Contemporary Adhesive Systems and Resin Composites

John F. Weston, DDS, FAACD — Page 3
Current composite resin restoratives offer strength, esthetics, and the ability to offer patients minimally invasive dentistry when restorations are required. The development of technology and chemistries that enhance strength and esthetics has led to the availability of universal composites that can be used in the anterior esthetic zone as well as in stress-bearing posterior regions. Adhesive systems for composite resins have also been developed with reliable bonding to enamel and dentin with total etch and self-etch options, as well as universal adhesives that can be used for both approaches.

**About the Author**

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Dr. John Weston, a native Californian who received his doctorate from Oklahoma University in 1989 and graduated with Omicron Kappa Upsilon Honors. As a commissioned officer in the US Navy, he received multiple advanced medical certifications while completing a General Practice Residency at the Naval Hospital, San Diego. He also served independent duty in support of operation Desert Storm. Dr. Weston has earned the credential of “Accredited Member” and “Accredited Fellow” from the American Academy of Cosmetic Dentistry (AACD), an honor shared by fewer than 50 clinicians worldwide. Dr. Weston has been the past Scientific Chair of the AACD Professional Education Committee twice, and has served two consecutive terms as an elected member to the Board of Directors. He is currently an active Accreditation and Fellowship Examiner and served a three year term on the American Board of Cosmetic Dentistry. He lectures nationally and internationally, publishes articles, evaluates new dental products and has been practicing in La Jolla for over 20 years with an emphasis in reconstructive and esthetic dentistry. He is owner and director of “Scripps Center for Dental Care”, a unique multi-specialty dental center located at Scripps Memorial Hospital, La Jolla CA. Dr. Weston is a consultant for 3M ESPE, the provider of the unrestricted educational grant for this course. Dr. Weston can be reached at drjohnfweston@aol.com.

**Educational objectives**

1. Review the historical development of composite resins and adhesive systems
2. Review the adhesive system options and considerations when selecting a specific method
3. Delineate the different types of composite materials and their relative physical and esthetic properties, as well as factors to consider when selecting an option
4. List and describe the factors involved in the provision of a durable, esthetic composite restoration.

**Abstract**

Contemporary adhesive systems and resin composites have changed the approach to tooth-colored restorative materials. The overall goal of this article is to provide dental professionals with information on direct composite restorative materials and adhesive systems. After completing this course, the reader will be able to:

**Introduction**

Modern restoratives had their beginnings in the 1700s with the introduction of a metal-based direct restorative material, followed by various developments in amalgam restoratives that continued to accelerate during the 20th century. It was not until the latter half of the 20th century that modern tooth-colored direct restorative materials became available. Initially, these were difficult to handle, offered relatively poor esthetics (although not compared to amalgam) and poor physical properties, and were not bonded to tooth structure. After the introduction of the early silicate materials, a series of innovations resulted in the introduction of other tooth-colored restoratives. The first composites were an improvement over previous materials; however, they exhibited surface roughness and poor polishability, stained readily, and, because of their poor strength, could only be used for anterior restorations.
Polymerization shrinkage was also high, which, in combination with the use of the then-available adhesive systems, resulted in marginal gaps and leakage as well as a propensity for marginal staining. A decade later, posterior composites became available that were suitable for low-stress-bearing areas. By the early 2000s, a notable decline in the use of amalgam had occurred. Increasingly, tooth-colored direct restorations are favored over amalgam – due to the demand for esthetics, adhesive systems, strength that affords their use posteriorly and, in some cases, their mercury-free composition.

Minimally invasive dentistry is widely recognized as helping to preserve oral health. Where possible, this entails preventive care to prevent/reverse carious lesions before they require restorative care. However, minimally invasive dentistry also favors the use of tooth-colored restorations when a restorative is required. No longer is it necessary to create classical preparations that require sufficient tooth structure be removed to create preparation undercuts and mechanical retention. Adhesive dentistry enables the preservation of tooth structure with removal of the minimum amount of tooth structure necessary. In addition to providing for retention, adhesive systems also reinforce the remaining tooth structure.

Adhesive Systems

Buonocore first published on the concept of adhesive systems for restorative materials in 1955 in the Journal of Dental Research. The adhesion concept was in fact derived from industry, where metal surfaces were already being etched to provide for improved adherence of paints to their surfaces. At the time of his publication, Buonocore described the then-existing lack of ability of materials to adhere to tooth structure as a “major shortcoming” and discussed the potential with an adhesive system to prepare teeth without the need for resistance form – an early indication of the contribution to dentistry that adhesive systems would later make. His early experiments were focused on the etching of enamel with phosphoric acid, demonstrating retention of acrylic resins. Shortly after this, research on dentin bonding began, although the results were initially poor. Since then, along with improvements in composite resins, the improvements in adhesive system chemistries and the manner in which these are used has led to improved adhesion and retention of restorations and reductions in microleakage. Bonding is now effective for enamel and dentin. Adhesive systems rely on micromechanical locking into the relevant tooth structure for retention.

Through the generations

One of the methods to categorize adhesive systems is by generation based on when they were introduced, with each generation offering something different (e.g., total etch for earlier generations and self-etch in later generations). This could convey that a later generation superseded all earlier ones, when in fact earlier and later generations are still in use. A different classification utilizes the approach of usage and number of bottles/steps rather than generation. This classification is based on total etch and self-etch modes of use.

Total etch (etch-and-rinse) adhesive systems

Total etch adhesive systems were the first adhesive systems, initially for enamel-only etching and adhesion and subsequently for both enamel and dentin. A reliable bond to dentin was achieved when hydrophilic monomers were added that enable penetration of the dentin by the adhesive resin. Total etch adhesive systems are available in either a 3-bottle or a 2-bottle system – in the case of the 3-bottle system, a primer is applied before use of the bonding agent, while with the 2-bottle system the bonding agent and primer are combined. Note that although commonly referred to as a 3-bottle or 2-bottle system, etchants are now typically delivered in a syringe as a gel rather than in a bottle. The etchant consists of phosphoric acid (varying from 10-40%). Etching is generally recommended for 15 to 30 seconds – the manufacturer’s recommendations should be followed for specific adhesive systems. Care should be taken not to exceed the etching time and overexpose dentin to the etchant.

The primer is hydrophilic, containing a hydrophilic
monomer that aids dentin penetration (see above) by wetting the collagen.\textsuperscript{12,13}

Etch-and-rinse adhesives produce higher resin-dentin bonds that are more durable than most 1- and 2-step self-etch adhesives. They have been proven to offer effective bonding to enamel and dentin.\textsuperscript{14} A recent review of 3-step etch-and-rinse adhesive systems found that at 13 years post-placement, composites were still clinically acceptable with bond degradation that was minor, with small clinically acceptable marginal defects.\textsuperscript{15} Total etch options can be found in Table 1.

**Self-etch adhesives**

Self-etch adhesives reduce the number of steps required for bonding to enamel and dentin. They consist of either a 2-step system comprising use of a primer that also contains the etchant followed by use of the bonding agent (2 separate bottles), or a single-step system that combines all steps into one either using a solution in one bottle or two separate bottles that require premixing prior to application (Table 1). With both a 1-step system and a 2-step system, no rinsing is performed prior to application of the separate bonding agent – rinsing is contraindicated and will result in failure. Rewetting to achieve moist dentin is also not required, as the self-etch adhesive systems are aqueous. This further simplifies the use of self-etch adhesives with fewer bottles/ steps and no rinsing, saving time and reducing the chances for error.

Both total etch and self-etch adhesives are effective for dentin bonding, with infiltration into the dentin and formation of a hybrid layer, although a recent study found higher microtensile bond strengths for dentin and enamel with total etch adhesive compared to self-etch or universal adhesive.\textsuperscript{16} During formation of the dentin hybrid layer, the primer monomer permeates the dentin, leading to adhesion with the dentin substrate and improved bonding and marginal seal. Incomplete permeation is believed to lead to nanoleakage of water into exposed collagen fibrils.\textsuperscript{17}

Use of a total etch adhesive provides for a stronger bond to enamel than do self-etch adhesives, with a recent *in vitro* study finding enamel shear bond strengths that were significantly higher with etchant concentrations ranging from 2.5\% to 40\%.\textsuperscript{18} Increasing etching time does increase surface roughness but was found in another study to have no effect on bond strength. In addition, as noted above, dentin should not be overetched.\textsuperscript{19} Agitating the primer used with a self-etch adhesive on moist dentin can improve bond strength, but this has been found to have no effect on bond strength to enamel at various application times (10-30 seconds).\textsuperscript{20,21} In a comparison of composite margins following use of total etch and self-etch adhesives and after thermocycling of samples, enamel margins were superior with use of a total etch technique. For dentin margins, no significant differences were found with use of either technique.\textsuperscript{22}

Roughening and etching the enamel at the margins of the preparation may help reduce the likelihood of marginal staining with all adhesive systems. However, while enamel beveling has been recommended, one study found that the 18-month survival rate and level of marginal adapta-

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**TABLE 1. Adhesive systems**

<table>
<thead>
<tr>
<th>Total Etch (Etch-and-Rinse)</th>
<th>Self-etch</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-step three bottle</td>
<td>2-step two bottle</td>
</tr>
<tr>
<td>2-step two bottle</td>
<td>1-step two bottle (mix)</td>
</tr>
<tr>
<td></td>
<td>1-step single bottle (no mixing)</td>
</tr>
</tbody>
</table>

Note that although referred to as bottles, etchant is now typically delivered in a syringe.
tion or discoloration were not influenced by either enamel beveling or selective etching of enamel.\textsuperscript{23} As a result of the lower bond strengths to enamel with self-etch adhesives, the less retentive the preparation and the more reliant it is on enamel bonding rather than dentin for adhesion (for example, a Class IV versus a Class II restoration), the stronger the indication for use of a total etch technique. A study conducted on Class V restorations found total etch and self-etch adhesive systems to be equally effective in providing bonding for composite restorations and without any differences in microleakage.\textsuperscript{24} Application of self-etch adhesive has been found to result in greater shear bond strength between resin-modified glass ionomers and composite layers used in the sandwich technique, compared to use of a total etch adhesive.\textsuperscript{25} Self-etch options can be found in Table 1.

**Selective etch**

Following the development of self-etch adhesives, selective etching was introduced. The objective of selective etching is to pre-etch the enamel margins adjacent to preparations prior to using a self-etch adhesive to increase subsequent bond strength (Fig. 1). Selective etching does improve enamel bonding, and can increase enamel bond strength to levels experienced with total etch adhesive techniques.\textsuperscript{22,26} Pre-etching dentin must be avoided with some self-etch products, as it can reduce bond strength.\textsuperscript{27} The steps for total etch and self-etch (whether or not self-etch is preceded by selective etching) can be found in Figure 2.

**Universal adhesives**

Universal adhesives are the latest addition to the range...
of adhesive systems. These can be used with a total etch or a self-etch technique as well as for selective etching. This simplifies the number of adhesive systems required in the office, while allowing flexibility in selecting a technique. Universal adhesives allow use on dry or moist dentin, and permit suitable bond strengths. Application of universal adhesive to moist or dry dentin gave the same results in a 2012 study, and the universal adhesive also compared favorably with a 2-step self-etch adhesive. A 1-step universal adhesive offers the option of carrying one adhesive, and in the case of dentin reduces the complexity of treatment by being able to bond to moist and dry dentin. This also removes the possibility of inadvertently applying a total etch adhesive to dry dentin. One recent study found universal adhesive to be equally reliable regardless of the technique used in the testing. Options tested were total etch with moist or dry dentin, self-etch, and selective etching.

**Current Composite Resin Restorative Materials**

As described earlier, composites for anterior and posterior direct restorations now offer significantly higher strength, esthetics, and ease of use than earlier variants. The basic broad categories include microfilled, hybrid/microhybrid, and nanofilled composite resins. These are grouped by filler level/type, with differing properties and characteristics. Most recently, universal composites have become available that offer esthetics and strength.

**Category and fillers**

Microfilled composites contain a low filler load with particles that are between 0.004 and 1 micron in size, usually consisting of pre-polymerized resin particles and silica. These offer high polishability and, with pre-polymerized particles, reduced polymerization shrinkage, but are relatively weak and only used in the anterior region (non-stress-bearing areas). Hybrid/microhybrid composite resins are stronger, with a higher filler load (and higher for the hybrid than the microhybrid resins). The filler particle load consists of a mix of particles – both silica-based fillers and glass particles. On the other hand, hybrid/microhybrid resins are less esthetic than microfilled composites with a lower level of polishability and long-term loss of polish. The third category based on filler characteristics is the nanofilled composite resins. These resins, as their name suggests, contain smaller particles (nanoparticles). The filler load is higher in nanofilled composites, resulting in favorable strength and wear resistance, while the particles themselves consist of zirconium oxide (0.02 – 0.1 microns in size), which favors...
esthetics and high polishability. Nanofilled composites are available with particles that are pre-polymerized/sintered into zirconia/silica clusters to increase strength and reduce polymerization shrinkage.31

Handling characteristics

Flowable composites flow easily and are low viscosity with a lower filler load. This means they offer easy handling for placement as well as bulk fill (within the confines of the maximum depth of composite that can be cured at a time) and allow use of a syringe tip to place them. They readily flow into and adapt to preparation margins and walls. Their disadvantage is that the lower filler load results in reduced strength, making them suitable only for anterior restorations and non-stress-bearing areas and for the inner layer of a restoration created using a sandwich technique. In contrast, high viscosity composites have lower flowability but higher strength due to their higher filler load, and can be “packed” with hand instruments.

Universal composite resins

Universal composites are intended for use in anterior and posterior regions, with chemistries designed to provide the strength and esthetic requirements of a universal material. How our eyes perceive variables associated with esthetic restorations is related to how light interacts with the material – how it scatters/reflects/refracts, how it is absorbed or transmitted. Relevant characteristics for an esthetic restorative material include opacity (with a higher opacity typically associated with greater filler load and used where masking of staining is necessary and in deep dentin defects),32,33 translucency, opalescence, hue, chroma (degree of saturation), and value (degree of whiteness or blackness of the shade). Ideally, the composite will also exhibit a chameleon effect whereby it blends seamlessly into the surrounding tooth structure.

Optimizing esthetics and ease of use

Using universal composites with sufficient strength for posterior stress-bearing areas, and with esthetics that meet the requirements for the anterior esthetic zone, simplifies and streamlines procedures. The incorporation of nanoparticles in universal composite provides for light scattering that results in excellent translucency and opalescence for the anterior zone, while wear resistance helps composite retain a high gloss after finishing and polishing.34 This too helps with esthetics by reflecting light well and reducing the risk of staining. Since the surface is smooth, it also helps reduce biofilm buildup. The combination of shades that is required with a universal composite is also simplified.

Although a single shade of composite may suffice in the posterior region, it is rarely adequate for the anterior esthetic zone. In complex esthetic cases, a multi-layering technique with four or more shades is often used to obtain the shading and degrees of opalescence, opacity, and translucency required to match the natural esthetics of the tooth and adjacent teeth.

By using a universal composite, in this author’s experience, it is usually possible to achieve with two main shades what was previously often only attainable with multiple layers of different composite shades and to create highly polished esthetic restorations. This simplifies placement of the composite restoration and saves chair time without compromising esthetics.

Clinical cases

The following cases demonstrate esthetic results using nanofilled universal composites.

Posterior restorations

This patient presented with old, leaking amalgams in teeth #29 and 30, as well as proximal caries mesially in #30 (Fig. 3). The patient stated that she also did not like the appearance of the amalgam fillings. In this case, the restorations would have a large area of dentin for bonding as well as the enamel margins. As a result, retention would not rely solely on enamel bonding (which would have suggested use of a total etch approach). The amalgams were removed and the teeth prepared to remove
caries and any amalgam staining. Care was taken to ensure that the margins in the boxes were in enamel, which would aid integrity of the restoration and was possible since the proximal caries did not extend deeply subgingivally. After preparation of the teeth, selective etching of the enamel was completed and the area then rinsed. Universal adhesive was then applied using a one-step approach and light cured (Figs. 4,5). Given that contemporary universal composites offer sufficient compressive and flexural strength, as well as fracture resistance and wear resistance, nanofilled universal composite was selected for the restoration together with an underlying
layer of flowable composite. The polishability and wear resistance of universal composite are also such that long-term esthetics would also be achieved. A flowable composite was used that would readily flow and adapt well in the base of the preparations and proximal boxes (Fig. 6). A single shade nanofilled universal composite was selected that would provide for both strength and esthetics. This was placed in three separate light-cured increments over the cured flowable composite, after which the restorations were contoured, finished and polished (Figs. 7,8). An esthetic result was achieved (Fig. 9).

Anterior restorations

The patient presented with a fractured incisal edge in tooth #9 (Fig. 10). On examination, the patient was found to have good oral hygiene and no carious lesions, and no root pathology or fracture was found on the periapical radiograph taken. It was decided to place a composite restoration to restore the tooth and to close the diastema at the patient's request.

Composite resin was first placed over the area (without any adhesive system so that it could easily be removed) and an incisal edge guide taken of this using vinyl polysiloxane bite registration material (Fig. 11). After the index
Figure 12. Application of etchant

Figure 13. Etched enamel

Figure 14. Creating the framework

Figure 15. Finished framework

Figure 16. Application of dentin shade

Figure 17. Application of enamel shade
and composite were removed, the tooth was prepared by creating a long bevel on the enamel surface using a coarse diamond. Since the restoration would rely on bonding to enamel for retention, a 2-step total etch approach was chosen. The etchant was applied for 15 seconds, and then rinsed off and the area dried (Figs. 12, 13). Care was taken to leave the dentin slightly moist afterward. The universal bonding agent was then applied to the preparation and light cured. The incisal guide index was repositioned over the area to serve as a support and guide while the composite framework for the restoration was created, and then removed (Figs. 14, 15).
For this case, three shades were selected that were sequentially placed and light cured. An opaque shade of nanofilled universal composite was used, followed by a more translucent “enamel shade,” and then an incisal edge shade (Figs. 16-18). After light curing of the incisal shade, the restoration was contoured, finished and polished. The diastema on the adjacent tooth was then treated. A Teflon strip was first placed over the new Class IV restoration to protect it. As before, a total etch approach was used since the restoration would rely on enamel bonding. After applying the etchant for 15 seconds, the area was rinsed off and the enamel dried. Universal adhesive was then applied and light-cured (Figs. 19-21). A single shade (Shade A2) of universal composite was then placed and light-cured, closing the diastema (Figs. 22,23). The single shade restoration was then finished and polished. The result was highly esthetic with a lifelike appearance and gloss finish for both restorations and an excellent esthetic match with each other (Fig. 24).

Conclusions

Modern science-based and tested materials have enabled the provision of esthetic, minimally invasive restorations. In addition, esthetics and strength have been optimized and combined in universal restorative materials that allow a streamlined and predictable approach to anterior and posterior restorations.

References


Webliography
1. Modern tooth-colored direct restorative materials became available in the ___________.
   a. first half of the 20th century
   b. last two decades
   c. last decade
   d. latter half of the 20th century

2. By the early 2000s, a notable decline in the use of __________ had occurred.
   a. amalgam
   b. sealants
   c. composites
   d. none of the above

3. Minimally invasive dentistry favors the use of __________ when a restorative is required.
   a. tooth-colored direct restorations
   b. veneers
   c. indirect restorations
   d. dentures

4. Adhesive dentistry ____________.
   a. enables removal of the minimum amount of tooth structure necessary
   b. reinforces the remaining tooth structure
   c. is in its early days
   d. a and b

5. The adhesion concept was derived from industry, where __________ were already being etched.
   a. plastic surfaces
   b. metal surfaces
   c. graphites
   d. all of the above

6. Buonocore described the then-existing lack of ability of materials to adhere to tooth structure as ____________.
   a. an inconvenience
   b. unfortunate
   c. a “major shortcoming”
   d. none of the above

7. Adhesive systems rely on ____________ into the relevant tooth structure for retention.
   a. chemical adhesion
   b. micromechanical locking
   c. macromechanical locking
   d. all of the above

8. Total etch adhesive systems were the first adhesive systems, initially for _______ bonding.
   a. enamel-only
   b. dentin-only
   c. enamel and dentin
   d. amalgam

9. A reliable bond to dentin was achieved when ___________ were added that enable penetration of the dentin by the adhesive resin.
   a. hydrophobic monomers
   b. hydrophilic polymers
   c. hydrophilic monomers
   d. all of the above.

10. Total etch adhesive systems are available in ____________.
    a. a 3-bottle or 2-bottle system
    b. a 2-bottle or 1-bottle system
    c. a 3-bottle, 2-bottle or 1-bottle system
    d. only a 1-bottle system

11. Etch-and-rinse adhesives produce higher resin-dentin bonds that are _________ than most 1- and 2-step self-etch adhesives.
    a. more durable
    b. less durable
    c. more visible
    d. none of the above

12. A recent review of 3-step etch-and-rinse adhesive systems found that the composite restorations were clinically acceptable _______ years post-placement.
    a. ten
    b. eleven
    c. twelve
    d. thirteen

13. Compared to total etch, self-etch adhesives ____________ required for bonding to enamel and dentin.
    a. reduce the number of steps
    b. increase the number of steps
    c. change the configuration of the crystals
    d. b and c

14. A self-etch adhesive consists of a ____________.
    a. 2-step system with two bottles
    b. 1-step system with two bottles
    c. 1-step system with one bottle
    d. any of the above
15. If a 2-step self-etch adhesive system is used, ___________ is performed prior to application of the separate bonding agent.
   a. rinsing
   b. no rinsing
   c. decontamination
   d. none of the above

16. Incomplete permeation of dentin by primer is believed to lead to nanoleakage of water into exposed ___________.
   a. enamel prisms
   b. collagen fibrils
   c. composite
   d. all of the above

17. Roughening and etching the enamel at the margins of the preparation may help reduce the likelihood of ___________ with all adhesive systems.
   a. marginal staining
   b. poor permeation of primer
   c. sensitivity
   d. all of the above

18. Application of self-etch adhesive has been found to result in greater shear bond strength between ___________ used in the sandwich technique.
   a. flowable and packable composite layers
   b. resin-modified glass ionomers and composite layers
   c. amalgams and the tooth surface
   d. none of the above

19. Universal adhesives ___________.
   a. allow use on dry or moist dentin
   b. reduce the complexity of treatment
   c. can be used with a total etch or a self-etch technique
   d. all of the above

20. Microfilled composites ___________.
   a. contain a low filler load
   b. offer high polishability
   c. can only be used in non-stress-bearing areas
   d. all of the above

   a. are stronger than microfilled
   b. are less esthetic than microfilled
   c. have a higher filled load than microfilled
   d. all of the above

22. When a composite blends seamlessly into the surrounding tooth structure it is said to be exhibiting a ___________.
   a. translating effect
   b. camouflage effect
   c. chameleon effect
   d. none of the above

23. A nanofilled composite ___________ than microfilled and microhybrid/hybrid composites.
   a. contains smaller particles
   b. has a higher filler load
   c. has a more favorable strength and wear resistance
   d. all of the above

24. Selective etching is used to pre-etch the enamel margins adjacent to preparations prior to using a self-etch adhesive to increase subsequent ___________.
   a. bond strength
   b. primer permeation
   c. dentin bonding
   d. all of the above

25. Universal composites ___________.
   a. are intended for use in anterior and posterior regions
   b. are less esthetic than microfilled composites
   c. have been around for 30 years
   d. all of the above

26. An opaque composite shade is used when ___________.
   a. a grey incisal edge is required
   b. deep dentin defects are present
   c. the enamel is chalky
   d. all of the above

27. Wear resistance helps composites ___________.
   a. retain a high gloss after finishing and polishing
   b. increase bond strength
   c. increase fracture resistance
   d. all of the above

28. The incorporation of nanoparticles in universal composites provides for ___________.
   a. light transmission
   b. light scattering
   c. light absorption
   d. chameleon activity

29. When a restoration would rely largely or wholly on bonding to enamel for retention, a ___________ approach is preferred.
   a. 3-step total etch
   b. 2-step total etch
   c. self-etch
   d. a or b

30. Universal restorative materials allow a ___________ approach to anterior and posterior restorations.
   a. streamlined
   b. predictable
   c. deliberative
   d. a and b
EDUCATIONAL OBJECTIVES
- Review the historical development of composite resins and adhesive systems
- Review the adhesive system options and considerations when selecting a specific method
- Delineate the different types of composite materials and their relative physical and esthetic properties, as well as factors to consider when selecting an option
- List and describe the factors involved in the provision of a durable, esthetic composite restoration.

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Please evaluate this course using a scale of 5 to 1, where 5 is excellent and 1 is poor

1. To what extent were the course objectives accomplished overall?  5    4    3    2    1
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4. How do you rate the author's mastery of the topic? 5    4    3    2    1
5. Please rate the instructor's effectiveness.  5    4    3    2    1
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7. Would you participate in a similar course?  5    4    3    2    1
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