quality assurance” (CODA, 2016, p. 26). In the literature review, Gadbury-Amyot et al. (2015) reported many strategies have been implemented in academic settings to promote self-assessment among students such as portfolio assessment, reflective writing, reflection essays, and reflective writing workshops. Self-assessment is a broad topic in the literature. However, for the purpose of this research study, only factors that affect self-assessment accuracy are discussed.

Literature reveals the relationship between the accuracy of self-assessment and academic ability (Kruger & Dunning, 1999). Kruger and Dunning (1999) conducted a
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seminal study utilizing a series of four studies to explore the relationship between level of competence and self-assessment skills. In Study 1, a convenience sample of Cornell University undergraduates \((N = 65)\) were chosen to participate. A 30-item questionnaire made up of jokes was used. Students were asked to rate each joke on a Likert scale, and predicted their answers to others’ based on a percentile ranking. Students who fell in the lowest quartile \((n = 16)\) significantly overestimated their abilities in comparison to their peers \((p < .0001)\), and believed their abilities was above average. In contrast, those in the top quartile underestimated their ability \((p < .05)\).

Study 2 was conducted to further support findings in Study 1. Different than the previous study, this study focused on another domain, intellectual. A convenience sample of Cornell University undergraduates \((N = 45)\) were chosen to participate in the study. Students were asked to complete a 20-item logical reasoning test, and estimated how many test questions they had answered correctly, and how they scored in comparison to others. Significant difference in the actual and estimated test scores of bottom quartile students was found \((p < .0001)\). Those in the bottom quartile continued to significantly overestimate themselves \((p < .0001)\), and believed their performance was above average \((p < .05)\). In contrast, those in the top quartile underestimated abilities relative to others \((p < .05)\), and their actual scores \((p < .06)\).

Phase 1 of Study 3 was conducted to further support findings in previous studies. The basic procedures were similar to previous studies except the domain. In this study, Cornell University undergraduates \((N = 84)\) were chosen to participate. Students were asked to complete 20-item test on grammar. They were required to determine whether the underlined portion of each sentence was grammatical correct or not. Bottom quartile
students continued to significantly overestimate their scores and abilities \( (p < .0001) \). Although top quartile students underestimated their abilities to the peers \( (p < .0001) \), no significant discrepancy was found between their perceived and actual scores (perceived 16.9, actual 16.4). These three studies revealed those whose scores fell in other quartiles overestimated their abilities and test scores less than those who fell in the bottom quartile, and high-performing students more accurately self-assessed work products than the lower-performing students. Additionally, individuals who lack the knowledge to perform well also were not aware of their incompetence leading to inflated self-assessment.

Further, phase 2 of Study 3 was conducted to investigate whether incompetent individuals were able to realize their incompetence by observing responses of others. Following the grammar study, students from the top \( (n = 19) \) and bottom quartile \( (n = 17) \) were asked to participate in a follow-up study. Each was given five tests that were completed by their peers. They were asked to assess how competent each test taker was by evaluating how many correct questions five test takers had achieved, and re-rate their abilities and scores after the grading. There was no significant difference in abilities, actual test scores, ranking relative to others found in bottom quartile students before and after grading. On the other hand, top quartile students demonstrated significant findings in ability \( (p \leq .05) \) and ranking among others \( (p < .01) \). This study found bottom quartile students did not realize their own incompetence when seeing the superior performances of others while the top-quartile were able to evaluate the performances of the other test takers, and subsequently self-assessed their own performance more accurately.

The last study of the series investigated whether logical training enhanced self-assessment skills among poor performing students. Cornell University undergraduates \( (N \)
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=140) were participants. Students were given a test on logical reasoning, and asked to self-assess their skills and performance in relative to their peers. Students were then randomly divided into an experimental group \( (n = 70) \) and control group \( (n = 70) \). The experimental group received logical training; the control group did not. After the training, all students were asked to re-assess themselves, and compared their performance with others. Participants who fell in the bottom quartile \( (n = 19) \) significantly improved their self-assessment skill \( (p < .001) \) after receiving the logical training in comparison to those who did not receive the training \( (n = 18) \). The results of the last two studies further indicated lack of metacognitive skills contributed to the overestimation of the low-performing participants.

Likewise, Edwards, Kellner, Sistrom, and Magyari (2003) found similar results in medical students’ \( (N = 1152) \) self-assessment of performance on an obstetrics and gynecology clerkship. The study reported lower-performing students displayed a tendency to overestimate their work products, and higher-performing students underestimated their work products. This implies incompetent students who fail to realize their own mistakes and errors on their work products tend to assume their performance skills are fine, and thus lead to inflated self-assessment (Kruger & Dunning, 1999). After conducting an analysis on 77 research studies published between 1990 and 2006, Colthart et al. (2008) found similar findings corroborating previous findings. This systemic review denoted competent individuals are capable of making accurate self-assessment while under-performing students are less likely to recognize their ability deficiencies.
On the other hand, Leopold et al. (2005) provided a different perspective on inflated self-assessment. These authors examined the association between self-confidence level and the accuracy of one’s own self-assessment. Ninety-three practitioners (N = 93), comprising medical doctors (n = 43), osteopathic physicians (n = 3), advanced registered nurse-practitioners (n = 35), and physicians’ assistants (n = 12), who attended a continuing education course on knee injection were chosen as study participants. Prior to receiving the instruction on knee injection, participants with higher confidence level exhibited poorer performance (r = - .253, p = .02). After receiving the instruction, there was a direct correlation between self-confidence level and the optimal performance criteria (r = 0.24, p = .04). However, this relationship was not as strong as the correlation between the self-confidence level and the participants’ self-rating of their own skills (r = 0.72, p = .001). These data indicate overestimation of self-assessment associates with. According to Hills, Ryan, Smith, and Warren-Forward (2012), social environment plays a role in professional students’ overconfidence level, specifically Millennials. Due to the tendency of constantly receiving praise and encouragement from parents, Millennials’ high self-confidence level prevented them from accepting negative feedback, being open to constructive feedback, and often lead to self-deception in their actual skills or performance. These findings contradict Kruger and Dunning’s (1999) previous findings that indicated inflated self-rating was due to the lack of the metacognitive skill-the-self-awareness of an individual on their own performance, and the ability to reflect and evaluate one’s own knowledge and skills (Chartier, 2001).

The literature suggests different strategies to enhance self-assessment accuracy (Colthart et al., 2008; Kruger & Dunning, 1999). While Kruger and Dunning suggested
increasing metacognitive skills, Colthart et al. (2008) reported providing feedback on performance, particularly video and verbal, increasing the students’ knowledge on the task, and providing benchmark guidance have positive impacts on self-assessment accuracy among students. Although Kruger and Dunning revealed the lack of metacognitive skills hinder poor performers from recognizing the actual performance either in themselves or others, the lack of underlying knowledge actually contributes to the lack of the metacognitive skills (Colthart, 2008). In order to analyze and reflect on one’s own learning about a specific performance or skill, an individual needs to possess the knowledge of it because “the same knowledge that underlies the ability to produce correct judgment is also the knowledge that underlies the ability to recognize correct judgment” (Colthart, 2008; Kruger & Dunning, 1999, p. 1121). This may explain why poor performers continued to overestimate themselves after seeing the superior performances of others, while top scorers were able to evaluate the performances of other people, leading to more accurate self-assessment.

**Dental hygiene students.** The previously discussed literature elucidates important concepts incorporated into this remedial strategy. In addition to incorporating research findings and learning theories in designing a restorative remediation, it is important to understand who the students are and their learning preferences. Research studies show the majority of dental hygiene students fit a Millennial’s learning preferences. Millennials are defined as “[t]hose who were born after 1980 and graduated from high school beginning in 2000,” and share general characteristics such as confidence, optimism, good self-esteem, assertive, a sense of entitlement, group-orientation, collaboration, achievement-orientation, structured learner, and technology
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Additionally, they have a tendency for multitasking and the need for immediate feedback. The explosion of accessible technology in 21st century has an impact on this generation’s learning style. They are confident with technology and prefer to use the internet as their main learning source (Beebe, Gurenlian, & Rogo, 2014). To investigate whether dental hygiene students’ learning preferences were consistent with the learning profile of a typical millennial, Blue (2009) conducted a study on dental hygiene students (N = 101) from University of Arizona, University of Minnesota, and Virginia Commonwealth University. These students were asked to complete a Learning Type Measure consisting of 26 questions to determine their learning style preferences. The Learning Type Measure reveals four different types of learners: (a) Concrete-Random Learner (Type I) prefers to know why he or she is involved in a learning, (b) Abstract-Sequential Learner (Type II) prefers to know what to learn, (c) Concrete-Sequential Learner (Type III) prefers to know how to apply the learning, and (d) Abstract-Random Learner (Type IV) prefers to know correct versus incorrect, and how to make appropriate modifications. Results revealed dental hygiene students exhibited similar characteristics as Millennial learners. The majority of dental hygiene students exhibited Type I (40%) and Type II (35%) learning preferences. These students prefer a structured learning environment, teamwork, and to reflect on new presented knowledge before taking action. They value sequential information, and prefer to critique information, seek details, and accuracy rather than making subjective judgments (Blue, 2009).

To further investigate whether Millennials have different learning preferences than other generations, and whether there was difference in expectation between
Millennial students and faculty members, Henry and Gibson-Howell (2011) conducted a survey study. A Likert-type survey consisting of three different topics including technology, group work, and authority was distributed to full-time dental hygiene students ($N = 94$) and full-time dental hygiene faculty members ($N = 20$) at a baccalaureate dental hygiene program. There was a 96% response rate from students ($n = 90$) and 60% response rate from faculty members ($n = 12$). Most students ($n = 79$, 87.7%) were Millennials and others ($n = 11$, 12.2%) were non-Millennials. All faculty members were non-Millennials. There were significant differences in the expectations between Millennials ($n = 79$) and non-Millennial ($n = 11$) dental hygiene students in several areas such as authority ($p = .027$), community service ($p = .014$), attendance ($p = .006$), and evaluation ($p = .025$). No significant difference was found in regards to technology between these Millennial and non-Millennial students. However, significant differences between Millennial students and faculty members were found in regards to issues of technology ($p = .008$), community service ($p = .000$), homework ($p = .000$), and interaction ($p = .000$). These Millennials expected faculty members to incorporate technologies, digital media, and interactive learning into the course curriculum. This expectation fits Millennial learners’ characteristics as found in other studies (Beebe et al., 2014; Blue, 2009; Hills et al., 2012). The differences in expectations between Millennial students and non-Millennial faculty members may be due to the generation gap. Millennials have different needs as learners while faculty members have different expectations and teaching styles (Henry & Gibson-Howell, 2011). These data need be considered when developing a restorative remediation program. Although one-on-one faculty instruction is the most common remediation method utilized at Eastern
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Washington University (EWU) and in the literature, this method may not fit the learning profile of Millennial dental hygiene students. The use of instructional videos may be used as a more interactive method to accommodate Millennial dental hygiene students’ learning style.

The use of mobile devices. In order to accommodate Millennials’ learning preferences, it is imperative to incorporate emerging technologies into educational settings. While there are many available devices in the market, the use of mobile devices such as smartphones and tablets have increased in the U.S. According to Dahlstrom and Bichsel (2014), 86% of undergraduates own a smartphone, and 47% own a tablet. Pearson surveyed 1211 college students across the U.S in 2015 also found 86% of college students use a smartphone while 51% reported using a tablet. Besides entertainment and communication, many studies have shown iPad®’s benefits in educational settings (George, Dumenco, Doyle, & Dollase, 2013; Rossing, Miller, Cecil, & Stamper, 2012). As Rossing et al. (2012) indicated a mobile device such as iPad® supports collaborative learning environment, affords different learning styles, preferences, learning paces, and allows students to obtain higher knowledge and skill by not limiting themselves to only text books and lectures. George et al. (2013) also conducted a study investigating the effectiveness of using iPad® and student’s attitudes toward the incorporation of iPad® into undergraduate medical education. First-year medical students (N = 109) enrolled in Fall 2011 were chosen to participate in this study; each student was required to purchase an iPad® upon admission to Warren Alpert Medical School of Brown University. An eight-item survey written in Likert Scale was distributed to the students twice, in September 2011 and January 2012, to determine their perception towards the
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effectiveness of using the iPad®. Additionally, two focus groups were conducted in September 2011 and January 2012. The first focus group included 13 randomly selected first-year students while the second focus group comprised of 12 randomly selected students. With a response rate of 61.5% (n = 67) and 52.2% (n = 57) in the first and second survey, the study found mixed students’ attitudes toward the use of iPad® in the curriculum. Some students felt the iPad® provided some benefits in undergraduate medical education, others believed it cannot replace printed handouts.

According to a Pearson survey (2015), laptops (87%), smartphones (64%), and tablets (40%) are common mobile devices students use for college work. Indeed, “the practical benefits of mobile devices may be the reason why students are using them more than desktop computers” (Khatoon et al., 2014, p. 671). Laptops are convenient for students who need to take their work with them. However, their size makes them cumbersome for carrying (Corbeil & Valdes-Corbeil, 2007). This explains why more students prefer to use laptops at home rather than school. On the other hand, with small size and mobile internet feature, smartphones are convenient to use anywhere. However, its small screen makes Web browsing, and reading text difficult (Corbeil & Valdes-Corbeil, 2007). Among smartphone owners, 95% (n = 952) owned a standard size smartphone in 2014. Although the percentage of students owning a larger size smartphone doubled in 2015, 89% (n = 915) still owned standard size smartphone (Pearson, 2015). This explains why students reported laptops being the device they learn best on and enjoy most (Pearson, 2015).

Even though each device has its own pros and cons, these devices help facilitate individualized learning among college students. Their popularity in the U.S. and among
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college students is undeniable. Therefore, the mobile device iPad® was used as an accessible tool for watching videos in this study.

**Calibration among restorative faculty members.** In order to facilitate the success of the restorative remediation program, all critical elements need to be reviewed. Literature discussed previously mostly focuses on important learning concepts and students’ learning preferences. Another concept that cannot be overlooked is calibration among faculty members. For pragmatic reasons, only the information regarding the importance of the calibration and how calibration is conducted among faculty members is discussed. Inconsistency between faculty members oftentimes leads to students’ frustration. Additionally, conflicting information may decrease students’ satisfaction with the academic institution. If the grading system is perceived as unpredictable and varied among faculty members, it may decrease students’ desire to strive for a better performance in class (Garland & Newell, 2009; Jack, 2009). To ensure faculty members are consistent, calibration is a must. According to Jacks (2009), understanding and following specific criteria established by the program when evaluating students’ performance is crucial. Additionally, pairing a new and seasoned faculty member can also facilitate the calibration process (Jacks, 2009).

**Historical perspective of grading at WREB and EWU.** The literature mentioned above provides an in-depth review of those factors that need consideration when developing a specific restorative remediation program. Another concept is the historical perspective of restorative grading at WREB and EWU, where the study was implemented.
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The restorative portion of WREB examination provides a reliable evaluation of dental hygiene students’ clinical competency in restorative (WREB, 2011). To facilitate the grading process, a WREB Dental Hygiene Restorative Examination Grading Criteria is used (see Figure 5). Students are required to complete two assigned restorations using amalgam and composite materials. Three examiners independently grade the restoration and evaluate for any hard and soft tissue damage. Three categories, Occlusal, Margins, and Proximal, are independently graded by three examiners on a 5-1 scale according to the Grading Criteria Chart found in Figure 7. Out of three scores assigned by three different examiners, the middle (median) score is chosen as a final score for each category. Scores for each category are weighed as follows: Occlusal = 30%, Margins = 35%, and Proximal = 35%. According to WREB, “a final value of three (3) or higher is considered passing level. The value of three (3) is defined to reflect minimally competent performance for all scoring criteria, and can be interpreted as corresponding to 75% in states where the passing level is legislated as 75%” (WREB, 2016, p.8).

To prepare students for the Restorative WREB examination, Mock WREB timed-carvings are incorporated into EWU Restorative courses. A timed-carving (TC) is a practical examination used to examine students’ restorative skills in the laboratory. The settings and examination process are similar to WREB. The WREB grading rubric is used for grading the Restorative Mock WREB at EWU. The EWU Carving grading rubric (see Figure 6) is also used during the grading because it walks faculty members through each criterion and allows students to receive detailed feedback for each restoration. The grading team always involves the Restorative Course Director and two other part-time restorative faculty members. The only difference between the WREB and
Mock WREB is the lack of independent grading by three different examiners on same restorations. Due to time constraints of the restorative course, each student’s restorations are graded by only one faculty member. Each faculty member grades individually and the Restorative Course Director evaluates all of the students’ mock timed-carvings one more time before assigning final grades. Calibration is done between restorative laboratory faculty members prior to and during the grading. At EWU, all restorative lab instructors follow criteria in the EWU Carving grading rubric and the WREB Dental Hygiene Restorative grading rubric to evaluate students’ Mock WREB timed-carvings. During grading, under the guidance of the Restorative Course Director, who attended the WREB Dental Hygiene Restorative workshop where the method of calibration WREB uses was demonstrated, students’ work products are passed around, and evaluated by all instructors to ensure the consistency among all lab instructors and facilitate the calibration process.

In addition to Mock WREB timed-carvings, EWU also has a standard grading system. Frequent timed-carvings in the restorative course curriculum provide a formative assessment of students’ restorative laboratory competency. The EWU Carving grading rubric found in Figure 6 is used in the standard grading system. There are three main criteria similar to the WREB rubric on the grading rubric, Occlusal, Proximal, and Margins. Each main criterion comprises many different detailed items such as marginal ridge height/shape, spill way, fossa, triangular ridge, central groove, etc. Instead of giving scores on a scale of 5-1 like WREB does, an “X” indicates a minor error, and an asterisk indicates a major error. On a scale of 4.0, each “X” constitutes 0.5-point deduction for each minor error, and each asterisk constitutes one full grade scale
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deduction for each major error. Figure 7 explains the laboratory course grade. As

defined by the Restorative Course Director, “a major error includes but is not limited to a

marginal ridge breaking, no contact, gross excess, or severely over carving” (Speer, 2016, 
p. 6). The grading team always involves the Restorative Course Director and two other

part-time restorative faculty members. Calibration is done between restorative laboratory

faculty members prior to and during the grading using the EWU Carving grading rubric.

Each faculty member grades individually, and the Restorative Course Director evaluates

all of the students’ timed-carvings one more time before assigning final grades.
THE USE OF VIDEOS IN RESTORATIVE REMEDIATION

<table>
<thead>
<tr>
<th>Ocular</th>
<th>Replicates proper anatomy (revealing harmonious form)</th>
<th>Slight variation of harmonious form.</th>
<th>Moderate variation of harmonious form.</th>
<th>High variation of harmonious form.</th>
<th>Irregular anatomy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ridges and marginal ridge present and properly formed.</td>
<td>Mouth grooves formed and positioned correctly.</td>
<td>Minor grooves formed and positioned correctly.</td>
<td>Moderate grooves formed and positioned correctly.</td>
<td>Irregular anatomy</td>
</tr>
<tr>
<td></td>
<td>Smooth surface, no pits or voids.</td>
<td>Functional occlusion.</td>
<td>Slight variation of occlusal surface.</td>
<td>Moderate variation of occlusal surface.</td>
<td>Severe variation of occlusal surface.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Marginal</th>
<th>Minimal variation of surface margin (1).</th>
<th>Slight variation of surface margin (1 or 2).</th>
<th>Moderate variation of surface margin (2 or 3).</th>
<th>Severe variation of surface margin (3 or 4).</th>
<th>Inconsistent margin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Slight scarring of tooth structure (one area).</td>
<td>Slight scarring of tooth structure (multiple areas).</td>
<td>Moderate scarring of tooth structure (multiple areas).</td>
<td>Severe scarring of tooth structure (multiple areas).</td>
<td>Irregular margin</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Proximal</th>
<th>Replicates proper anatomy (revealing harmonious form).</th>
<th>Slight variation of proximal contour, shape, and/or position of contact area.</th>
<th>Moderate variation of proximal contour, shape, and/or position of contact area.</th>
<th>Severe variation of proximal contour, shape, and/or position of contact area.</th>
<th>Irregular proximal contour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Optimal contact - will allow waxed to pass through contact with proper resistance.</td>
<td>Nearly optimal contact - will allow waxed to pass through contact with poor resistance.</td>
<td>Slight surface irregularities (pitting or voids).</td>
<td>Moderate surface irregularities (pitting or voids).</td>
<td>Severe surface irregularities</td>
</tr>
</tbody>
</table>

Figure 5. WREB Dental Hygiene Restorative Examination Grading Criteria 2016
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**Figure 6.** EWU Carving Grading Rubric

<table>
<thead>
<tr>
<th>Carving Evaluation Form</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student</strong></td>
</tr>
<tr>
<td><strong>Directions:</strong> Circle the appropriate description for each improvable criteria. Grading competency level will be outlined in the course syllabus.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Occlusal</strong></th>
<th><strong>Marginal Ridge</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesial (location/not developed/high/low/wide/narrow/shape/flat)</td>
<td></td>
</tr>
<tr>
<td>Distal (location/not developed/high/low/wide/narrow/shape/flat)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Spillway</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesial (location/high/low/defined)</td>
</tr>
<tr>
<td>Distal (location/high/low/defined)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Fossa</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesial (position/excess/overcarved/shape/not developed/defined)</td>
</tr>
<tr>
<td>Central (position/excess/overcarved/shape/not developed/defined)</td>
</tr>
<tr>
<td>Distal (position/excess/overcarved/shape/not developed/defined)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Triangular Ridge</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Transverse-(M) (location/high/low/wide/narrow/shape/bulky)</td>
</tr>
<tr>
<td>Oblique or D Transverse (location/high/low/wide/narrow/shape/bulky)</td>
</tr>
</tbody>
</table>

| **Overall anatomy** (gross excess/rough/overcarved/not cleared) |
| **Central groove** (location/defined/low) |

<table>
<thead>
<tr>
<th><strong>Proximal</strong></th>
<th><strong>Contact</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesial (location/broad/small/high/low/open/tight/closed/flat)</td>
<td></td>
</tr>
<tr>
<td>Distal (location/broad/small/high/low/open/tight/closed/flat)</td>
<td></td>
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<table>
<thead>
<tr>
<th><strong>Embrasure</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesial Buccal or Lingual (excess/over/shape)</td>
</tr>
<tr>
<td>Distal Buccal or Lingual (excess/over/shape)</td>
</tr>
<tr>
<td>Occlusal (location/excess/overcarved/shape/open)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Gingival</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gingival Floor (mesial/overhang/subcatches)</td>
</tr>
<tr>
<td>Distal (overhang/subcatches)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Cavosurface</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mesial (buccal or lingual) (flashing/sub)</td>
</tr>
<tr>
<td>Central (buccal or lingual) (flashing/sub)</td>
</tr>
<tr>
<td>Distal (buccal or lingual) (generalized/slight/moderate/flashing/sub)</td>
</tr>
<tr>
<td>Catches (buccal/lingual/occlusal/proximal margins/gingival)</td>
</tr>
</tbody>
</table>

<p>| <strong>Tooth damage</strong> (minor/moderate/major/mesial/distal/central) |</p>
<table>
<thead>
<tr>
<th>Date</th>
<th>Tooth #’s</th>
<th>Pass</th>
<th>Redo</th>
<th>Comments</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>
Course content/curriculum. As an accredited educational institution that provides restorative education, EWU is required to follow CODA guidelines in designing restorative course curriculum. Accreditation requires EWU to include dental sciences, dental hygiene sciences, and specific lab and clinical practice into the restorative course curriculum (CODA, 2016). A variety of lab learning experiences and clinical practice are provided throughout the course curriculum to ensure students obtain laboratory and clinical competence upon graduation. EWU Dental Hygiene program was a three-year program and operated on a quarter system. The program is in the transition to the semester system; therefore, students participating in this study took both quarter and semester system courses. Their first and second year were on quarter system and their third year was on semester system. Figure 8 reveals the sequence of courses in the restorative course curriculum.
<table>
<thead>
<tr>
<th>Course</th>
<th>Quarter</th>
<th>Course Description</th>
<th>Didactic/Laboratory Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dental Anatomy DNHY 301</td>
<td>Fall quarter (1&lt;sup&gt;st&lt;/sup&gt; year)</td>
<td>Focus on tooth morphology</td>
<td>Evaluate students for restorative courses later in the curriculum</td>
</tr>
<tr>
<td>Principles of Restorative Dentistry DNHY 380</td>
<td>Winter quarter (2&lt;sup&gt;nd&lt;/sup&gt; year)</td>
<td>This course is the first of several courses that provide basic didactic and laboratory information required to facilitate the selection, manipulation and placement of dental materials.</td>
<td>A variety of didactic learning activities are included such as CE courses, writing Mercury Awareness Reaction Paper, weekly learning journal, presentation on dental material properties. Students are required to complete laboratory requirements using wax and amalgam materials and demonstrate their ability to complete requirements at an acceptable level. Timed carves: students are required to pass timed carvings at a minimum of a 2.0 (77%). If the grade falls below a score of 2.0, restorations need to be redone until an acceptable level of carving is reached.</td>
</tr>
<tr>
<td>Principles of Restorative Dentistry DNHY 381</td>
<td>Spring quarter (2&lt;sup&gt;nd&lt;/sup&gt; year)</td>
<td>This course is the second of several courses that provides basic didactic and laboratory information required to facilitate the selection, manipulation and placement of dental materials.</td>
<td>- A variety of didactic learning activities are included such as weekly learning journal, Dentist/Restorative Hygienist Interview - Students are required to fulfill Restorative Peer Helper requirements in order to prepare them before seeing patients next quarter. - Students are required to complete a variety of laboratory requirements using amalgam and composite materials and demonstrate their ability to complete requirements at an acceptable level.</td>
</tr>
<tr>
<td>Restorative Dentistry II DNHY 480S</td>
<td>Fall Semester (3rd year)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------------------------</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>- This second semester course of a three-semester sequence in clinical restorative practice is comprised of lectures, restorative clinics, and laboratory experiences designed to facilitate the student's knowledge of various restorative materials and clinical procedures as well as the refinement of restorative manipulative skills.</td>
<td>Didactic requirements: weekly learning journal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laboratory requirements:</td>
<td>- Students are required to complete amalgam and composites restorations on a variety of preparations and demonstrate their ability to complete restoration at an acceptable level.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- WREB: Requirements are evaluated according to the WREB criteria. Half of the maxillary and mandibular requirements must be composite and each requirement must be done on a different tooth. Requirements must receive an average score of a 4 to be checked off.</td>
<td>- Timed carves and mock WREB: students are required to pass timed-carvings at a minimum of a 2.0 (77%) and mock WREB at a score of a 3. If the grade falls below a score of 2.0, restorations need to be redone until an acceptable level of carving is reached. The original grades for the timed carve or mock WREB are not changed after the redo.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical requirements:</td>
<td>- Students are required to complete a specific number of class II, III, IV, or V either in amalgam or composite restorations.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
- Clinic utilization points system is utilized to ensure students work with patients efficiently and appropriately fill each clinical session.

<table>
<thead>
<tr>
<th>Course</th>
<th>Semester</th>
<th>Description</th>
<th>Requirements</th>
</tr>
</thead>
</table>
| Restorative Dentistry III | Spring Semester (3rd year) | This third semester course of a three-semester sequence in clinical restorative practice is comprised of lectures, restorative clinics, and laboratory experiences designed to facilitate the student's knowledge of various restorative materials and clinical procedures as well as the refinement of restorative manipulative skills. | **Didactic requirements:**  
weekly learning journal  

**Laboratory requirements:**  
- Students are required to complete amalgam and composites restorations on a variety of preparations and demonstrate their ability to complete restoration at an acceptable level.  
- WREB: Requirements are evaluated according to the WREB criteria. Half of the maxillary and mandibular requirements must be composite and each requirement must be done on a different tooth. Requirements must receive an average score of a 4 to be checked off.  
- Timed carves and mock WREB: students are required to pass timed carvings at a minimum of a 2.0 (77%) and mock WREB at a score of a 3. If the grade falls below a score of 2.0, restorations need to be redone until an acceptable level of carving is reached. The original grades for the timed carve or mock WREB are not changed after the redo.  

**Clinical requirements:**  
- Students are required to complete a specific number of class II, III, IV, or V either in amalgam or composite restorations.  
- Clinic utilization points system is utilized to ensure students work with clients efficiently and appropriately fill each clinical session.
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| fill each clinical session. |

Figure 8. Sequence of courses in restorative curriculum at EWU (EWU, 2016; Speer, 2016)

Summary (Significance of the Study)

Remediation is the most common remedy used for at-risk students; however, there are few prospective studies on this topic. Most studies regarding remediation and its effects on licensure pass rates, students’ improved performance, remediation protocols, and instructional methods are descriptive program evaluation reports. Previous studies suggest the need for prospective studies to identify effective components of remedial interventions (Cleland et al., 2010). There is a current gap in the literature in identifying the components of remedial interventions and incorporating these into the program curriculum. There is a need for a well-designed experimental study to determine the components of the remediation process.

It is well-documented in the literature that one-on-one instruction is an effective teaching method. However, it is impractical to provide this strategy to every dental hygiene student who is struggling with poor performance in the restorative laboratory due to the cost and limited availability of baccalaureate full-time faculty. Various strategies have been explored in the literature to identify an alternative individualized teaching instruction for students. Many research studies and theories support the use of video as a teaching aid. Although there are some controversies about whether the use of instructional videos can predict the improvement of the dental hygiene students on restorative procedures, this method is indicated because it shows promise in enhancing students’ learning experiences in the laboratory setting (Aragon & Zibrowski, 2008; Gadbury-Amyot et al., 2014; Nikzad et al., 2012; Patel et al., 2015). Furthermore, the
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concept of recognition skills was explored in prior studies, but was limited to the pre-clinical students and novice learners. It is unclear how significant recognition skills are in students who have previous experiences in restorative procedures. This study explores or examines the effectiveness of instructional videos on dental hygiene students’ performance and providing insight into the importance of recognition skills in providing remediation on restorative procedures for senior dental hygiene students.
Methodology

Research Method or Design

In this study, a mixed method design was used. The principal investigator (PI) developed a video with step-by-step procedures on how to complete an amalgam restoration (video A), and a video with specific steps on how to evaluate the same restoration (video B). A counterbalanced experimental design was used. Students were randomly assigned to two groups. Each group watched the videos in different orders. Group 1 watched the videos in the order of A-B, and Group 2 watched the videos in the order B-A. A timed-carving (TC) is a practical examination used to examine students’ restorative skills in the laboratory. Quantitative data from pre-test timed-carving scores prior to the video implementation were gathered from both groups. Additionally, scores from post-test timed-carvings after the first and second round of video implementation were collected. Students were required to self-evaluate their own timed-carvings before turning them in using the WREB Restorative Grading rubric. The EWU Carving Grading rubric was also used because it guided students through each criterion to ensure all aspects of a restoration were evaluated. Qualitative data were gathered using open-ended questionnaires to assess students’ perception towards the use of videos in remediation on restorative procedures.

Procedures

Human subjects’ protection/informed consent. Prior to study implementation, students were enrolled and informed consent gained. Students were informed their academic records, and timed-carving scores would be collected, and extra measures
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would be taken to maintain the confidentiality of the collected data. Each student was
given a code to facilitate an anonymous grading process. Only restorative laboratory
instructors and the PI had access to the students’ identity after the grading process. The
students’ timed-carving scores were kept confidential by securing the collected data in a
locked file cabinet to which only PI and Restorative Course Director had access.
Additionally, students’ responses were collected anonymously. To maintain anonymity,
students did not put their name on the open-ended questionnaires. Students returned the
questionnaire in a manila envelope to the Restorative Course Director after their last
timed-carving.

Sample source, plan, sample size, description of setting.

Criteria for sample selection. The population of the study was senior dental
hygiene students from the baccalaureate dental hygiene program at EWU (N = 31). All
students who completed Restorative Dentistry I course, and learned basic skills on how to
complete amalgam and composite restorations met the inclusion criteria. The students’
GPA was not considered as an exclusion criterion. Data collection would disclose
whether the introduced method of remediation is effective in improving restorative skills
in students with poor, moderate, and high levels of restorative achievements.

Description of the setting. This study was conducted at the EWU restorative
laboratory located in the dental hygiene clinic on the Spokane Campus of EWU. During
the restorative laboratory sessions, iPad®s were provided for students to access videos.
Students were only allowed to watch videos during laboratory sessions. However, they
could watch the videos as many times as they wished during laboratory and slow or pause
as many times while watching. The laboratory environment remained as normal.
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Typically, restorative laboratory for senior dental hygiene students is a self-directed laboratory where students can work on their requirements independently. Restorative laboratory instructors were instructed not to provide verbal feedback to students on #19 MO once the study began.

**Source.** The population of the study was senior dental hygiene students from the baccalaureate dental hygiene program at EWU. For pragmatic purposes, this source was chosen because of the PI’s academic affiliation as a graduate student and a clinical instructor at EWU.

**Plan.** A convenience sampling was used to recruit a total of 31 dental hygiene students. Participation in this intervention and data collection was incorporated as a part of the normal course requirements as outlined in the course syllabus. Students had an opportunity to earn extra-credit for their timed-carvings as an incentive for their participation in this study.

**Size.** The sample size was 31 because this is the size of the senior dental hygiene class. This sample size was used for convenience purposes. Statistical significance of the results was set at $p < 0.05$.

**Variables.** The use of the step-by-step instructional video and self-evaluation video in restorative laboratory were considered the independent variables; and the dental hygiene students’ restorative skills were the dependent variable. Efforts were taken to minimize the confounding variables in the study. The same type of Acadental prep teeth was provided to ensure every student had the same material. Students had been using the same of type of amalgam in restorative laboratory for all of their requirements and timed-carvings. Therefore, amalgam capsules were not provided to students in this study.
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Senior dental hygiene students were randomly assigned into two groups. Each group alternately watched two different video contents in different orders. Group 1 watched the video in the order of A-B, and Group 2 watched the video in the order of B-A. After the first and second round of video implementation, timed-carvings were used to determine whether in providing restorative remediation for dental hygiene students, the use of the instructional videos affected their restorative skills.

**Instruments.** The time-carvings were evaluated by three calibrated instructors based on the WREB Dental Hygiene Restorative Examination Grading criteria and EWU Carving Grading rubric found in Appendix A and B. To minimize bias, the PI was not involved in the grading process. The EWU Carving Grading rubric was developed by former EWU Restorative Course Director Ardean Nickerson. The PI gained permission to use this rubric in this study (Appendix F). The EWU Carving Grading rubric allowed restorative instructors to follow each criterion to ensure all aspects of a restoration were graded. In the EWU Carving Grading rubric, each main category includes many other criteria. Occlusal category comprises of marginal ridge, spillway, fossa, triangular ridge, central groove, and overall occlusal anatomy. Proximal category comprises of contact, Buccal, Lingual, Occlusal, and Gingival embrasures, while Margins category comprises of gingival floor, and carvosurface.

The WREB Dental Hygiene Restorative Examination Grading criteria was developed by WREB. The PI gained permission to use this rubric in this study. See Appendix G. The WREB Dental Hygiene Restorative Examination Grading Criteria chart provides descriptions for each category on a 5-1 scale. In this rubric, Occlusal, Margins, and Proximal are the three main categories graded.
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• Occlusal surface is the surface that contacts an opposing tooth in the opposing jaw. In order to maintain proper patient’s occlusion, it is crucial to maintain correct anatomy on the occlusal surface when restoring a tooth.

• Proximal area of a tooth is the area adjacent to another tooth. The Proximal area comprises the Contact and Embrasures. Embrasures are triangularly shaped spaces between proximal surfaces of adjacent teeth. Maintaining proper Contact and Embrasures when restoring a tooth is crucial because it affects the longevity of a restoration and periodontal health.

• Margin of a restoration is a continual line between the tooth and restorative material. When restoring a tooth, it is important to ensure the margin of a restoration is completely sealed, smooth, and free from any voids or excess because the margin is the most common area recurrent decay occurs.

According to Popp, a psychometrician at WREB, for performance-based data with multiple examiners, calculating percentage of exact agreement per criterion among examiners provides more accurate internal reliability of the grading rubric than running the Cronbach’s alpha (Popp, personal communication, July 12, 2016). Ten dentoforms were randomly chosen after a Mock Board timed-carving. Mock Board timed-carvings scores from three different laboratory instructors (30 scores) were used to evaluate faculty agreement. The weighted average of EWU faculty member agreement for the Mock Board timed-carving was 89.1%, with 6.4% harsh, and 4.8% lenient.
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with 92.3% of agreement, 3.7% harsh, and 4.0% lenient of the weighted average of WREB examiner agreement for the Dental Hygiene Restorative examination in 2015 (Popp, personal communication, June 23, 2016), these data indicated a high percentage of agreement among EWU laboratory instructors. Additionally, according to a WREB technical report (2008), Cronbach’s alpha value was 0.894 which demonstrated a good internal consistency of the WREB Restorative Grading rubric.

**Steps to implementation.** Figure 9 demonstrates the timeframe of this research study.

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timed Carving (TC) #1 to establish the baseline #19MO Ag Students were required to self-evaluate their TC before turning them in</td>
<td><strong>GROUP 1</strong> Watch the step-by-step video</td>
<td>Timed Carving #2 #19MO Ag Students were required to self-evaluate their TC before turning them in</td>
<td><strong>GROUP 2</strong> Watch the self-evaluation video</td>
<td><strong>GROUP 1</strong> Watch the self-evaluation video</td>
</tr>
<tr>
<td><strong>GROUP 2</strong> Watch the self-evaluation video</td>
<td></td>
<td></td>
<td></td>
<td>Timed Carving #3 #19MO Ag Students were required to self-evaluate their TC before turning them in</td>
</tr>
</tbody>
</table>

*Figure 9. Research Design*

The PI discussed with Restorative Course Director incorporation of this study in the Restorative course content and syllabus. For the purpose of this study, to maintain consistency, the #19-MO Acadental prep with amalgam material was assigned as the preparation in all three timed-carvings.

1. The PI developed a 20 minute-step-by-step instructional video. This video included step-by-step procedures involved in the placement and carving of #19-MO using amalgam material. This video showed students how to condense
amalgam into the preparation, clear and carve the occlusal anatomy, buccal, lingual, gingival, and occlusal embrasures, and marginal ridges.

2. The PI developed a 20 minute-interactive-self-evaluation video. This video showed students how to evaluate their work product using the EWU Carving Grading rubric and WREB Dental Hygiene Restorative Examination Grading criteria. Additional examples were also used to show students what ideal and non-ideal examples look like. A short quiz was used at the end of the video to assist students in the process of assessing their evaluation skills on restorative products.

3. The PI contacted an IT technician to assist in uploading the videos on 31 iPad®s. Students were only allowed to watch videos during restorative laboratory. iPad®s were distributed to students in both groups at the beginning of each laboratory session and were collected at the end of each lab period. Students had the ability to start and stop the videos, and use them without interrupting their classmates.

4. Study implementation began with gaining informed consent from participants.
   a. The PI presented the study and recruited students to participate in this study. The PowerPoint® presentation provided some background information about remediation, the relationship between self-evaluation and clinical performance, and the benefits of exploring the effectiveness of another teaching method in providing restorative remediation.
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b. Informed consent included the nature of the study, associate risks, and benefits, and informed students that their academic records (timed-carving scores) would be collected.

5. In week 1 of the study, students’ timed-carving #1 scores were collected for baseline data. Students performed the timed-carvings on #19-MO on Acadental prep, using amalgam material. Students were given 35 minutes to complete the restoration.

a. To maintain an anonymous grading process, each student was given a randomized digit code. Students’ identities were kept confidential; only PI and Restorative Course Director had access to students’ academic records.

b. The #19-MO Acadental prep was provided to students.

c. The grading team always involves the Restorative Lead and two other part-time restorative faculty members. Calibration was done between all restorative laboratory faculty members prior to the grading. The evaluation video was shown to restorative faculty members to establish calibration between every member before grading. The standard grading procedure was followed. Each faculty member graded individually, and the Restorative Course Director evaluated all of the students’ timed-carvings one more time before assigning final grades.

d. Students turned in the EWU Carving Grading rubric with their #19-MO timed-carvings. Their self-evaluation of their timed-carving was a part of
their extra-credit scores. Extra credit was given depending on students’ self-evaluation skills:

- If there was no discrepancy between faculty and student in the total score, 5% was added to students’ total score.
- If the discrepancy was within 1 point, 3% was added to students’ total score.
- If the discrepancy was within 2 points, 1% was added to students’ total score.

6. In week 2 of the study, students were randomly assigned to two groups. Group 1 was given copies of the step-by-step video; and group 2 was given copies of the self-evaluation video.

   a. Students from both groups were required to watch the instructional videos during restorative laboratory sessions. Attendance was mandatory. iPad®s were distributed to students at the beginning of lab, and collected after the lab session. Students were only allowed to watch videos during laboratory session. However, they could watch the videos as many times as they wished during laboratory and slow or pause as many times while watching.

7. In week 3 of the study, students’ timed-carving #2 scores were collected from both groups. Students performed the timed-carvings on #19-MO on Acadental prep, using amalgam material. Students were given 35 minutes to complete the restoration.

   a. The procedures followed steps 5a-5d in week 1 of the study.
8. In week 4 of the study, Group 2 was given copies of the step-by-step video; and Group 1 was given copies of the self-evaluation video.

   a. Students from both groups were required to watch the instructional videos during assigned laboratory sessions. Attendance was mandatory. iPad®s were distributed to students at the beginning of lab, and collected after the lab session. Students were only allowed to watch videos during laboratory session. However, they could watch the videos as many times as they like during laboratory and slow or pause as many times while watching.

9. In week 5 of the study, students’ timed-carving #3 were collected from both groups. Students performed timed-carvings on #19-MO on Acadental prep, using amalgam material. Students were given 35 minutes to complete the restoration.

   a. The procedures followed steps 5a-5d in week 1 of the study.

Summary

The research design ensures all participants receive the same number of “treatments.” This design allows the PI to use every possible order of the “treatment” with an equal number of students participating in each order, thus facilitating control for order effects. However, carryover effects still exist in this design. The effect of watching the step-by-step instructional video may carry over to the next “treatment.” Following the exposure to the step-by-step video, students in Group 1 may acquire new skills that make them perform better in subsequent timed-carving. Similarly, students in Group 2 may gain new skills that affect their performance in subsequent timed-carving following the exposure to the self-evaluation video. Although it is difficult to investigate the effectiveness of each “treatment” due to the carryover effects, the PI sought to determine
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whether watching a step-by-step instructional video impacts students’ performance in restorative procedures, and watching a self-evaluation instructional video affects students’ ability to accurately self-assess their work product at TC #2. Additionally, this methodology allowed the PI to test the overall effect, and determine whether the order in which students watch the instructional videos affected their overall restorative performance.
Results

Description of Sample

The PI recruited senior dental hygiene students from the baccalaureate dental hygiene program at EWU ($N = 31$). This study was conducted at the EWU restorative laboratory located in the dental hygiene clinic on the Spokane Campus of EWU. Participation in this intervention and data collection were incorporated as a part the course requirements. All 31 senior dental hygiene students completed consent forms, and gave permission to include their timed-carving scores in the study. Of those students completing consent forms, 15 were randomly assigned to Group 1 and 16 were randomly assigned to Group 2. All students completed the study, and yielded a total of 93 timed-carving scores after performing three timed-carvings on #19-MO. Out of 93 timed-carving scores collected, 100% ($n = 93$) were usable. Additionally, all students completed their self-evaluation scores using the WREB grading rubric, and yielded a total of 93 scores. Out of 93 self-evaluation scores collected, 99% ($n = 92$) were usable, and 1% ($n = 1$) was omitted due to incorrect score input.

Statistical Analysis

Quantitative data from pre-test timed-carving scores prior to the video implementation were gathered from both groups. Additionally, scores from post-test timed-carvings after the first and second round of video implementation were collected. Students’ self-evaluation scores were also collected at the end of each timed-carving. Qualitative data were collected using open-ended questionnaires to assess students’ perception towards the use of videos in restorative laboratory.
The PI entered all data into Excel© 2015 and transferred it to SPSS® Version 23 for analysis. Data was collected and stored on a password-protected computer. The statistical analysis and results are organized according to the study questions.

**First hypothesis.** For the first research question, “Does watching a step-by-step instructional video impact students’ performance in restorative procedures?” a Wilcoxon matched-pairs signed-ranks test was used to compare performance of students in Group 1 at TC #1 and TC#2. The mean score of TC#1 and TC#2 were two sets of observations from the same population, therefore a Wilcoxon matched-pairs signed-ranks test was used for data analysis to determine whether the mean score of two data samples differed.

Results from TC#1 and TC#2 showed an increase in the mean score from 76.4 at pretest to 79.1 in Group 1 (see Table 1, for descriptive statistics of TC#1 and TC#2 in Group 1). The $p$ value was $p = 0.615$, therefore null hypothesis was accepted (see Table 2, for a Wilcoxon test data for TC#1 and TC#2 in Group 1). Although the mean score at TC#2 was higher than the mean score at TC#1, this improvement may or may not be associated with the watching of the step-by-step video due to the lack of the control group. Another Wilcoxon test ran separately demonstrated significant improvement at TC#2 in students whose TC#1 scores fell below 75 (see Table 3 for descriptive statistics of TC#1 and TC#2 in students whose TC#1 scores fell below 75 in Group 1, and Table 4 for Wilcoxon test data).
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Table 1

*Descriptive Statistics for TC#1 and TC#2 in Group 1*

<table>
<thead>
<tr>
<th>Measure</th>
<th>n</th>
<th>M</th>
<th>Range</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC#1</td>
<td>15</td>
<td>76.4</td>
<td>46.30</td>
<td>82.3</td>
</tr>
<tr>
<td>TC#2</td>
<td>15</td>
<td>79.1</td>
<td>33</td>
<td>79.55</td>
</tr>
</tbody>
</table>

Table 2

*Wilcoxon Signed-rank Test for TC#1 and TC#2 in Group 1*

<table>
<thead>
<tr>
<th>Negative Ranks</th>
<th>Positive Ranks</th>
<th>Ties</th>
<th>Total</th>
<th>Z</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>7</td>
<td>1</td>
<td>15</td>
<td>-.502</td>
</tr>
</tbody>
</table>

*Note.* Confidence interval 95%, *p* < .05.

Table 3

*Descriptive Statistics for TC#1 and TC#2 in Group 1 for Students whose TC#1 Scores Fell Below 75*

<table>
<thead>
<tr>
<th>Measure</th>
<th>n</th>
<th>M</th>
<th>Range</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC#1</td>
<td>5</td>
<td>60.66</td>
<td>31.55</td>
<td>61.00</td>
</tr>
<tr>
<td>TC#2</td>
<td>5</td>
<td>83.34</td>
<td>15.50</td>
<td>84.10</td>
</tr>
</tbody>
</table>

Table 4

*Wilcoxon Signed-rank Test for TC#1 and TC#2 in Group 1 for Students whose TC#1 Scores Fell Below 75*

<table>
<thead>
<tr>
<th>Negative Ranks</th>
<th>Positive Ranks</th>
<th>Ties</th>
<th>Total</th>
<th>Z</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5</td>
<td>0</td>
<td>5</td>
<td>-2.023</td>
<td>.043</td>
</tr>
</tbody>
</table>

*Note.* Confidence interval 95%, *p* < .05.

**Second hypothesis.** The second research question was “Does watching a self-evaluation instructional video affect students’ ability to accurately self-assess their work product? To determine the accuracy of students’ assessment per criterion, the PI calculated the differences between faculty’s and students’ scores, and ran a descriptive report of the differences per criterion among faculty and students to calculate the percentage of agreement among them. According to Popp, a testing specialist at WREB,
percentage of agreement per criterion is a better indicator of high agreement among faculty and students than Spearman or Pearson correlations because wildly different ratings, if rank-ordered the same can produce Pearson or Spearman correlations near 1.00 (Popp, personal communication, July 12th, 2016). For every set of two grades assigned to a single graded criterion, the PI determined whether a student’s score was within one point from faculty’s assigned score. If it matched exactly, or was within one point away, it was considered in agreement. If it was more or less than one point away from faculty’s score, it was not considered in agreement. Occlusal, Proximal and Margins were three criteria evaluated at TC#1, TC#2 and TC#3 in Group 1 and Group 2.

There was an increase in Group 2 students’ self-evaluation skills on Occlusal, Proximal, and Margins criteria after watching the self-evaluation video. The increase in their percentage of agreement detected at TC#2 and TC#3 indicated improvement in self-evaluation skills of students in Group 2. There were 36.2%, 12.5% and 6.3% increase in the percentage of agreement on Occlusal, Proximal and Margins criteria, respectively (see Table 5).

Table 5

Descriptive Statistics for the Percentage of Agreement between Faculty and Students in Group 2 on Occlusal, Proximal and Margins Criteria at Three Different TC

<table>
<thead>
<tr>
<th>Measure</th>
<th>n</th>
<th>Percentage of agreement between faculty and student on Occlusal</th>
<th>Percentage of agreement between faculty and student on Proximal</th>
<th>Percentage of agreement between faculty and student on Margins</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC#1</td>
<td>15</td>
<td>62.6%</td>
<td>81.4%</td>
<td>81.3%</td>
</tr>
<tr>
<td>TC#2</td>
<td>16</td>
<td>93.8%</td>
<td>93.9%</td>
<td>87.6%</td>
</tr>
<tr>
<td>TC#3</td>
<td>16</td>
<td>87.6%</td>
<td>93.8%</td>
<td>87.6%</td>
</tr>
</tbody>
</table>
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There was an increase in Group 1 students’ self-evaluation skills on Occlusal and Margins criteria after watching the self-evaluation video. The increase in their percentage of agreement at TC#3, after they were exposed to the self-evaluation video indicated improvement in self-evaluation skills of students in Group 1. There were 20.1%, 0% and 6.7% increase in the percentage of agreement on Occlusal, Proximal and Margins criteria, respectively (see Table 6). It is important to note that no improvements in students’ self-evaluation skills were detected at TC#2 in Group 1 students, before students were exposed to the self-evaluation video.

Table 6

<table>
<thead>
<tr>
<th>Measure</th>
<th>n</th>
<th>Percentage of agreement between faculty and student on Occlusal</th>
<th>Percentage of agreement between faculty and student on Proximal</th>
<th>Percentage of agreement between faculty and student on Margins</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC#1</td>
<td>15</td>
<td>86.7%</td>
<td>86.7%</td>
<td>86.6%</td>
</tr>
<tr>
<td>TC#2</td>
<td>15</td>
<td>73.3%</td>
<td>86.7%</td>
<td>86.7%</td>
</tr>
<tr>
<td>TC#3</td>
<td>15</td>
<td>93.4%</td>
<td>86.7%</td>
<td>93.4%</td>
</tr>
</tbody>
</table>

To determine the correlation between students’ self-evaluation skill and restorative performance on each Occlusal, Proximal, and Margins criterion, a Wilcoxon signed-ranks test was used. While significant Occlusal score improvement was found at TC#2 and TC#3 in Group 2 students, significant results were not detected until TC#3 in Group 1 students. There were no significant results found in the Proximal and Margins criteria in both groups (see Table 7 and Table 8).
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Table 7

Descriptive Statistics of Students’ Performance on Each Occlusal, Proximal and Margins Criterion in Group 1 and Group 2

<table>
<thead>
<tr>
<th>Measure</th>
<th>Group1</th>
<th></th>
<th></th>
<th>Group2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>M</td>
<td>Range</td>
<td>Mdn</td>
<td>n</td>
<td>M</td>
</tr>
<tr>
<td>O-TC#1</td>
<td>15</td>
<td>2.46</td>
<td>3</td>
<td>3</td>
<td>16</td>
<td>2.43</td>
</tr>
<tr>
<td>O-TC#2</td>
<td>15</td>
<td>2.8</td>
<td>2</td>
<td>3</td>
<td>16</td>
<td>3.125</td>
</tr>
<tr>
<td>O-TC#3</td>
<td>15</td>
<td>3.13</td>
<td>2</td>
<td>3</td>
<td>16</td>
<td>3.125</td>
</tr>
<tr>
<td>P-TC#1</td>
<td>15</td>
<td>3.73</td>
<td>4</td>
<td>4</td>
<td>16</td>
<td>4.125</td>
</tr>
<tr>
<td>P-TC#2</td>
<td>15</td>
<td>3.73</td>
<td>1</td>
<td>4</td>
<td>16</td>
<td>3.875</td>
</tr>
<tr>
<td>P-TC#3</td>
<td>15</td>
<td>3.73</td>
<td>3</td>
<td>4</td>
<td>16</td>
<td>4.0</td>
</tr>
<tr>
<td>M-TC#1</td>
<td>15</td>
<td>3.6</td>
<td>4</td>
<td>4</td>
<td>16</td>
<td>4.0625</td>
</tr>
<tr>
<td>M-TC#2</td>
<td>15</td>
<td>3.6</td>
<td>3</td>
<td>4</td>
<td>16</td>
<td>3.875</td>
</tr>
<tr>
<td>M-TC#3</td>
<td>15</td>
<td>4.2</td>
<td>2</td>
<td>4</td>
<td>16</td>
<td>4.0625</td>
</tr>
</tbody>
</table>

Table 8

Descriptive Statistics of Students’ Performance on Each Occlusal, Proximal and Margins Criterion in Group 1 and Group 2

<table>
<thead>
<tr>
<th>Measure</th>
<th>Criterion</th>
<th>Group1</th>
<th></th>
<th></th>
<th>Group2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n</td>
<td>Z</td>
<td>Sig. (2-tailed)</td>
<td>n</td>
<td>Z</td>
<td>Sig. (2-tailed)</td>
</tr>
<tr>
<td>TC#1-TC#2</td>
<td>O</td>
<td>15</td>
<td>-.997</td>
<td>.319</td>
<td>16</td>
<td>-2.598</td>
<td>.009</td>
</tr>
<tr>
<td>TC#1-TC#3</td>
<td>P</td>
<td>15</td>
<td>-1.977</td>
<td>.048</td>
<td>16</td>
<td>-2.653</td>
<td>.008</td>
</tr>
<tr>
<td>TC#1-TC#2</td>
<td>M</td>
<td>15</td>
<td>--.279</td>
<td>.780</td>
<td>16</td>
<td>-973</td>
<td>.331</td>
</tr>
<tr>
<td>TC#1-TC#3</td>
<td></td>
<td>15</td>
<td>-1.75</td>
<td>.861</td>
<td>16</td>
<td>-486</td>
<td>.627</td>
</tr>
<tr>
<td>TC#1-TC#2</td>
<td></td>
<td>15</td>
<td>-.144</td>
<td>.886</td>
<td>16</td>
<td>-905</td>
<td>.366</td>
</tr>
<tr>
<td>TC#1-TC#3</td>
<td></td>
<td>15</td>
<td>-1.725s</td>
<td>.084</td>
<td>16</td>
<td>.000</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Note. Confidence interval 95%, *p < .05.

Third hypothesis. For the third research question, “Does the order in which students watch the instructional videos affect their overall restorative performance?, Mann Whitney U tests were used to determine whether there were any differences in the mean scores between Group 1 and Group 2 at TC#1 and TC#3.

Results from TC#1 and TC#3 in Group 1 showed an increase in the mean score from 76.4 at pretest to 83.6 after the exposure to both videos indicating a 7.2-point increase following the exposure the step-by-step instructional video and self-evaluation video, respectively (see Table 9). Results from TC#1 and TC#3 in Group 2 also showed
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an increase in the mean score from 81.05 at pretest to 84.01 after the exposure to both videos indicating a 2.96-point increase following the exposure the self-evaluation video and step-by-step instructional video, respectively (see Table 9).

Table 9

<table>
<thead>
<tr>
<th>Measure</th>
<th>Group 1</th>
<th></th>
<th></th>
<th>Group 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>M</td>
<td>Range</td>
<td>Mdn</td>
<td>n</td>
<td>M</td>
</tr>
<tr>
<td>TC#1</td>
<td>15</td>
<td>76.4</td>
<td>46.30</td>
<td>82.3</td>
<td>16</td>
<td>81.05</td>
</tr>
<tr>
<td>TC#3</td>
<td>15</td>
<td>83.61</td>
<td>37.2</td>
<td>84.1</td>
<td>16</td>
<td>84.17</td>
</tr>
</tbody>
</table>

Results indicated there was no statistically significant difference between Group 1 and Group 2 in the mean scores at TC#1 (U = 109.000, N1 = 15, N2 = 16, p = .682, two-tailed). At TC#3, results showed there was no statistically significant difference between Group 1 and Group 2 in the mean scores (U = 118.500, N1 = 15, N2 = 16, p = .953, two-tailed). Therefore, the null hypothesis was accepted. The order of watching the videos did not affect students’ overall restorative performance in both groups (see Table 10).

However, there were less timed-carving failures after the exposure to both videos in both groups (see Table 11).

Table 10

<table>
<thead>
<tr>
<th>Measure</th>
<th>n</th>
<th>Mann-Whitney U</th>
<th>Z</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC#1</td>
<td>31</td>
<td>109.000</td>
<td>-.437</td>
<td>.682</td>
</tr>
<tr>
<td>TC#3</td>
<td>31</td>
<td>118.500</td>
<td>-.061</td>
<td>.953</td>
</tr>
</tbody>
</table>
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Table 11

Descriptive Data of Students’ TC Scores in Both Groups at TC#1, TC#2 and TC#3

<table>
<thead>
<tr>
<th>Measure</th>
<th>Group 1</th>
<th></th>
<th></th>
<th>Group 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Amount</td>
<td>Amount</td>
<td>n</td>
<td>Amount</td>
<td>Amount</td>
</tr>
<tr>
<td></td>
<td></td>
<td>of score less</td>
<td>score greater than</td>
<td></td>
<td>of score less</td>
<td>score greater than</td>
</tr>
<tr>
<td></td>
<td></td>
<td>than 75 (failing score)</td>
<td>than 75 (passing score)</td>
<td></td>
<td>than 75 (failing score)</td>
<td>than 75 (passing score)</td>
</tr>
<tr>
<td>TC#1</td>
<td>15</td>
<td>5</td>
<td>10</td>
<td>16</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>TC#2</td>
<td>15</td>
<td>3</td>
<td>12</td>
<td>16</td>
<td>2</td>
<td>14</td>
</tr>
<tr>
<td>TC#3</td>
<td>15</td>
<td>1</td>
<td>14</td>
<td>16</td>
<td>1</td>
<td>15</td>
</tr>
</tbody>
</table>

Fourth hypothesis. For the fourth research question, “Do students who use the videos in the restorative laboratory setting perceive that the videos enhance their learning experiences? Thematic analysis identified common themes in students’ responses (see Table 12). The majority of students (n = 30, 97%) believed the videos were helpful visual aids, helped take them back to the basics and improved their self-evaluation skills. The quality of the videos was reported as clear and the focus close enough to see the tooth and strokes. Some negative aspects of the videos were also reported such as the timing of incorporating these videos in the restorative course curriculum, limited exposure to both videos, limited lab time, and the difficulty to evaluate the pictures in a two-dimensional video without being able to use the mirror and evaluate the examples from different angles.
Table 12

*Dental Hygiene Students’ Perception Toward the Use of the Instructional Videos in Restorative Laboratory*

<table>
<thead>
<tr>
<th>Thematic Category</th>
<th>Key terms</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive aspects</td>
<td>Self-paced learning</td>
<td>“Being able to pause the videos and watch certain parts over gain.” “Able to pause and get closer looks at things.” “They give me the opportunity to re-watch (pause, rewind, etc.)”</td>
</tr>
<tr>
<td></td>
<td>Refresh knowledge</td>
<td>“They reinforced/reminded me of steps that I had either forgotten or don’t put enough emphasis on.” “They took me back to basics.” “I really enjoyed taking things back to the basics with the step-by-step video. I like seeing what instruments professor used.”</td>
</tr>
<tr>
<td></td>
<td>Helpful visual aid</td>
<td>“Visual evaluation” “Visual aids are helpful. I like step-by-step instructions.” “I really like step-by-step video, helped me start right and finish the restoration with position the anatomy and push pull for the margins, not make it flat.” “It is a visual/verbal aid that can be watched as often as possible.”</td>
</tr>
<tr>
<td></td>
<td>Improve self-evaluation skills</td>
<td>“Know exactly what professors are looking for in grading.” “Gave me an idea of where to start in self-evaluation.” “I was able to evaluate so much better after, and with self-evaluation I was able to remember the importance while carving.” “It was good to see how to evaluate teeth based on WREB requirements.”</td>
</tr>
<tr>
<td>Negative aspects</td>
<td>Limited lab time</td>
<td>“Took time away from my lab time to complete requirements.”</td>
</tr>
<tr>
<td></td>
<td>Limited exposure to both videos</td>
<td>“Can only watch videos once” “I would prefer to watch these videos at home at my own time.” “We never had extra time outside of lab to view it.”</td>
</tr>
<tr>
<td></td>
<td>Difficult to evaluate a restoration/minor mistakes on a two-dimension picture</td>
<td>“It was difficult to evaluate pictures.” “More minor mistakes shown for WREB grading would have been helpful.” “Difficult to fully see the concepts. The examples were very drastic, hard to know the “small” errors.”</td>
</tr>
<tr>
<td></td>
<td>Too late in the restorative curriculum to modify their</td>
<td>“As third-year-students we are pretty set in our carving techniques. After watching the videos, I didn’t feel”</td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>own techniques</th>
<th>compelled to change the way I am comfortable with. The carving steps weren’t what I do and it was hard to change this far into it.”</th>
</tr>
</thead>
</table>
| Introduced too late in the restorative curriculum | “I actually really enjoyed the videos. I wish we could have had them available to us first year.”
| | “This would have been more beneficial when first starting amalgam.”
| | “These would have been very beneficial last year when we were first learning placement steps.” |

| Video quality | Clear
|----------------|----------------------------------------------------------------------------------------------------------------------------------|
| Good quality | “Good quality”
| | “I thought the videos were good quality, easy to see and understand.”
| | “They were very organized and clear.”
| | “The quality of the videos is very good -I think they were nicely done, included all important information.”
| | “Clear and close enough to see the teeth, strokes and what she was talking about.” |

| Prefer device for video access | iPad®
| Computer | “iPad® works great!”
| Phone | “I like independent iPad®s”
| Canvas | “Iphone/iPad® was fine, maybe upload on YouTube to watch outside of lab”
| YouTube | “Any electronic device, I would prefer to download so I can view whenever I like.”
| | “They should be posted on Canvas so we can watch them whenever we want.” |
Discussion

Summary of Major Findings

Scores from the timed-carvings prior to and after the implementation of instructional and self-evaluation skill videos demonstrated an increase in students’ restorative performance. Even though the results were not statistically significant, there were less timed-carving failures after the exposure to both videos in two groups. The increase in the percentage of agreement between restorative instructors and students indicated the improvement in students’ self-evaluation skills. Qualitative data from the open-ended questionnaires suggested students’ positive perception towards the use of the videos in the restorative laboratory.

Discussion

To further understand the outcomes of this study, data collected from the statistical tests mentioned above are analyzed and discussed in detailed in this section. This section is organized based on the study questions.

The use of step-by-step instructional video. This study explored the effectiveness of the use of instructional videos on dental hygiene students’ restorative skills. Even though the results were not statistically significant, there was improvement in students’ restorative performance after the exposure to the step-by-step instructional video. These findings are consistent with findings of a study by Gadbury-Amyot et al. (2014) demonstrating the benefits of using instructional video hosted on an Apple iPad® in the restorative laboratory to facilitate self-paced learning environment, and accommodate both visual and auditory learners. Results of this study are also supported
by the research studies of Aragon and Zibrowski (2008), and Nikzad et al. (2012) who found the benefits of the instructional video use in improving students’ clinical performance.

In Group 1, significant improvement in TC scores were detected among students whose scores fell below the passing score of 75. Because GPA was not an exclusion criterion in this study, the PI recruited both high- and low-performing students. Therefore, scores of higher-performing students may hinder the significant increase in the TC scores of lower-performing students. The step-by-step instructional video included basic amalgam carving steps. This video was beneficial for low-performing senior students who were required to refresh their basic knowledge on how to carve a restoration step-by-step as demonstrated by the significant increase in their TC scores and less timed carving failures following the video exposure. A less meaningful impact of watching the instructional videos may have been seen for higher-performing students because they already possess the skills necessary to carve an amalgam restoration. Some students felt they were already familiar with their own techniques and therefore it was difficult to change the methods they were comfortable with. Another explanation for the insignificant results might be related to the selected population in this study. Since the population consisted of senior dental hygiene students who already have previous knowledge about the amalgam carving and evaluation, their previous knowledge and self-evaluation skills could have contributed to this insignificant results. Statistically significant results may have been detected if this study was implemented with first-year dental hygiene students who are just starting to learn amalgam carving. This explanation is supported by a study of Aragon & Zibrowski (2008) who found significant
improvement in restorative performance of preclinical dental students who were exposed to the restorative procedures for the first time. The incorporation of these instructional videos sooner in the restorative course curriculum may not only assist those who begin to learn amalgam carving, but also provide a great learning aid for those who are struggling with poor performance. This is implied by the significant improvement of those who failed to achieve a passing score at their TC#1 but achieved a passing score on future timed-carvings after watching the video.

The use of the self-evaluation video. The results clearly showed an increase in students’ self-evaluation skills after receiving recognition skills training through the interactive self-evaluation video. Additionally, there was also a direct correlation between students’ self-evaluation skills and their improvement in each graded criterion for TC#2 and TC#3. These findings are consistent with findings of previous research studies by Fitzgerald et al. (2003), Gadbury-Amyot et al. (2015), Jackson and Murff (2011), and Mould et al. (2011) demonstrating the benefits of self-assessment on academic performance and life-long learning skills. When students are unable to reflect and self-assess how well they performed in relation to the assessment criteria, it is challenging for them to identify errors in their performance and determine appropriate strategies to fix these errors. The inability of students to recognize gaps in their own performance makes it difficult for students to make any progress. Therefore, self-assessment skills are integral to students’ success. Results of this study are also supported by a seminal study of Kruger and Dunning (1999) who found the relationship between the accuracy of self-assessment and academic ability. See Table 5 and 6 for the percentage of agreement per criterion between restorative instructors and students at three
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different TC. The following discussion helps further understand students’ self-evaluation skills and their restorative performance in each graded criterion.

**Occlusal criterion.** Occlusal was the criterion students achieved the highest percentage of agreement with restorative instructors subsequent to the self-evaluation video exposure. As the percentage of agreement in the Occlusal criterion among restorative instructors and students increased, Occlusal criterion scores at TC#2 and TC#3 significantly improved. With the percentage of agreement among students and faculty in the Occlusal criterion were 62.6%, 93.8% and 87.6%, the Occlusal scores of Group 2 students were 2.43, 3.12, and 3.12 at TC#1, TC#2 and TC#3, respectively.

Results of this study are supported by research studies of Knight et al. (1990), Knight and Guenzel (1990), and Kruger and Dunning (1999) who found a direct correlation between the improvement in students’ recognition skills and an increase in clinical performance.

According to Popp, in 2015 the average median grade for Occlusal was 2.92, for Margins was 3.26, and for Proximal was 3.22. On average, WREB restorative examination candidates perform about 10% less well on the Occlusal criterion than on Margins and Proximal (Popp, personal communication, June 15th, 2016). Similar data were collected regarding how well students perform on each graded criterion in this study. See Table 7. While Occlusal is weighted slightly less than Margins and Proximal towards the final score, it can make a difference when a candidate already performs close to the minimal competence threshold and results in a passing score for the WREB restorative examination. In order to serve the community safely, dental hygiene students in Washington State need to be competent with their restorative skills upon graduation. Prior to the self-evaluation video implementation, the average occlusal score was 2.43,
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which was below the minimal competence level. This result suggests the self-evaluation video has the potential to be a helpful visual aid to assist students in the process of the evaluating a restoration based on WREB criteria, and subsequently improve their Occlusal carving skills.

The direct correlation between self-assessment skills and restorative performance were further supported by findings in Group 1 students. With the percentage of agreement among students and faculty in the Occlusal criterion were 86.7%, 73.3% and 93.4%, the Occlusal scores of Group 1 students were 2.46, 2.8, and 3.13 at TC#1, TC#2 and TC#3, respectively. No significant improvements in the self-evaluation skills and occlusal score were detected at TC#2 because students in Group 1 were not exposed to the self-evaluation video until after TC#2. These results are consistent with previous findings in the literature. Prior research study by Feil et al. (1994) indicates recognition skills must occur prior to any task production because without being able to recognize how an ideal product should look it is challenging for students to identify errors and make appropriate adjustment to fix these errors. This result reinforces the above findings that suggest the effectiveness of recognition skills and self-evaluation training in improving the Occlusal carving skills among senior dental hygiene students. These data suggest educators to spend more time on teaching the Occlusal anatomy. Additionally, providing self-evaluation training on the Occlusal anatomy is crucial because it is difficult for students to make progress without being able to self-evaluate the Occlusal anatomy. A separate video for the Occlusal could also be used in restorative laboratory to assist students in the process of distinguish ideal versus non-ideal Occlusal anatomy.
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*Proximal and Margins criteria.* There was none to a very slight increase in the percentage of agreement among students and restorative instructors in Proximal and Margins criteria. See Table 7. It is important to know that corresponding to this percentage of agreement, no statistically significant improvement in these graded criteria were found at TC#2 and TC#3. Prior to the self-evaluation video implementation, the average Proximal and Margins scores were 3.7 and 3.6 in Group 1, and 4.12 and 4.06 in Group 2, respectively. After the video exposure, no improvement in these two graded criteria were found. These findings further reinforce above findings about the relationship between self-assessment and amalgam carving skills. As the self-evaluation skills did not improve in these two categories, no significant increase in students’ performance was found. In providing restorative remediation for dental hygiene students, educators should consider providing self-evaluation training prior to any task production. Regardless how much effort a student puts into practice, without being able to recognize an error, a student tends to repeat the same mistake and unable to make any progress.

The sole use of instructional videos in this study may have hindered significant score improvement. The use of a two-dimensional video limited students the ability to physically check the carvosalve margins with an explorer, or examine the Proximal area from different angles with a mirror. Without being able to rotate the mirror to different angles to check the contour of the embrasures, physically floss the contact, and use an explorer to detect any catches or voids along the margins of a model restoration, it is difficult for students to make progress. Development of video technology that portrays the three-dimensional concepts of carving a restoration may be useful.
Additionally, the exclusion of faculty feedback in this study may contribute to the insignificant results. In order to determine the effectiveness of instructional videos as a tool of providing restorative remediation for senior dental hygiene students, faculty members were instructed not to provide feedback for students on #19MO once the study began. Although the video contains many examples of ideal versus non-ideal restorations with narratives, having faculty feedback would provide student additional guidance and confirmatory feedback to ensure they understand the teaching materials correctly. This explanation is supported by Merrill et al.’s study (1995) indicating the effectiveness of one-on-one tutoring and the importance of faculty feedback during student’s learning process. Knight et al. (1990), and Knight and Guenzel (1990), who found significant improvements in dental student’s recognition skills and performance after receiving recognition skills training sessions, also included faculty feedback in the training process. Dental and dental hygiene programs who wish to implement videos as a remediation technique should investigate the availability of faculty to provide in person feedback to further enrich the students’ learning experience.

**The order of watching the step-by-step instructional video and the self-evaluation video.** The order of watching the videos did not affect students’ overall restorative performance in both groups (see Table 10). However, the correlation between students’ self-evaluation skills and restorative performance in each graded criterion discussed above indicated the importance of achieving self-evaluation skill prior to carving skills. While research studies of Knight et al. (1990), and Knight and Guenzel (1990) indicated the effectiveness of recognition skills in improving restorative performance, these findings were based on first-year dental students with poor
performance. Since all senior dental hygiene students were recruited in this study, their previous knowledge in amalgam carving and evaluation skills may contribute to the insignificant results. Another explanation for these results was the lack of fine discrimination training in the video. The use of two-dimensional video also makes it difficult to identify minor mistakes between similar variants. This suggests use of three-dimensional technology may prove helpful in developing teaching videos for restorative skills building. This technology simulates the process of evaluating a restoration in laboratory where students are required to rotate the mirror to different angles in order to accurately examine a restoration.

With gross discrimination training provided in this study, improvement in under-performing students’ self-evaluation skills was found. However, with higher-performing students who already possess self-evaluation skills, finer discrimination training may be beneficial to detect improvement in these individuals. For example, a slight and moderate variation of harmonious form of the Occlusal, Proximal and Margins should be provided adjacent to the ideal examples so that students can learn how to look for small errors instead of bulk excess on the Occlusal surface or critical variation of proximal contour, contact area or carvosurface margin.

**Students’ perception towards the use of the instructional video in restorative lab.** The instructional videos were perceived positively by students. The majority of students felt this self-paced learning aid allowed them to refresh their basic amalgam carving skills and self-assess their work more accurately. These results are supported by Mayer (2001), R. Mayer, Dow, and S. Mayer (2013) who found students learn better when they are able to control their pace of the learning. Similar to this study, Aragon and
Zibrowski (2008), Gadbury-Amyot et al. (2014), and Patel et al. (2015) also found students’ positive perception of the use of the instructional video as a useful teaching aid in restorative laboratory. These insights are consistent with less timed-carving failures in both groups following the video exposure and an increase in the percentage of agreement between restorative instructors and students. Dental and dental hygiene programs who wish to implement instructional videos should consider the technology for hosting videos to allow students to start and stop the videos. This allows students to manage their personal pace in skill building.

**The use of instructional videos in clinical remediation to alleviate faculty workload.** The results of this study may further accommodate and contribute to the success of the restorative remediation in dental hygiene education while helping alleviate the heavy workload of dental hygiene educators. This study suggests instructional videos can be used as a supplemental effective method of providing restorative remediation among students. Making high-quality instructional videos is a very time-consuming process. To help alleviate faculty workload, these videos can be assigned to students or graduate students as student projects. To ensure the consistency in the restorative techniques and self-evaluation skills, a restorative content expert such as a Restorative Course Director needs to supervise and review these videos. Additionally, IT specialists are a useful resource in the process of making these videos.

In addition to restorative procedures, instructional videos may also be used as an alternative method of providing dental hygiene instrumentation remediation. As Wood et al. (2014) indicates instrumentation technique is the greatest area in need for remediation in dental hygiene programs. Therefore, providing instrumentation remediation to help
students accomplish fine motor skills is necessary to ensure student success. However, considering the faculty heavy workload, providing one-on-one faculty instruction for every student with poor instrumentation performance is impractical on a large scale. Therefore, the use of the instructional video is demonstrated to be an effective tool of providing remedial activities for students in the future while ensuring this method accommodates students’ learning preferences and affords them the benefits of individualized instruction.

While instructional video provides great visual aids, the effectiveness for one-on-one faculty instruction in the literature is undeniable. Although specific and immediate feedback is necessary to eliminate any confusion that may arise during the learning experiences, the need for one-on-one instruction is not required because the videos allow students to learn how to carve a restoration step-by-step, and develop recognition skills at their own pace. This helps alleviate faculty’s heavy workload and gives them more time to fulfill other academic responsibilities. In providing restorative remediation for dental hygiene students in the future, actual ideal and non-ideal examples should be provided in addition to instructional video to facilitate the learning process for students.

**The incorporation of technology in providing remediation for students.** In order to control the video exposure in both groups, videos hosted on an iPad® were used as a tool for watching video in this study. However, in reality, instructional videos can be uploaded to a Learning Management System or a private YouTube® URL that only enrolled students are able to access. Consultation with an IT specialist is recommended to assist the instructor in creating a private YouTube® URL. Videos could be uploaded to this private channel and access provided only to enrolled dental hygiene students.
Students could watch these videos multiple times during the course via their own mobile devices. In addition to iPad®, other available electronic devices in the market such as smart phones, and laptops could be used to access the instructional videos in restorative laboratory. In fact, a Pearson survey across 1211 college students in the U.S. in 2015 indicated laptops and smartphones are the two most common mobile devices students use for college work. Their popularity in the U.S. and among college students is undeniable. Virtually all college students own some kind of mobile devices, and have access to Wi-Fi whether at home or college (Pearson, 2015). Therefore, smartphones or Laptops can be used as an accessible tool for watching videos in academic environment.

Limitations

Although this research methodology was carefully designed to minimize confounding variables, there are still limitations. Data was collected from a one-time study of a small convenience sample, which precludes generalizability of findings. Additionally, the limited exposure to the videos of students contributed to the results of this study. In a quantitative study, it is important to control variables and minimize confounding factors. However, it is also an element that impacts the final results. With the improvement in students’ restorative skills and less failures subsequent to the video exposure, it is suggested with more exposure to the videos, more significant results are warranted.

The design of this repeated measures study ensures all participants receive the same number of “treatments.” This design allows the PI to use every possible order of the “treatment” with an equal number of students participating in each order, thus facilitating control for order effects. However, carryover effects still exist in this design.
THE USE OF VIDEOS IN RESTORATIVE REMEDIATION

The effect of watching the step-by-step instructional video may carry over to the next “treatment.” Following the exposure to the step-by-step video, students in Group 1 may acquire new skills that make them perform better in subsequent timed-carving. Similarly, students in Group 2 may gain new skills that affect their performance in subsequent timed-carving following the exposure to the self-evaluation video. Skill repetition from performing three different timed-carvings using the same tooth may also contribute to improved students’ performance. Although improvement in students’ timed-carving scores was detected at TC#2 and TC#3, the lack of the control group in this study made it implausible to draw the conclusion regarding the effectiveness of the video exposure and student performance. In addition, external factors during the study such as additional practice completed outside regular laboratory, and student attendance may affect these results. Small population is also another limitation of this study. Because the sample size was small, it was difficult to find statistically significant relationship from the data, as statistical tests normally required a larger sample size to ensure a representative distribution of the population to whom results are generalized.

**Recommendations/Suggestions for Future Research**

The results from this study suggest instructional video is a useful learning aid in providing restorative remedial activities for dental hygiene students. Since the study recruited all high-and low-performing senior dental hygiene students as participants, scores of higher-performing students may hinder the significant increase in the TC scores of lower-performing students. Therefore, it was difficult to detect significant improvements in final results. It is recommended to determine the effectiveness of the instructional videos in improving restorative skills among only low-performing students.
THE USE OF VIDEOS IN RESTORATIVE REMEDIATION

in future study. Next, participants felt the instructional videos could be introduced earlier in the restorative curriculum to assist first-year students as they begin to learn amalgam carving skills. With previous knowledge in carving an amalgam restoration, these students had determined their own techniques of completing a restoration, thus many were not too compelled to change their own method. Therefore, a study to investigate the effectiveness of the instructional video in increasing first-year dental hygiene students’ performance and self-evaluation skills is suggested. One of the limitations of this study is the use of two-dimensional videos. Therefore, the use of three-dimensional technology and Haptic technology is suggested in developing instructional videos in future studies. The use of three-dimensional videos allows students to evaluate a restoration from different angles while Haptic technology renders them the ability to use virtual instrumentations and handpiece in the creation of virtual anatomy of a restoration. Additionally, the lack of the control group is another limitation of this study. A future study with a third group for control will aid in accurately assessing the causal relationships between the video exposure and students’ restorative skills. Lastly, research to replicate this study with a larger more diverse group of students, including other dental hygiene programs is recommended for future studies.
**The Use of Videos in Restorative Remediation**

**Conclusions**

The explosion of accessible technology in 21st century has an impact on Millennials’ learning style. In order to accommodate this generation’s learning preferences, it is imperative to incorporate emerging technologies into educational settings. Educational programs must adapt to new teaching technology models, and faculty are expected to be technology competent. Educators need to review and make adjustments in the program curriculum in order to accommodate different learning preferences of students.

In competency-based learning programs, each student demonstrates mastery of psychomotor skills at different paces. Some may reach the competent level faster than others. However, the goal is to make sure dental hygiene students graduate as highly competent professionals. Remediation is inevitable to assist lower-preforming dental hygiene students in order to strengthen their clinical skills, and thus be able to provide the highest quality of care for the community upon graduation. With the current challenges we face with traditional methods of providing remediation in academic institutions, the use of the instructional videos may prove to be beneficial in providing restorative remediation for dental hygiene students. The incorporation of the technology in providing remediation for students does not only help alleviate the heavy workload of faculty members, but also accommodate the learning preferences of a technology-savvy student population like Millennials.
References


Carr E., Ennis R., Baus L. (2010). The Dental Hygiene Faculty Shortage: Causes,


THE USE OF VIDEOS IN RESTORATIVE REMEDIATION


http://web.b.ebscohost.com/ezproxy.library.ewu.edu/ehost/pdfviewer/pdfviewer?vid=3&sid=22e0c9de-e212-4d5c-bae6-71a7d0beadb%40sessionmgr106&hid=118


THE USE OF VIDEOS IN RESTORATIVE REMEDIATION


THE USE OF VIDEOS IN RESTORATIVE REMEDIATION


THE USE OF VIDEOS IN RESTORATIVE REMEDIATION

Examination Program. Retrieved from https://www.wreb.org/Files/Articles/08report.pdf
### Appendix A

#### WREB Dental Hygiene Restorative Examination Grading Criteria

<table>
<thead>
<tr>
<th>WREB RESTORATIVE GRADING CRITERIA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5</strong></td>
</tr>
<tr>
<td>1. <strong>Occlusal</strong></td>
</tr>
<tr>
<td>- Replicates proper anatomy (restoring harmony form).</td>
</tr>
<tr>
<td>- Ridges and marginal ridge present and properly formed.</td>
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<tr>
<td>- Smooth surface, no pits or voids.</td>
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<tr>
<td>- Functional occlusion.</td>
</tr>
<tr>
<td>- Slight variation of harmonious form.</td>
</tr>
<tr>
<td>- Major grooves formed and positioned correctly.</td>
</tr>
<tr>
<td>- Supplemental grooves may or may not be present.</td>
</tr>
<tr>
<td>- Fossa present.</td>
</tr>
<tr>
<td>- Ridges and marginal ridge present, but slight variation.</td>
</tr>
<tr>
<td>- Slight surface irregularities (pitting or voids).</td>
</tr>
<tr>
<td>- Functional occlusion.</td>
</tr>
<tr>
<td>- Moderate variation of harmonious form.</td>
</tr>
<tr>
<td>- Anatomy adequate.</td>
</tr>
<tr>
<td>- Marginal ridge height has functional contour.</td>
</tr>
<tr>
<td>- Anatomy or marginal ridge can be corrected with minimal polishing and finishing.</td>
</tr>
<tr>
<td>- Moderate surface irregularities (pitting or voids).</td>
</tr>
<tr>
<td>- Functional occlusion.</td>
</tr>
<tr>
<td>- Anatomy inadequately carved and/or over/under carved.</td>
</tr>
<tr>
<td>- Marginal ridge contourheight improper. (Pits and fissures improperly placed would alter occlusion or cause food impaction).</td>
</tr>
<tr>
<td>- Any ridges, oblique and/or traverse, improperly placed.</td>
</tr>
<tr>
<td>- Critical surface irregularities or defects (pitting or voids).</td>
</tr>
<tr>
<td>- Placement of gingivae全民adhesive resin over finished restoration.</td>
</tr>
<tr>
<td>- Hyper-osclusion; contact marks appear only on restoration.</td>
</tr>
<tr>
<td>- Equilibrated.</td>
</tr>
<tr>
<td>- Hyper-osclusion; contact marks appear only on restoration.</td>
</tr>
<tr>
<td>- Severe variation of proximal contour, shape, and/or position of contact area.</td>
</tr>
<tr>
<td>- Severe variation of proximal contour, shape, and/or position of contact area.</td>
</tr>
<tr>
<td>- Improper contact - light (may break through).</td>
</tr>
<tr>
<td>- Improper contact - light (may break through).</td>
</tr>
<tr>
<td>- Improper manipulation or infiltration of material.</td>
</tr>
<tr>
<td>- Severe surface irregularities or defects (pitting, voids, and/or fractures).</td>
</tr>
<tr>
<td>- Unscrewed.</td>
</tr>
<tr>
<td>- Severe variation of proximal contour, shape, and/or position of contact area.</td>
</tr>
<tr>
<td>- Severe variation of proximal contour, shape, and/or position of contact area.</td>
</tr>
<tr>
<td>- Improper contact - light (may break through).</td>
</tr>
<tr>
<td>- Improper contact - light (may break through).</td>
</tr>
<tr>
<td>- Improper manipulation or infiltration of material.</td>
</tr>
<tr>
<td>- Severe surface irregularities or defects (pitting, voids, and/or fractures).</td>
</tr>
<tr>
<td>- Unscrewed.</td>
</tr>
</tbody>
</table>
# Appendix B

**EWU Carving Grading Rubric**

<table>
<thead>
<tr>
<th>Carving Evaluation Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student: ___________________</td>
</tr>
</tbody>
</table>

**Directions:** Circle the appropriate description for each improvable criteria. Grading competency level will be outlined in the course syllabus.

<table>
<thead>
<tr>
<th>Carving Area</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Marginal Ridge</strong></td>
<td>Mesial (location/not developed/high/low/wide/narrow/shape/flat)</td>
</tr>
<tr>
<td></td>
<td>Distal (location/not developed/high/low/wide/narrow/shape/flat)</td>
</tr>
<tr>
<td><strong>Spillway</strong></td>
<td>Mesial (location/high/low/defined)</td>
</tr>
<tr>
<td></td>
<td>Distal (location/high/low/defined)</td>
</tr>
<tr>
<td><strong>Fossa</strong></td>
<td>Mesial (position/excess/overcarved/shape/not developed/defined)</td>
</tr>
<tr>
<td></td>
<td>Central (position/excess/overcarved/shape/not developed/defined)</td>
</tr>
<tr>
<td></td>
<td>Distal (position/excess/overcarved/shape/not developed/defined)</td>
</tr>
<tr>
<td><strong>Triangular Ridge</strong></td>
<td>Transverse (M) (location/high/low/wide/narrow/shape/rounded)</td>
</tr>
<tr>
<td></td>
<td>Oblique or D Transverse (location/high/low/wide/narrow/shape/bulky)</td>
</tr>
<tr>
<td><strong>Overall Anatomy</strong></td>
<td>Gross (excess/rough/over curved/not cleared)</td>
</tr>
<tr>
<td><strong>Central Groove</strong></td>
<td>Location/define/low</td>
</tr>
<tr>
<td><strong>Contact</strong></td>
<td>Mesial (location/broad/small/high/low/open/tight/closed/flat)</td>
</tr>
<tr>
<td></td>
<td>Distal (location/broad/small/high/low/open/tight/closed/flat)</td>
</tr>
<tr>
<td><strong>Embrasure</strong></td>
<td>Mesial Buccal or Lingual (excess/over/shape)</td>
</tr>
<tr>
<td></td>
<td>Distal Buccal or Lingual (excess/over/shape)</td>
</tr>
<tr>
<td></td>
<td>Occlusal (location/excess/overcarved/shape/open)</td>
</tr>
<tr>
<td><strong>Gingival</strong></td>
<td>Location/excess/overcarved/shape</td>
</tr>
<tr>
<td><strong>Gingival Floor</strong></td>
<td>Overhang/subcrotches</td>
</tr>
<tr>
<td></td>
<td>Distal (overhang/subcrotches)</td>
</tr>
<tr>
<td><strong>Cavosurface</strong></td>
<td>Mesial (buccal or lingual) (flashing/sub)</td>
</tr>
<tr>
<td></td>
<td>Central (buccal or lingual) (flashing/sub)</td>
</tr>
<tr>
<td></td>
<td>Distal (buccal or lingual) (generalized/slight/moderate/flashing/sub)</td>
</tr>
<tr>
<td></td>
<td>Catches (buccal/lingual/occlusal/proximal/margins/gingival)</td>
</tr>
<tr>
<td><strong>Tooth Damage</strong></td>
<td>Minor/moderate/major/minis/distal/central</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>Tooth #’s</th>
<th>Pass</th>
<th>Redo</th>
<th>Comments</th>
<th>Instructor</th>
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Appendix C

Outline of A 20-Minute Step-By-Step Instructional Video

1. Overview anatomy of #19MO preparation.
   a. Place dental mirror on the distal part of #19MO to check the gingival floor, make sure it is completely sealed.
   b. Make sure the matrix band is not too tight. If the band is too tight, it may result in open contact. Explain how a tight band looks like.
3. Condense amalgam into the preparation
   a. After triturated, amalgam should be condensed within 2-3 minutes.
   b. Select appropriate condenser. Use small condenser to condense amalgam into the corner cut, and gingival floor. Angle the condenser approximately 45-degree angle to ensure amalgam is condensed into the line angles of the cavity preparation. A bigger condenser size can be used on the pulpal floor.
   c. Use a fair amount of pressure and condense with overlapping lateral and vertical pressure against the matrix band, corner cut, gingival floor and cavity walls.
   d. Use overlapping strokes to avoid voids and ensure amalgam is well adapted to the cavity prep.
   e. Upon completion of each increment, we should be able to see the shiny appearance at the surface.
   f. Overfill the preparation. Make sure amalgam at least 1mm above and beyond the margins.
   g. Use ball burnisher to burnish amalgam. Move the burnisher back and forth across the cavity preparation and along the margina. This ensures good adaption of amalgam at the carvorsurface margins.
4. Clearing steps (Use Half-Hollenbeck for the clearing steps)
   a. Clear excess of the occlusal surface.
   b. Clear excess amalgam away from the matrix band by an explorer, and remove the matrix band
   c. Clear gingival margins and embrasures
   d. Clear excess amalgam from fossae and triangular ridges
   e. Clear the marginal ridge
   f. Clear excess amalgam along the carvorsurface
5. Carving steps (Use mostly with cleoid-discoid, avoid using the Half-Hollenbeck to prevent over-carving the anatomy)
   a. Carve the embrasures
   b. Carve fossa and triangular ridges
   c. Define central groove, fossae, and supplemental grooves
   d. Smooth and finish the carving
Appendix D
Outline of A 20-Minute-Self-Evaluation Video (Knight et al., 1990)

1. Briefly explain how to evaluate a restoration using EWU Carving Grading Rubric and WREB Dental Hygiene Restorative Examination Grading criteria.
2. Provide an ideal example of each category to assist students in the process of distinguishing ideal model versus variants.
3. Provide two variants of each category and demonstrate how to evaluate the variants using the rubric.
4. Explain appropriate steps to correct the errors.
5. Provide a variety of examples for students to practice their self-evaluation skills. Students are required to identify the errors and select appropriate statements. Answer keys are provided.
Appendix E

Students’ Perceptions Towards the Use of Videos in Laboratory Questionnaire

The purpose of this questionnaire is to determine the students’ perception towards the use of videos in Restorative laboratory.

1. What is/are the positive aspect(s) you have found with the videos?
2. What is/are the negative aspect(s) you have found with the videos?
3. How do you think about the quality of the videos?
4. Do you have any problems watching or accessing the videos?
5. What type of device would you prefer to use to watch the videos?
6. How many times did you watch the step-by-step instructional video during the restorative lab session?
7. How many times did you watch the evaluation video during the restorative lab session?
Appendix F

Permission to Use EWU Carving Grading Rubric (Nickerson, personal communication, August 8, 2016)

Re: permission to use the EWU Carving Grading rubric - Lu, Chau

Re: permission to use the EWU Carving Grading rubric

ardean nickerson <ardeanrose@yahoo.com>

Mon 8/8/2016 9:04 PM

To: Lu, Chau <chaulu@eagles.ewu.edu>

Hi

It's good to hear from you. Hope all is going well!! You have my permission to use the rubric. Is there anything else you would need?? It was nice to see you last month.

Best Wishes

Ardean

On Mon, 8/8/16, Lu, Chau <chaulu@eagles.ewu.edu> wrote:

Subject: permission to use the EWU Carving Grading rubric
To: "ardeanrose@yahoo.com" <ardeanrose@yahoo.com>
Date: Monday, August 8, 2016, 2:05 PM

Hello Prof. Nickerson
I'm Chau
Lu. I hope you have a wonderful summer in Spokane.)
I am in the process of developing my thesis.
My thesis topic is about restorative remediation. In my thesis topic, I am going to investigate whether in providing restorative remediation for dental hygiene students, the use of the instructional videos predicts improvement in their performance. As a part of my study, I need to use the EWU Carving Grading rubric in addition to the WREB rubric to evaluate the dental hygiene students' performance on their Mock WREB examinations.
I am wondering if I could obtain your permission to use the EWU Carving Grading rubric?

Thank
Appendix G

Permission to Use WREB Dental Hygiene Restorative Examination Grading Criteria
(Yeager, personal communication, August 8, 2016)

Good morning Cristina,
Thank you for your email. You have permission to use the Restorative examination grading criteria chart.
Regards,

Robin Yeager
Director of Dental Hygiene Operations
23460 N. 19th Avenue, Ste 210
Phoenix AZ 85027
Direct-623-209-5408
Fax-602-371-8131

Hello,
I am Cristina Lu. I am currently enrolled in the MSDH at Eastern Washington University. I am on the process of developing my thesis. My thesis topic is about restorative remediation. In my thesis topic, I am going to investigate whether in providing restorative remediation for dental hygiene students, the use of the instructional videos predicts improvement in their performance. As a part of my study, I need to use the WREB Dental Hygiene Restorative Examination Grading Criteria to evaluate the dental hygiene students' performance. I am wondering if I could obtain WREB permission to use this rubric?
Thank you very much,
Cristina
Curriculum Vitae

Cristina Lu, RDH, BSDH, MSDH

10924 E 5th Court
Spokane, WA 99206
(509)768-3056
Email: chaulu90@yahoo.com
Citizenship: United States of America

EDUCATION

5/2016 Master of Science in Dental Hygiene
Eastern Washington University - Spokane, WA (Online)

6/2014 Bachelor of Science in Dental Hygiene
Eastern Washington University - Spokane, WA (Honors)

6/2011 Associate of Arts
Spokane Community College - Spokane, WA (President’s Honor Roll)

ACADEMIC EXPERIENCES

09/16 - Present Restorative and Clinical Instructor
Columbia Basin College – Pasco, WA

06/2016 Co-teaching Dental Hygiene Expanded Functions Restorative Course (9-day-dental restorative course)
Eastern Washington University – Spokane, WA

08/15 - 06/16 Restorative and Clinical Instructor
Eastern Washington University - Spokane, WA

CURRICULAR DEVELOPMENT

2016 Course Development, Department of Dental Hygiene,
Eastern Washington University,
Collaborated with faculty and MSDH student to develop a condensed 9-day-dental restorative course to prepare out-of-state dental hygienists for Restorative WREB examination.

2017 Course Development, Department of Dental Hygiene,
Eastern Washington University,
Collaborated with faculty to develop Advanced Restorative Course DNHY 482S as a part of MSDH Practicum
THE USE OF VIDEOS IN RESTORATIVE REMEDIATION

PROFESSIONAL EXPERIENCES

08/15 - 06/16  Part-Time/ Temporary Clinical Dental Hygienist
Various Offices – Spokane, WA

03/15 - 08/15  Full-Time Clinical Dental Hygienist
Lake City Way Dental Center – Seattle, WA

09/14 - 03/15  Part-Time Clinical Dental Hygienist
Affordable Dental Care – Covington, WA

08/14 - 02/15  Part-Time Clinical Dental Hygienist
Brighton Dental – Seattle, WA

PROFESSIONAL LICENSURE AND CERTIFICATIONS

08/14 - Present Washington State - Registered Dental Hygienist
08/14 - Present Washington State - Sealant Varnish Endorsement
06/11 - Present Healthcare Provider Certification in Basic Life Support,
CPR, First Aid

PROFESSIONAL ORGANIZATIONS

2015 - Present American Dental Education Association
2009 - Present American Dental Hygienists’ Association
2008 - 2014 Phi Theta Kappa Honor Society

HONORS AND AWARDS

06/14 Outstanding Restorative Clinician Award
Department of Dental Hygiene
Eastern Washington University – Spokane, WA

COMMUNITY SERVICES

2012 - 2016 Smiles for Veteran’s Day, Eastern Washington University
Dental Hygiene Clinic - Spokane, WA

2015 T-2-4 Elementary Career Fair at Spokane Convention
Center to help increase 5th grade students’ knowledge
about the dental hygiene profession

05/14 Volunteer for Service Learning project for ESL students at
Spokane Community College - Spokane, WA

01/14 Oral health care presentation for pregnant teenagers at Alexandra’s
House – Spokane, WA