Abstract
The loss of all of the teeth is a life-changing event that brings functional challenges. The treatment options for edentulous patients range from conventional complete dentures to fixed implant-supported restorations of varying complexities. In a case-scenario format, this course will review indications and contraindications for treatment options of the fully edentulous patient.

Educational Objectives
During this course the participant will:
1. Review the options for the rehabilitation of the edentulous patient
2. Review the indications/contraindications of implant-related treatment options
3. Evaluate advantages/disadvantages of fixed vs. removable implant options
4. Establish the most adequate treatment options for an edentulous patient

Author Profile
Alessandro Geminiani received his DDS and MSc degrees from the University of Siena (Italy). He continued his education at Eastman Institute for Oral Health, University of Rochester, Rochester NY, where he pursued a certificate in Advanced Education in General Dentistry, a certificate in Periodontics and a Master of Science in clinical and translational investigation. He is a diplomate of the American Board of Periodontology and is currently in private practice in Rochester, NY.

Author Disclosure
Alessandro Geminiani, DDS, MS, has no commercial ties with the sponsors or the providers of the unrestricted educational grant for this course.

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This course was written for dentists, dental hygienists and assistants, from novice to skilled.

Educational Methods:
This course is a self-instructional journal and web activity.

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Educational Disclaimer:
Completing a single continuing education course does not provide enough information to result in the participant being an expert in the field related to the course topic. It is a combination of many educational courses and clinical experience that allows the participant to develop skills and expertise.

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The information presented in this CE course is developed from clinical research and represents the most current information available from evidence-based dentistry.

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The information presented in this educational activity is derived from the data and information contained in reference section. The research data is extensive and provides direct benefit to the patient and improvements in oral health.

Registration:
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Abstract
The loss of all of the teeth is a life-changing event that brings functional challenges. The treatment options for edentulous patients range from conventional complete dentures to fixed implant-supported restorations of varying complexities. In a case-scenario format, this course will review indications and contraindications for treatment options of the fully edentulous patient.

Introduction
The incidence of edentulism has been declining the past few years\(^1\) thanks to improved access to dental care and preventive dentistry. However, the total number of edentulous patients in the US is still well over 12 million. Therefore, a considerable percentage of the population has to cope with this problem. They must adapt their lifestyle to a new condition that affects several aspects of their health, including functional limitations, nutritional implications, and the psychological consequences of the complete edentulism.

Fortunately, the progress made by the science of dentistry, in especially in the field of dental implants, offers many revolutionary treatment options for edentulous patients. Among these are fixed implant supported full-arch reconstruction, (as originally introduced by Brånemark in 1975), the implant-retained removable denture (or implant overdenture), and many other options that include fixed, removable, or a combination of both solutions. While the cost of these types of restorations varies considerably and often plays a major role in the clinician’s formulation of the proposed treatment plan, several other factors are involved in the final outcome of the fixed or removable full arch implant restoration.

Moreover, technical challenges presented by the increased complexity of certain kinds of full arch implant restorations might present a burden for clinicians and therefore are not offered to patients, resulting in less-than-ideal treatment. The goal of this course is to review different step-by-step “case scenarios” in which the option chosen for the rehabilitation of an edentulous patient is carefully analyzed, weighing advantages and disadvantages, long-term outcomes, home care maintenance, repairability, cost, and additional issues that will aid in the treatment decisions.

Basic Concepts and Terminology
The Complete Denture: When rehabilitating an edentulous patient, the clinician fabricates a new prosthesis. Herein, the fixed (screw or cement retained implant prosthetics) or removable will be referred to as a complete denture. The complete denture transfers chewing forces to the underlying soft and hard tissue in different ways, based on the design of the prosthesis itself. Therefore, these prostheses will be named either implant-supported or implant-retained.

The Implant-Supported Complete Denture: An implant-supported complete denture transfers 100% of the masticatory forces to the dental implants, and as a consequence, to the alveolar and basal bone\(^3\). An implant-supported complete denture can be fixed, such as the prosthesis suggested by Brånemark (i.e., the hybrid prosthesis\(^4\)) or the All-on-4 as presented by Malo\(^5\). This type of prosthesis can be removed by the dentist, however, it has been designed to function in the mouth without the need for removal by the patient. An implant-supported complete denture could also be removable\(^6\). This type of prosthesis offers the advantages of being completely supported by implants for increased comfort, but is removed by the patient to maintain proper oral hygiene. An example of this type of prosthesis is the milled-bar implant overdenture.

The Implant-Retained Complete Denture: An implant-retained complete denture transfers masticatory forces to the dental implants (and consequently the underlying bone), and the alveolar mucosa\(^7\). The term “retained” indicates that the purpose of the dental implants in this type of prosthesis is mostly to resist vertical and lateral forces that would otherwise dislodge the complete denture. An example of an implant-retained complete denture is the commonly named “implant denture,” a conventional complete denture that engages two or more prefabricated implant attachments (i.e., Locator attachments, or bar with clips). Ideally, an implant-supported prosthesis, transferring more load to the implants, requires an increased number of dental implants for its successful outcome compared to an implant-retained prosthesis. However, biomechanics is not the only criterion in the treatment planning of the edentulous patient. Other factors, such as esthetics, speech, cost, ease of maintenance, and patient expectations, play a major role in treatment planning. For more information on this topic, the reader is referred to Part 1 of this course.

Scenario 1 - Implant-supported complete denture (fixed)
Medical and Dental History: A 56-year-old male presented with a chief complaint of, “My teeth are hurting me and they are ugly!” A review of the medical history included hypertension treated with a combination of diuretics and beta-blockers, hypercholesterolemia treated with statin and diet modification, and an allergy to penicillin. Social history revealed consumption of alcohol (less than one drink per day) and smoking (one pack per day for more than 20 years). A few months prior to the initial dental consultation, this patient experienced a sudden and severe panic attack, and thought he was having a heart attack. Following a comprehensive medical examination, a heart attack was ruled out. However, his physician recommended that the patient seek dental care to prevent systemic diseases related to poor oral heath. He admitted to neglecting his...
oral health for many years, and the dental examination revealed poor oral hygiene, multiple carious lesions, and a severe form of chronic periodontal disease. (Figures 1 through 6)

Figures 1 to 6—Intraoral photographs at initial examination

After initial periodontal therapy, oral hygiene education, and smoking cessation instruction, the prognosis of the dentition was evaluated. The patient improved his oral hygiene, and quit smoking. However, several maxillary and mandibular teeth were considered hopeless due to advanced bone loss and caries. The surgical/restorative treatment plan reviewed with the patient included the removal of the maxillary teeth, the placement of six dental implants, and the fabrication of an implant-supported fixed complete denture.

Why and How: However, while the chewing efficiency of an implant-supported removable complete denture is comparable to the one offered by an implant-supported fixed complete denture, patients generally favor the fixed option. This is due mostly to the stigma associated with removable dentures. Two factors that will influence the removable approach is cost and bone availability in the premaxilla and posterior mandible. In addition, factors such as lip support, smile line, speech ease of home care, and professional maintenance are all critical components as well. Advantages and disadvantages of these factors are summarized in Table 1 and discussed in detail in the first part of this course (see Part 1).


Table 1

<table>
<thead>
<tr>
<th>Implant-Supported Complete Denture</th>
<th>Fixed</th>
<th>Removable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lip Support</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>High Smile Line</td>
<td>Difficult to camouflage</td>
<td>Easier to camouflage</td>
</tr>
<tr>
<td>Speech</td>
<td>Possible whistling</td>
<td>Less whistling</td>
</tr>
<tr>
<td>Ease of Home Care</td>
<td>Difficult</td>
<td>Easy</td>
</tr>
<tr>
<td>Maintenance (attachment/screw wear)</td>
<td>Low maintenance</td>
<td>Might require replacement of attachment</td>
</tr>
<tr>
<td>Repairability</td>
<td>More difficult and more costly</td>
<td>Easier and less expensive</td>
</tr>
<tr>
<td>Psychological Factor</td>
<td>Preferred by the patient</td>
<td>Stigma of being a denture</td>
</tr>
</tbody>
</table>

The factor that played a major role in the treatment selection was the excellent support of the upper lip even after extraction of the maxillary teeth. Moreover the patient presented a moderate smile line (Figure 7) that could easily camouflage the transition between the alveolar process and the acrylic of the fixed prosthesis.

Figure 7 - Patient smile line

The final plan included an implant-supported complete maxillary denture. During surgical implant planning, it was considered that the maxillary prosthesis would oppose natural dentition, therefore undergoing a considerable occlusal load. This affected the placement position and the number of implants that extended from first molar to first molar in order to maximize the anterior-posterior spread of the dental implants. To avoid the need for augmentation of the maxillary sinus and quicken the healing time, distally angled implants were placed. (Figure 8)

Figure 8 - Panoramic radiograph showing the anterior posterior spread of the implants

The implant placement was facilitated by the use of a conventional surgical guide that also doubled as a bone reduction guide. (Figure 9)
It is important to note that in order to fabricate a well designed and long lasting implant-supported fixed complete denture, a minimum of 12 mm of vertical space (to an ideal 15 mm of vertical space) is needed. If this amount of vertical space is not available, alveoloplasty is required. (Figure 10)

Figure 10 - Alveoloplasty performed to increase the interocclusal space to 15 mm

The implants were immediately loaded with an acrylic complete denture. (Figures 11 through 13) During the healing phase, the prosthesis fractured in the anterior (Figure 14). At this point, the prosthesis was easily retrieved and repaired.

Figure 11 - Temporary all-acrylic implant-supported complete denture used for immediate loading.

Figure 12 - The metal-milled bar fabricated for the final implant-supported complete denture

Figure 13 - The final implant-supported complete denture, intraoral view

Summary and Analysis: When properly planned and executed, the implant-supported fixed prosthesis can provide patients with an extremely favorable outcome as far as comfort and function. Some of the drawbacks include high laboratory cost, a higher level of home care, and clinical difficulty with retrievability and repairability. Moreover, the requirement for interocclusal space (12-15mm) is considerable, and if lip support is lacking, it cannot be easily improved with this kind of prosthesis.

Figure 14 - Delamination of acrylic teeth in an implant-supported complete denture.
To overcome some of the aforementioned complications, the use of a monolithic zirconium prosthesis has been suggested. This recently developed material has the advantage of combining good flexural resistance, reducing the number of interfaces exposed to fatigue. A traditional prosthesis would present four interfaces:

1. dental implants—abutment
2. abutment—titanium bar
3. titanium bar—pink acrylic
4. pink acrylic—denture teeth.

Each interface constitutes a possible point of fracture or failure of the bonding forces between materials\(^\text{19-20}\). Denture teeth to pink acrylic is the bond most frequently subject to failure\(^\text{21}\). Therefore, the introduction of a monolithic material can, at least in theory, reduce the incidence of delamination. (Figures 15 and 16)

**Figure 15** - Monolithic zirconium implant supported complete denture (occlusal view)

**Figure 16** - Monolithic zirconium implant supported complete denture (intaglio view)

**Scenario 2 - Implant-supported complete denture (removable)**

**Medical and Dental History:** A 67-year-old female presented with a chief complaint of "My dentures are loose." Her medical history was positive for osteoporosis in treatment with oral bisphosphonate (alendronate). She reported a prolonged hospital stay and immobilization due to a severe hip fracture, after which she was no longer able to wear and tolerate the upper and lower denture. After consultation with her treating physician to evaluate the risk of medication-related osteonecrosis of the jaw, it was established that her risk was low given the dose and length of time during which she used alendronate\(^\text{22}\).

The risk of osteonecrosis of the jaw after dental implant surgery was reviewed in detail with the patient, and it was decided that the benefits of dental implants strongly outweighed the risks. The surgical/restorative treatment plan reviewed with the patient included the fabrication of an implant-supported removable complete denture for the maxillary arch, and an implant-supported fixed complete denture for the mandibular.

**Why and How:** The main factor that played a role in the decision of fabricating a removable vs. fixed implant-supported prosthesis was the severe horizontal and vertical bone deficiency\(^\text{23}\) of the anterior maxilla, resulting in a completely unsupported upper lip (Figure 17) and a considerable esthetic dilemma.

**Figure 17** - Support of the upper lip with (bottom) and without (top) maxillary complete denture.

In order to restore support of the upper lip, an acrylic flange was needed. However, a fixed acrylic flange would create difficulties during oral hygiene procedures. Therefore, a removable prosthesis supported by four implants was treatment planned. The implants were splinted by a titanium-milled bar (Figure 18), and retention for the chrome-cobalt suprastructure (Figure 19) was achieved using four spring-loaded bolts.

**Figure 18** - Titanium milled bar with four spring-loaded bolts
Summary and Analysis: Due to the anatomy of the maxillary alveolar and basal bone, dental implants placed in the upper jaw most commonly present a medial-lateral angulation (Figure 20). Therefore, retention of the denture with prefabricated attachments is either not possible, or will result in excessive wear of the nylon gaskets.

Scenario 3 - Implant-retained complete denture

Medical and Dental History: A 71-year-old female patient presented with the chief complaint of, “I’ve heard dental implants can help keep my denture in place.” Due to severe periodontal disease her teeth were removed more than 30 years ago, and she has worn complete maxillary and mandibular dentures ever since. Over the course of her life, only minor adjustments were made to the maxillary complete denture, but coping with the challenges of the lower denture had always been difficult. She experienced reduced control of the fine muscles (including the muscles of the tongue), and chewing with the lower complete denture had become more of a challenge. Upon clinical examination the mandibular alveolar ridge presented with severe resorption.

Several treatment options were discussed with the patient for the rehabilitation of the lower arch. It was decided to proceed with the placement of two dental implants in the infraforaminal area, and the fabrication of an implant-retained complete denture (overdenture).

**Why and How:** A female patient with a limited budget was interested in improving the retention of the mandibular denture. A starting point was the placement of two dental implants for an implant-retained overdenture. These could be upgraded to an implant-supported prosthesis in the future by adding more implants. After alveoloplasty of the most superficial aspect of the alveolar crest, the residual basal bone presented a buccolingual width of 8 mm, therefore the implants were placed without need for additional bone grafting. Dental implants were placed in the right and left mandibular canine areas.

Because the implants were placed with ideal parallelism, they could be easily restored with prefabricated attachments.
Summary and Analysis: The patient was extremely satisfied with the additional retention achieved by the two attachments, and she reported significant improvements in her nutrition and general well-being. However, prefabricated attachments such as the LOCATOR have the limitation of quickly losing retention if angulation between implants exceeds 40 degrees. In these instances, a bar can be fabricated to overcome angulation problems and clip attachments can be used for the retention of the mandibular prosthesis.

Recently, in order to further reduce the cost of this treatment option and increase the patient’s access to care, the use of one single dental implant was proposed for the fabrication of implant-retained mandibular dentures. While this technique is promising, a higher incidence of complications has been reported such as fracturing of the denture, and further research is needed to confirm treatment validity. The minimum number of implants recommended for the fabrication of a mandibular implant retained overdenture is two for the mandible and four for the maxilla.

Conclusions
Several treatment options are available for the edentulous patient interested in restoring the missing dentition. The technical complexity, and therefore the cost, of these restorations can vary greatly. However, a more complicated and more expensive solution does not always guarantee a more comfortable or functional outcome for the patient. When formulating a treatment plan and deciding between a fixed and removable prosthesis, the clinician should consider several factors, including: need for maxillary lip support through the use of an acrylic flange, patient compliance with oral hygiene instructions, bone quality and quantity, and patient’s medical history. While financial factors and patient preference for either removable or fixed prosthesis are important criteria and considerations in formulating a treatment plan, they should not be considered the main or exclusive factors in the selection of the type of prosthesis used for the rehabilitation of the patient.

References

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Doctor Geminiani received his DDS and MSc degree from the University of Siena (Italy). He continued his education at Eastman Institute for Oral Health, University of Rochester, Rochester NY, where he pursued a certificate in Advanced Education in General Dentistry, a certificate in Periodontics and a Master of Science in clinical and translational investigation. He is a diplomate of the American Board of Periodontology and is currently in private practice in Rochester, NY.

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Questions

1. The number of the edentulous patients in the United States is estimated to be:
   a. Less than 1 millions
   b. Between 5 and 15 millions
   c. More than 35 millions
   d. None of the above

2. The percentage of edentulous patients in the United States is:
   a. Slowly declining
   b. Rapidly increasing
   c. Stable
   d. None of the above

3. Which one of the following treatment modalities is available for the edentulous patient:
   a. Complete Removable Dentures
   b. Implant-Supported Complete Dentures
   c. Implant-Retained Complete Dentures
   d. All of the above

4. Which one of the following factors play a role in the decision of the best treatment option for edentulous patient:
   a. Phonetics and Esthetic
   b. Patient compliance with oral hygiene
   c. Cost
   d. All of the above

5. The treatment of the edentulous maxillary and mandibular arches:
   a. Is better address by a “one-kind-fits-all” treatment modalities
   b. Presents no challenges for the clinician
   c. Presents different anatomical and functional challenges that are typical for each arch
   d. All of the above

6. Important criteria to consider during planning of a fixed implant-support ed prosthesis of the maxillary arch include:
   a. Patient’s compliance to home care instructions
   b. Support of the upper lip without denture
   c. a and b
   d. None of the above
7. Implant-supported fixed prosthesis can be fabricated one or more of the following materials
a. Titanium bar
b. Denture teeth (acrylic)
c. Zirconium oxide
d. All of the above

8. Dental implants are absolutely contraindicated in patients with medical history positive for:
   a. Pre-hypertension
   b. Well-controlled diabetes
   c. Bisphosphonate therapy discontinued for more than 3 months
   d. None of the above

9. In an edentulous patient, the smile line:
   a. Plays an important role in treatment planning
   b. Does not exist, therefore should be ignored during treatment planning
   c. Is important only if patient is single
   d. None of the above

10. Which one of the following factors does not play a major role in the decision of the best treatment modality for the edentulous patient:
    a. Age
    b. Patient expectation
    c. Treatment cost
    d. Support of the upper lip without denture in place

11. Lip support and lip line:
    a. Play an important role in the selection of fixed versus removable prostheses
    b. Can be assessed with the use of diagnostic dentures
    c. If deficient can be corrected by the use of a buccal acrylic flange
    d. All of the above

12. If the edentulous alveolar ridge is shown during a patient full smile:
    a. Surgical correction (alveoplasty) might be required
    b. A fixed implant-supported prosthesis is always the best treatment option
    c. The esthetic outcome of a fixed implant-supported prosthesis could present a challenge for the clinician
    d. a and c

13. In patients with a limited interarch space:
    a. Surgical correction (alveoplasty) might be required
    b. A removable implant-retained prosthesis is always contraindicated
    c. Always requires the use of more than 6 implants in each arch
    d. None of the above

14. A complete denture can be:
    a. Exclusively supported by implants
    b. Exclusively supported by the mucosa
    c. Either be fixed or removable
    d. All of the above

15. An implant-supported complete denture, differs from an implant-retained complete denture:

Questions (Continued)

a. In the former, the occlusal load is transferred to the implants exclusively
b. In the latter, the occlusal load is distributed between implants and mucosa
   c. a and b
   d. None of the above

16. An implant-supported complete denture:
   a. Requires a minimum of four dental implants
   b. Can have a buccal acrylic flange
   c. Can still be a removable prosthesis
   d. All of the above

17. The use of distally-angled dental implants in the maxillary arch:
   a. May reduce the need for sinus grafting
   b. Increases the anterior-posterior spread of the dental implants
   c. Is a well-proven procedure
   d. All of the above

18. An implant-retained complete denture:
   a. Requires a minimum of two implants in the mandibular arch
   b. Requires a minimum of four implants in the maxillary arch
   c. Always requires the removal of the prostheses during routine home care oral hygiene
   d. All of the above

19. An implant-supported complete denture on four dental implants:
   a. Can reduce the need for grafting of the maxillary sinuses
   b. Has a reduced cost, compared to options requiring five, six or more implants
   c. Requires complex oral hygiene maneuvers
   d. All of the above

20. An implant-supported complete denture on four dental implants:
    a. Involves the placement of dental implants in the anterior maxilla, an area that commonly present a good amount of bone
    b. Allows for the use of acrylic material to mask the transition line
    c. Can create challenging esthetic outcome in patient with high lip line and/or short upper lip
    d. All of the above

21. For patients with severely resorbed maxillary arches:
    a. The use of dental implants, frequently requires bone grafting
    b. The use of zygomatic dental implants could be required
    c. Most likely requires support of the upper lip with an acrylic flange
    d. All of the above

22. For patients with severely resorbed mandibular arches:
    a. An implant-supported fixed prostheses is never possible
    b. An implant-retained removable prostheses is always the best treatment option
    c. Bone grafting is always required for implant treatment options
    d. None of the above

23. The interocclusal space requirement of implant prosthesis:
    a. Can be underestimated as it does not create a challenge for the clinician
    b. Ranges from a minimum of 9 to 16 millimeters
    c. Can be easily corrected after implant placement
    d. Is related to the patient gender

24. The interocclusal space required for an implant-retained prosthesis:
    a. Is a minimum of 9 mm if prefabricated low-profile attachment are used
    b. Can be as high as 16 mm if a custom milled-bar is used
    c. Can be easily corrected after implant placement
    d. a and b

25. The retention of an implant overdenture:
    a. Frequently requires the use of a bar for the maxillary overdenture
    b. Can commonly achieve with the use of attachment for the mandibular overdenture
    c. Is dependent on the angulation of the dental implants
    d. All of the above

26. The laboratory costs for the fabrication of an implant prosthesis:
    a. Is normally less for implant-retained prosthesis
    b. Is higher for implant-supported prostheses
    c. Should be accurately estimated when planning the implant treatment
    d. All of the above

27. The domiciliary care of implant prosthesis:
    a. Is easier for removable prosthesis
    b. Is easier for fixed prosthesis
    c. Does not play a role in the long term success of an implant prosthesis
    d. Is not necessary as long as the patient return for biannual professional hygiene recalls

28. To establish the best treatment option for the edentulous patient:
    a. The clinician has to consider several parameters such as: esthetic, phonetics, anatomy.
    b. The clinician should take into consideration the patient: compliance, neuromuscular function, and expectations
    c. The clinician should discuss advantages and disadvantages of each treatment modality with the patient, so to involve them in the final decision
    d. All of the above

29. The minimum number of dental implants required for the retention of a mandibular denture is:
    a. 4
    b. 3
    c. 2
    d. None of the above

30. The minimum number of dental implants required for the retention of a maxillary denture is:
    a. 6
    b. 4
    c. 2
    d. None of the above
ANSWER SHEET

Treatment Options for the Edentulous Patient: Case Scenarios, Part II

Name: __________________________ Title: __________________________ Specialty: __________________________

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EDUCATIONAL OBJECTIVES

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COURSE EVALUATION

1. Were the individual course objectives met?
   - Objective #1: Yes No
   - Objective #2: Yes No
   - Objective #3: Yes No

   Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

2. To what extent were the course objectives accomplished overall? (circle one)
   - Strongly Agree
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   - Very Poor

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   - Good
   - Average
   - Poor
   - Very Poor

6. Please rate the author's grasp of the topic.
   - Excellent
   - Good
   - Average
   - Poor
   - Very Poor

7. Was the overall administration of the course effective?
   - Excellent
   - Good
   - Average
   - Poor
   - Very Poor

8. Please rate the usefulness and clinical applicability of this course.
   - Excellent
   - Good
   - Average
   - Poor
   - Very Poor

9. Please rate the usefulness of the supplemental webliography.
   - Excellent
   - Good
   - Average
   - Poor
   - Very Poor

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    - No

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    - No

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13. Was there any subject matter you found confusing? Please describe.

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