Comparing Stimulus Equivalence-Based Instruction to a Video Lecture to Increase Religious Literacy in Middle-School Children

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Abstract

Being familiar with world religions and their diverse practices is referred to as *religious literacy*. The present study compared the effects of stimulus equivalence-based instruction (EBI) and video lecture (VL) to increase religious literacy in middle-school students; 10 participants were assigned to either the EBI or the VL group. Participants in the EBI group were taught five 6-member equivalence classes using match-to-sample (MTS) software on a computer. Within each class of (1) Judaism, (2) Islam, (3) Christianity, (4) Hinduism, and (5) Buddhism, the visual stimulus members were (A) name of the religion, (B) major religious symbol, (C) sacred text, (D) notable religious figure, (E) name of religious service leader, and (F) notable celebrated holiday. The VL participants were given an opportunity to complete a fill-in written worksheet while viewing a video lecture about the 5 religions using the same stimuli as the EBI group. Participant responding in each group was compared across worksheet, oral, and MTS pretests and posttests. The results showed that 5 of 5 participants in the EBI group formed equivalence classes but only 1 of 5 did so in the VL group. Class-consistent responding generalized to oral vignettes to a greater degree for the EBI participants than for the VL participants. In addition, at an approximately 2-week follow-up, EBI participants maintained class-consistent responding to a greater degree than VL participants did. Duration measures showed that even though EBI was more effective, EBI training did require more time than the VL did. Although not explicitly programmed for, social distance survey scores showed that participants improved equally in their ratings of the acceptability of people from other faiths following training, regardless of training type. Thus, EBI may be an effective method to teach schoolchildren about religious literacy.

Keywords Diversity · Education · Equivalence-based instruction · Religion · Religious literacy

Of the 324 million people in the United States, 76.5% identify with one of the five major world religions (i.e., Judaism, Christianity, Islam, Buddhism, and Hinduism; Pew Research Center, 2015). Yet many Americans are unfamiliar with religious practices and cultures that differ from their own (American Academy of Religion, Religion in the Schools Task Force, 2010; Passe & Willox, 2009; Pew Research

Center, 2010; Rosenblith & Bailey, 2008). Being familiar with other religions and their diverse practices is referred to as *religious literacy* (American Academy of Religion, Religion in the Schools Task Force, 2010; Harvard Divinity School Religious Literacy Project, 2016a; Rosenblith & Bailey, 2008). It has been suggested that low levels of religious literacy are associated with distorted or erroneous beliefs about the characteristics of people of religions other than one's own, potentially increasing racism, discrimination, and violence (American Academy of Religion, Religion in the Schools Task Force, 2010; Anti-Defamation League, 2016; Passe & Willox, 2009; Thorn, 2010). Given these concerns, it may be beneficial to investigate methods to increase religious literacy.

Although children may learn about tolerance and diversity in their homes and communities (Rosenblith & Bailey, 2008), religious literacy instruction may be lacking in U.S. public schools. Despite the fact that schools are legally permitted to provide religious literacy instruction (American Academy of

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Religion, Religion in the Schools Task Force, 2010; Fish, 2005; Heinrich, 2015; Lester, 2011; Passe & Willox, 2009), it may be omitted for a number of reasons. These include (a) misunderstandings about “separation of church and state” (Heinrich, 2015), (b) lack of guidelines about how to effectively teach religious literacy (American Academy of Religion, Religion in the Schools Task Force, 2010; Heinrich, 2015), and (c) lack of information about what is permissible to teach in public schools (Anti-Defamation League, 2013; Pew Research Center, 2010). Even when educators are familiar with these laws, it may be challenging to teach religious literacy given requirements to teach other academic material (Metzger, 2002; New Jersey Department of Education, 2014; Southern Poverty Law Center, 2016).

Although the National Council for the Social Studies (2017) identifies religious literacy as “an essential part of the social studies (p. 92) curriculum,” to date, no standardized and effective procedures have been developed for teaching religious literacy (American Academy of Religion, Religion in the Schools Task Force, 2010; Creath, 2014; Fischer, 2016). One potential option to teach religious literacy is equivalence-based instruction (EBI). EBI is a well-researched instructional method used to teach students academically relevant classes of physically disparate stimuli through specific overlapping conditional discriminations (Fienup, Covey, & Critchfield, 2010). Typically conducted with matching-to-sample (MTS) procedures, EBI results in the emergence of additional untaught, or derived, relations, thereby documenting class formation (e.g., Brodsky & Fienup, 2018; Critchfield & Fienup, 2008; Fienup et al., 2010; Sidman, 1994; Stromer, Mackay, & Stoddard, 1992). For example, a student could be taught to select a picture of a book (B) in the presence of the spoken word *book* (A), and the written word *book* (C) in the presence of the spoken word. After teaching the AB and AC baseline conditional relations, the remaining derived relations (i.e., BA, CA, BC, and CB) should emerge without additional training. Although this phenomenon has been empirically investigated with humans since the early 1970s (e.g., Sidman, 1971; Sidman, Cresson, & Willson-Morris, 1974), in recent years the number of studies in which EBI has been used to teach academic content has increased (Brodsky & Fienup, 2018). For example, EBI has been used to teach statistics (Albright, Reeve, Reeve, & Kisamore, 2015), brain-behavior relations (Fienup et al., 2010), and neuroanatomy (Pytte & Fienup, 2012), among other content areas (see review by Brodsky & Fienup, 2018).

To date, no studies in the behavior-analytic literature have investigated methods to increase religious literacy. Thus, one purpose of the present study was to investigate whether computer-based EBI could be used to accomplish this with middle-school children. In addition, although EBI has been shown to be effective in teaching academic content across numerous domains, limited research exists to determine how

EBI compares to other types of academic instruction with regards to effectiveness and efficiency of training (Brodsky & Fienup, 2018). Thus, another purpose of the study was to compare EBI to a video lecture (VL) with a written fill-in worksheet, a teaching strategy that would likely be used in a school setting. Religious literacy was assessed through computer MTS, written, and oral pretests and posttests. To assess efficiency, duration of training for each group was compared. Although not specifically programmed for, we also assessed whether participants in the EBI or the VL groups would increase the degree to which they reported being tolerant of people from other religious and social groups.

Method

Participants

Participants were 10 middle-school students (aged 11–13 years) from Grades 6–7. They were recruited by contacting parents from local public schools in New Jersey. Because religion is listed in the New Jersey Common Core Curriculum for eighth graders (*Common Core State Standards Initiative*, 2016), we recruited middle-school students to decrease the likelihood that they had already been exposed to formal religious literacy instruction in school. This lack of formal instruction was orally confirmed by the participants and their parents prior to the study. Although no participants had prior experience with EBI, all reported they had experience filling out worksheets and watching instructional video lectures at school. Participants were included in the study if they scored below 70% correct responding on each of the worksheet, oral, and MTS pretests (described next). No participants were excluded from the study. Prior to the study, all parents provided informed consent for their children to participate, and all participants provided their oral assent. Participants received a \$25 gift card of their choice (e.g., toy store, online retailer, online gaming site) following completion of the study.

Prior to the study, parents of the participants completed the Index of Spiritual Existence survey (Kass et al., 1991) to provide demographic information about their families’ history and affiliation with religion, if any. Of the 10 participants and their families, seven identified as Christian, one as Jewish, and two as religiously unaffiliated. These proportions approximated a representative sample of American religious life (Pew Research Center, 2015). Although it was not possible to evenly match the two groups in the present study on religious affiliation, block randomization was used for group assignment within each religious affiliation to ensure that each group had approximately the same number of participants from the same religion (e.g., each group contained one

religiously unaffiliated participant and either three or four Christian participants).

Setting

Sessions took place either in a small empty classroom at a private university or in a quiet room at the participant's home. The area had a table or desk, chairs, and a Microsoft Windows-based laptop computer. A small video camera located behind the participant was used to record sessions for interobserver agreement and procedural integrity data purposes. Session duration was 1–2 hr per day across 2–3 days per participant, with a 1- to 3-week follow-up session.

Materials, Apparatus, and Stimuli

For equivalence class training and testing (EBI group only) and MTS pretests and posttests (EBI and VL groups), stimuli were presented on the screen in 6.4 cm × 4.7 cm white rectangles. An independent fill-in written worksheet, adapted from Creath (2014), was given to all participants as a pretest and posttest generalization measure (available upon request). The worksheet was also used during training for the VL participants.

Participants were taught five 6-member classes (see Table 1). The classes were (1) Judaism, (2) Islam, (3) Christianity, (4) Hinduism, and (5) Buddhism. Within each class, the members were (A) name of religion, (B) major religious symbol, (C) sacred text, (D) notable religious figure, (E) name of religious service leader, and (F) notable celebrated holiday. All stimuli in the equivalence classes were exclusively textual except for the religious symbols. All stimuli presented during EBI were also compound stimuli in that an identifying textual contextual cue was provided in addition to the class member. For example, if the word for the Buddhist sacred text *Tripitaka* was presented, the words *sacred text* were presented above it. Similarly, if a Star of David symbol was presented, the words *religious symbol* appeared above it. Thus, across all five equivalence classes, each specific class member type was identified by a common textual label above the actual class member. For the oral pretest and posttest, vignettes were presented that contained exemplars from each religion and class member. For example, to assess the religious symbol for Judaism, the following vignette was presented, “While walking down the street, you notice a building with a *Star of David* on the outside sign.”

For the VL group, a video was created using Microsoft® PowerPoint software with voice-over narration provided by the first author. The voice-over script was written at no higher than a sixth-grade comprehension level as indicated by the Flesch-Kincaid function embedded in Microsoft Word. A total of 34 slides was presented, and the order of the slides was the same for all participants. The presentation duration of each

slide was approximately 14 s with a total duration of approximately 8 min for the entire video lecture. Each slide depicted a class member, a pictorial image of the stimulus (if applicable), and a brief description or fact about the stimulus. Slides were designed to approximate lecture material an educator might present during instruction. For illustrative purposes, Fig. 1 depicts a sample slide presented for “Iman” (Islamic service leader).

Two different surveys were developed to assess the social validity of the equivalence class member stimuli. The first survey was used to select general stimuli for the class members, whereas the second survey asked respondents to rank the items from most common to least common to identify the most representative exemplar for each class member. Both surveys were created using a web-based survey platform (i.e., www.surveymonkey.com) and were validated by three PhD-level educators with expertise in religious studies. The first survey had questions scored via a 4-point Likert-type rating scale with answers ranging from 1 for *completely disagree* to 4 for *completely agree*. A stimulus was included in the second survey if responses indicated a mean score of 3.5 or higher.

The second survey (not shown) asked respondents to rank all potential correct responses for the class members of “celebrated holiday” and “notable figure.” These items were ranked from 1 for *most commonly associated with the religion* to 5 for *least commonly associated with the religion*. Items ranked most common were used as the equivalence class stimuli (see Table 1), whereas the other, less common stimuli were included as acceptable participant responses for the written and oral generalization probes. For example, the word *Christmas* would be accepted as correct for “notable holiday” for Christianity.

Response Feedback

Participants in the EBI group were provided with textual feedback (i.e., “correct” and “incorrect”) following selection responses during training trials. Feedback was not presented following responses during any derived relations tests.

Participants in the VL group received written feedback on their training worksheet from the experimenter in the form of a check mark for correct answers and an X for incorrect answers. After returning it to the participant, and before testing occurred, the worksheet was orally reviewed with the experimenter to simulate a classroom-type exercise. No VL group participants required more than 5 min to review the worksheet.

Design

The present study used a pretest-training-posttest-maintenance design (Walker & Rehfeldt, 2012) with a

Table 1 Stimulus members in experimenter-defined equivalence classes

Notation	Class Mem.	Classes				
		1	2	3	4	5
A	Name of religion	JUDAISM	ISLAM	CHRISTIANITY	HINDUISM	BUDDHISM
B	Religious symbol	religious symbol: (Star of David)	religious symbol: (Star and Crescent)	religious symbol: (Cross)	religious symbol: (Om)	religious symbol: (Dharma Wheel)
C	Sacred text	sacred text: TORAH	sacred text: QURAN	sacred text: BIBLE	sacred text: VEDAS	sacred text: TRIPITAKA
D	Notable figure	notable figure: MOSES	notable figure: MOHAMMAD	notable figure: JESUS	notable figure: MOHANDAS GANDHI	notable figure: DALAI LAMA
E	Name of religious service leader	name of religious service leader: RABBI	name of religious service leader: IMAM	name of religious service leader: MINISTER	name of religious service leader: PUROHIT	name of religious service leader: BHIKKU
F	Celebrated Holiday	celebrated holiday: YOM KIPPUR	celebrated holiday: EID AL-ADHA	celebrated holiday: EASTER	celebrated holiday: HOLI	celebrated holiday: WESAK

between-subjects comparison across the EBI and VL groups. The order of phases was (a) social distance scale; (b) stimulus pronunciation testing and training; (c) computer familiarization training; (d) written, oral, and computerized MTS pretests; (e) EBI or VL intervention; (f) written, oral, and computerized MTS post-tests; (g) social distance scale; (h) written, oral, and computerized MTS maintenance tests; and (i) social validity assessment.

Dependent Variables

Data were collected on correct comparison selections during computerized MTS portions of the study along with responding during the written worksheet tests and oral vignette tests. During MTS portions of the study, correct and incorrect responses were automatically scored by the software. These data were summarized as the percentage of correct trials. A correct (+) oral response was scored if a

Fig. 1 Sample slide from video lecture

participant stated the class member to which the vignette belonged. An incorrect response (–) for the vignette was scored if a participant orally stated the incorrect class or said, “I don’t know.” A correct written response was scored if the participant wrote the correct stimulus in the fill-in box on the worksheet. An incorrect written response was scored if the participant wrote an incorrect stimulus or left the box blank.

Data were also collected on trial blocks to reach mastery criterion for each trained baseline relation and tested derived relation for participants in the EBI group. The criterion for mastery was 100% correct responding for baseline relation trial blocks and 90% or higher for derived relations trial blocks. To assess the efficiency of the EBI and VL procedures, total duration was also recorded from video time stamps for each group.

Procedure

Social distance scale Participants completed the Bogardus Social Distance Scale (Bogardus, 1968; Parillo & Donaghue, 2013) before the pretests and after the posttests. This assessment provides a 1–7 Likert-type scale to evaluate the degree to which a person reports he or she is tolerant of others. Although we did not program for teaching tolerance of others per se in the study, we were interested in determining whether social distance scores improved as a function of the type of religious literacy training.

Stimuli pronunciation testing and teaching To ensure that participants could pronounce the stimuli correctly during subsequent oral vignette tests (described later), the pronunciation of each class member was assessed in a 30-trial block. Each of the six stimuli from the five equivalence classes was typed on an index card in 16-point Arial font (the symbols appeared with their textual names). The experimenter held up each card in random order and asked the participant to “please read this aloud for me.” Each participant was given 5 s to read the word independently. A correct pronunciation was scored if a participant’s oral response matched the pronunciation key. An oral

approximation was scored correct only if it contained at least half of all the syllables in the words pronounced correctly. For example, for the four-syllable word *Tripitaka*, if a participant said “trippy-take-uh” instead of “trip-it-uh-kuh,” the response would be scored as incorrect. If a participant responded incorrectly, the experimenter held up another card with a phonetic transcription of the word (i.e., International Phonetic Alphabet; International Phonetic Association, 2015) while simultaneously providing a vocal model. The participant was then asked to repeat the model. The trial continued this way until the participant pronounced the word correctly. Praise was provided for correct pronunciations (e.g., “Yes, you got it!”). The entire trial block was repeated until each participant could independently pronounce each stimulus without correction. All participants learned the correct pronunciations within three blocks.

Computer familiarization training Before the computerized MTS pretest (described later), participants learned how to use the computer software. To accomplish this, sets of common related pictures and words not used in the experiment were presented in a 9-trial block (e.g., a picture of an apple matched to the written word “APPLE”). The sample was presented centered at the top of the screen. Clicking on the sample with the mouse produced five comparisons with a 0-s delay presented in a horizontal array at the bottom of the screen. Clicking the correct comparison removed the stimuli and produced the word “CORRECT” centered on the screen. Although an incorrect comparison selection would have resulted in the word “WRONG” being presented, all participants met 100% mastery criterion within one block.

Pretests Three pretests were presented in the following order for all participants: (a) written fill-in worksheet (topography-based generalization assessment), (b) oral vignettes (topography-based generalization assessment), and (c) computerized MTS test (selection-based responding). We presented the pretests in this order so that the open-ended tests (i.e., written fill-in and oral) were presented before the closed-ended test (i.e., computer MTS). In this way, no information that might be gleaned from the MTS test could be used to answer correctly during the open-ended tests. In addition, because the written and oral tests assessed responding with different topographies than those used during EBI (i.e., selection-based responding), it was possible to evaluate the degree to which response generalization occurred following training. No feedback was provided for responses during pretests. All written stimuli and vocal instructions were written at no higher than a sixth-grade reading level according to the Flesch-Kincaid grade level tool in Microsoft® Word and were specific to their instructional task.

For the written pretest, participants were given a printed worksheet. Printed at the top of each of five columns in capital

letters was the name of each of the five religions (e.g., HINDUISM). Beneath the names were blank fill-in boxes with labels in capital letters corresponding to the other five class members (i.e., RELIGIOUS SYMBOL, SACRED TEXT, NOTABLE FIGURE, RELIGIOUS SERVICE LEADER, and CELEBRATED HOLIDAY). Thus, 25 fill-in answers were required to complete the written worksheet across the five equivalence classes.

For the oral pretest, the experimenter read aloud 25 vignettes (available from the first author) that were one to two sentences in length and were presented in a randomized order. After each one, the participant was asked to “say the name of the religion this belongs to.” For each class, there was a vignette corresponding to the religious symbol, sacred text, notable figure, religious service leader, and celebrated holiday. For example, the oral vignette for a celebrated holiday for Judaism was “*Yom Kippur* is one of the most important holidays for this religion.” The vignette for a notable figure for Hinduism was “The *Dalai Lama* is a popular world leader for this religion.”

During the MTS pretest, participants sat in front of the computer and were told “your job is to see if you can pick the item on the bottom of the screen that goes with the one at the top of the screen.” The computer software counterbalanced and randomized all stimulus presentations. The 150-trial MTS pretest contained all possible baseline and derived relations for each of the five equivalence classes. Following the MTS pretest, participants received either the EBI or VL intervention as described next.

EBI group A one-to-many training structure was used (Smeets & Barnes-Holmes, 2005) to train the AB, AC, AD, AE, and AF baseline relations during EBI. The order of presentation of each training and testing block is depicted in Table 2. A 10-trial block was used to train each baseline relation across the five classes, with each relation appearing twice in a block. Along with the sample, five comparison stimuli were presented during each trial as described previously for computer familiarization training. The presentation order of all trials within each training and testing block was randomized by the computer software, as was the location of the correct comparison in each trial. Feedback was provided following all comparison selections during baseline relations training. Each baseline training block was repeated until the mastery criterion of 100% correct responding was met for the block.

Each corresponding symmetry relation was tested with a 10-trial block following mastery of each baseline relation. Similar to baseline training, each symmetry relation (i.e., BA, CA, DA, EA, FA) appeared twice in its corresponding block. For example, after learning the AB baseline relation of Judaism (A1) and the religious symbol of the Star of David (B1), symmetry would be demonstrated when the participant selected the comparison “JUDAISM” (A1) from the array of

Table 2 EBI Baseline Training and Derived Relations Trial Blocks

Phase	Relation	Number of Trials in Block (or Questions)
1. Training: Baseline	AB	10
2. Testing: Symmetry	BA	10
3. Training: Baseline	AC	10
4. Testing: Symmetry	CA	10
5. Training: Baseline	AD	10
6. Testing: Symmetry	DA	10
7. Training: Baseline	AE	10
8. Testing: Symmetry	EA	10
9. Training: Baseline	AF	10
10. Testing: Symmetry	FA	10
11. Testing: Equivalence	BC, BD, BE, BF, CB, CD, CE, CF, DB, DC, DE, DF, EB, EC, ED, EF, FB, FC, FD, FE	100

religion names if the Star of David (B1) was the sample. No feedback was provided following comparison selections. Mastery criterion was defined as at least 90% correct (9 of 10 trials) per symmetry test block. If a participant failed a test block for symmetry, the prior baseline relation training was repeated until 100% correct responding was achieved. For example, if the CA symmetry test was failed, the AC baseline training block was repeated until mastery. Participants then completed the previously failed symmetry test again. This continued until mastery was met for each symmetry test block.

Next, all equivalence relations were tested (i.e., BC, BD, BE, BF, CB, CD, CE, CF, DB, DC, DE, DF, EB, EC, ED, EF, FB, FC, FD, FE) in a single 100-trial test block, with each relation appearing once. One example of an equivalence trial used the religious symbol as the sample (e.g., Star of David, B1) with the five names of sacred texts as the comparisons. Selecting the comparison Torah (C1) would be correct. Mastery criterion was defined as at least 90% correct responding (90 of 100 trials). If participants did not meet mastery, all baseline relations were retrained with a 50-trial block. After achieving 100% correct responding for one baseline relations block, the equivalence test block was re-presented. This continued until mastery criterion was met for the equivalence test block. Following this, all EBI participants completed the posttests.

Video-lecture group During training, participants viewed the video lecture on the computer. Prior to viewing, participants were provided with the same blank 25-item fill-in worksheet used during the written pretest. The experimenter told the participant to “please complete the worksheet as accurately as you can while watching the video.” Participants were also told “you can pause or reverse the video at any point and play

it as many times as you wish. Please let me know when you complete the worksheet and are done watching the video.” All information necessary to correctly complete the worksheet was presented at some point during the video lecture. After a participant completed the worksheet and stated that he or she had finished viewing the video, a 5-min break was provided while the experimenter scored the worksheet and made any corrections, if needed. No participant made more than two errors on the worksheet. After scoring it, the experimenter returned the worksheet to the participant and said, “Please look over your answers to see how you did. You can look at this as long as you want. Please let me know when you are done.” No participant reviewed the scored worksheet for more than 5 min, with most spending only 2–3 min. Participants then continued to the posttests.

Posttests and social distance scale The three posttests were identical to the pretests except that trial/vignette order was rerandomized for each test. After the posttests, participants also filled out the same social distance scale for a second time.

Maintenance Maintenance of class-consistent responding was evaluated 1–3 weeks following completion of the posttests by repeating the same three posttests. The maintenance interval differed due to variable participant availability, but on average, it was approximately 2 weeks for participants in each group. Maintenance tests were identical to the posttests except that trial/vignette order was randomized again.

Social Validity

Last, participants completed an intervention-rating questionnaire similar to Witt and Martens (1983) to assess the acceptability of the procedures, outcomes, and goals of the study (see Table 3).

Interobserver Agreement and Procedural Integrity

A second independent observer collected data for interobserver agreement (IOA) and procedural integrity using recorded video sessions. Trial-by-trial IOA data were collected for 50% of all sessions across all phases and participants. An agreement was scored when the observations of the experimenter and the second observer corresponded. The number of agreements was divided by the number of agreements plus disagreements and multiplied by 100. For duration-based measures to be scored as correct, the observers were required to be within 1 min of one another. Mean agreement was 98.2% (range = 97%–100%) for the written worksheet responses, 99.8% (range = 96%–100%) for the oral vignette responses, and 100% for duration, across participant pretests, training, posttests, and maintenance tests. Because the computer software automatically scored all MTS responses, no IOA data

were necessary. Prior to the study, however, the software was piloted and calibrated to ensure that it accurately recorded all selection responses.

The experimenter collected procedural integrity data for 100% of sessions. The observer scored procedural integrity for 50% of all video-recorded sessions using a data sheet created by the experimenter. Data were summarized as a percentage of correctly completed steps by dividing the number of correctly completed steps by the total number of steps and multiplying by 100 for IOA, procedural integrity, and IOA of procedural integrity. All procedures were correctly completed (100%) for both the EBI and VL groups. IOA of procedural integrity was also 100% for both groups.

Results

Pretest, Posttest, and Maintenance Performances

For Figs. 2, 3, and 4, the top and bottom graphs depict the individual data and group mean results for the EBI and VL participants, respectively, for the three different tests. Figure 2 shows the percentage of trials with correct responding during the MTS tests. Participants in the EBI group ($M = 47.8\%$, range = 22%–60%) and the VL group ($M = 55.0\%$, range = 41%–67%) showed similar low scores on the MTS pretests. It should be noted that further data analysis showed that responding during the MTS pretest was higher than chance responding (i.e., 20%) for both groups, predominantly as a result of a higher percentage of correct trials for the Judaism and Christianity classes. Following intervention, however, all five EBI participants met criterion on the MTS posttest ($M = 96.6\%$, range = 95%–100%), thus demonstrating the formation of the equivalence classes. Although participants in the VL group did show improvements following the video ($M = 75.4\%$, range = 51%–97%), only one of five participants passed the posttest and demonstrated equivalence class formation. Based on an analysis of difference scores, a one-tailed t -test showed that the mean increases from pretest to posttest were significantly higher for the EBI group than for the VL group, $t(9) = 3.03$, $p = 0.01$.

Figure 3 shows the percentage of correct responding for the oral vignette tests. Participants in both the EBI group ($M = 38.4\%$, range = 16%–56%) and the VL group ($M = 39.2\%$, range = 16%–56%) showed similar low scores for the oral pretest. As was true for the MTS pretest, most correct oral responses were for the Judaism and Christianity classes. Following intervention, correct responding for the participants in the EBI group increased substantially during the posttest ($M = 86.4\%$, range = 76%–100%). In contrast, correct responding for the participants in the VL group moderately improved during the posttest ($M = 61.3\%$, range = 48%–88%). Although mean difference scores from the pretest to the

Table 3. Social Validity Questionnaire Results

Survey Item	EBI Group		Video/Lecture Group	
	Mean	Range	Mean	Range
1. I feel like I respect people of other religions more than I did before.	4.8	2–4	4.4	2–6
2. Learning about other religions was good for me.	5.6	5–6	5.6	5–6
3. I liked the [computer lessons / video and worksheet].	4.6	3–6	5.4	5–6
4. I felt frustrated doing [the computer lessons / the worksheet]. ^a	3.2	2–6	3.0	2–5
5. The [computer lessons / video and worksheet] were easy for me.	4.0	2–5	2.6	1–4
6. I would like to learn other skills using [computer training / videos and worksheets].	5.2	4–6	5.2	3–6
7. I think my friends could learn with the [computer training / video and worksheet].	5.2	5–6	4.8	4–6
8. I would rather learn [on the computer / with a video and worksheet] by myself than learn about the topic in class.	4.2	1–6	5.4	3–6

Note. 1 = *strongly disagree*; 6 = *strongly agree*

^a Indicates a reverse-scored item

posttest were numerically greater for the EBI group than for the VL group, a one-tailed *t*-test showed that these differences only approached, but did not reach, significance, $t(9) = 1.6$, $p = 0.067$, *n.s.*

Figure 4 shows the percentage of correct responding for the written worksheet tests. Participants in both the EBI group ($M = 17.2\%$, range = 10%–33%) and the VL group ($M = 25.2\%$, range = 3%–53%) showed low levels of correct responding during the worksheet pretest. Again, most correct written responses were for the Judaism and Christianity classes. Following intervention, participants in both the EBI group ($M = 55.4\%$, range = 37%–70%) and the VL group ($M = 61.8\%$, range = 40%–83%) showed similar moderate increases in levels of correct responding during the worksheet posttest. Although there was a numerical difference for pretest to posttest scores for both groups, a one-tailed *t*-test found no significant difference between the groups, $t(9) = 0.28$, $p = 0.4$, *n.s.*

Maintenance

Figure 2 also shows maintenance results for the MTS tests. Scores were higher for the EBI group ($M = 90.6\%$, range = 73%–98%) than for the VL group ($M = 77.2\%$, range = 52%–99%). Compared to prior MTS posttest performances, there was a small decrease for EBI participants and a small increase for VL participants. As shown in Fig. 3, maintenance performances for the oral vignette test were also higher for the EBI group ($M = 86.4\%$, range = 64%–96%) than for the VL group ($M = 62.7\%$, range = 44%–92%). Both groups maintained performances comparable to those from the prior oral vignette posttest. Figure 4 shows that maintenance performance for the written worksheet for the EBI group was moderately higher ($M = 68.6\%$, range = 50%–93%) than for the VL group ($M =$

46.7%, range = 33%–87%). Compared to prior worksheet posttest performances, there was a small increase for EBI participants and a small decrease for VL participants.

Performances During EBI

During EBI, all five participants met criterion for each baseline and derived relation (see Fig. 5). Participants met mastery for each relation in the following mean number of trials: AB ($M = 4.0$, range = 1–8), BA ($M = 1.2$, range = 1–2), AC ($M = 2.8$, range = 2–5), CA ($M = 1.0$), AD ($M = 2.8$, range = 1–5), DA ($M = 1.2$, range = 1–2), AE ($M = 2.4$, range = 1–4), EA ($M = 1.0$), AF ($M = 3.0$, range = 2–5), FA ($M = 1.0$), emergent relations ($M = 1.4$, range = 1–2), and remedial baseline relations ($M = 1.5$, range = 0–4). Thus, all participants in the EBI group demonstrated the formation of five 6-member equivalence classes prior to the posttests.

Efficiency Measures

Duration data were collected to determine whether there were any efficiency differences between the two groups. Unsurprisingly, the mean duration to complete the pretests, posttests, and maintenance tests was nearly identical for the two groups, requiring an overall mean of 185 min (range = 171–202 min). Duration differences were observed for training, however, with the EBI group requiring nearly 50 min more ($M = 68$ min, range = 46–123 min) than the VL group ($M = 19$ min, range = 11–29 min).

Social Distance Scores

We also compared the effects of the EBI and VL interventions on participant Bogardus Social Distance Scale scores

Fig. 2 Individual and group mean performances for the MTS pretest, posttest, and maintenance test

(Bogardus, 1968; Parillo & Donaghue, 2013) with a 2×2 mixed analysis of variance (ANOVA). The main effect for type of training (i.e., EBI vs. VL) on social distance indicated no significant difference between groups, $F(1, 8) = 0.36$ $p = 0.57$. Social distance scores, however, did increase significantly from pretest to posttest regardless of experimental group, $F(1, 8) = 4.95$ $p = 0.049$.

Social Validity

Table 3 shows the results of the social validity survey completed by the participants. Generally, the results were favorable but did not differ systematically between the two groups. Overall, participants in both groups reported that (a) learning about religion helped them to respect other religions more

Fig. 3 Individual and group mean performances for the oral vignette pretest, posttest, and maintenance test

than before training, (b) learning about other religions was good for them, (c) they liked their respective training methods, and (d) they would like to learn other skills or content using the training method they received. Finally, participants also agreed that they would rather learn using the training methods in the present study than learn about religion topics in a typical classroom setting.

Discussion

The present study compared EBI to VL to teach classes of stimuli related to five major world religions. The results showed that all five participants in the EBI group formed equivalence classes following training, whereas only one of the five participants in the VL group did so. To our

Fig. 4 Individual and group mean performances for the worksheet pretest, posttest, and maintenance test

knowledge, this is the first study to date that has increased religious literacy using EBI. The need for behavior-analytic research investigating culturally important topics (e.g., religion, prejudice) has been previously noted by other researchers (e.g., Dixon, Branon, Nastally, & Mui, 2009; Sidman, 2003). Although a small number of prior studies have addressed these topics, they were primarily focused on a relational frame theory account (e.g., Dixon et al., 2009) and were

conducted with adult participants. The present study extends this literature by providing the first demonstration of increasing religious literacy using EBI and with younger participants.

Researchers have also called for additional research that assesses generalization of class-consistent responding beyond conditions experienced during training and testing of derived relations (e.g., Brodsky & Fienup, 2018). In the current study, both stimulus and response generalization were assessed. For

Fig. 5 Mean trial blocks to criterion for the EBI group

example, the oral vignettes were designed to present scenarios participants might encounter in their daily lives, such as hearing another person mention reading the Torah or seeing the Om symbol on a building. In addition, participants were required to emit an oral response rather than emit a selection-based or written response. Previous research has shown increases in class-consistent responding with a different response topography following selection-based EBI training (e.g., Lovett, Rehfeldt, Garcia, & Dunning, 2011; Reyes-Giordano & Fienup, 2015; Walker, Rehfeldt, & Ninness, 2010). Consistent with studies, participants in the EBI group scored higher (albeit not significantly) during the oral vignette posttest than participants in the VL group did. This is an important finding because one valued outcome of religious literacy education is for such skills to generalize to the natural environment and across different response topographies.

Although we did observe a moderate degree of generalization of class-consistent responding during the oral vignette tests, none of the participants in the current study met mastery during the written worksheet posttest. This may be due to the fact that the participants in the prior studies noted previously (e.g., Lovett et al., 2011; Reyes-Giordano & Fienup, 2015; Walker et al., 2010) were older than the participants from the present study. It is possible that training with selection-based responding (i.e., EBI) with middle-school participants is not sufficient to consistently increase class-consistent responding across other response topographies (i.e., written fill-in worksheet). Future researchers might wish to evaluate the effects of training across an additional topography (e.g., oral responding) during EBI to determine whether this increases the degree to which response generalization occurs with younger participants.

With regard to procedural efficiency, it is important to note that the EBI group required more training time than the VL group did. These results are consistent with those of Lovett et al. (2011), who found that a traditional lecture format was more time efficient than EBI. In contrast to Lovett et al., however, EBI was superior to lecture for establishing equivalence classes in the present study. We anticipated that participants in the VL group would require more training time than they did because they were allowed to replay the video and view it as many times as needed. Although no participant in the VL group made more than two errors when completing the worksheet used during the lecture, it is possible that the relatively short exposure time with the experimental stimuli by the VL participants resulted in lower posttest scores relative to the EBI participants. As such, it is possible that additional viewing time of the video might have increased posttest scores for the VL participants during the posttests. In a future study, researchers may wish to yoke VL viewing duration to that of the EBI training to determine whether a VL or EBI approach is superior when duration is equated.

The results showed that EBI participants maintained MTS performances at criterion level during maintenance, whereas the VL participants did not meet criterion in either the MTS posttest or maintenance. However, there was a small increase in VL participant performances during the MTS maintenance tests. Anecdotally, we noticed some distinct differences between the strategies participants used in each group to complete the computerized portions of the study. Of the two groups, the EBI participants were the only ones observed to talk aloud about their choice selections. This supports previous research (Lowe & Beasty, 1987) demonstrating that overt speaker responding during MTS trials may lead to improved

performance. Interestingly, this occurred for EBI participants in the current study without direct instruction to do so. Future research, however, should be conducted to determine the degree to which such overt verbal behavior contributed to the superiority of the EBI training and testing in the present study.

Following either EBI or VL training, we found that participants were likely to report increased tolerance of others as indicated by social distance scores. This indicates that regardless of the training procedure used, increased tolerance scores were achieved in less than 1 hr. Such outcomes are consistent with the goals outlined for educating children about the diversity of others with regard to religion (e.g., American Academy of Religion, Religion in the Schools Task Force, 2010; Rosenblith & Bailey, 2008; Tan, Dalisay, Zhang, Han, & Merchant, 2010). In the current study, however, we did not determine whether increases in reported tolerance of others would generalize to real-world social interactions with people of diverse religious backgrounds. Future research should explore the relationship among types of religious literacy training, social distance scale scores, and actual behavior indicative of tolerance. For example, participants could be exposed to confederates who clearly display characteristics of a person from a particular religion. The confederates could also speak about how much they value their specific religious holidays, places of worship, or holy books. By conducting such research, we could determine whether improved tolerance scores translated to increased interactions with those religiously diverse persons.

The results of the social validity survey showed that participants agreed it was important to learn about other religions. They reported that they enjoyed their specific training protocol and that it would be acceptable to the participants if it was administered at the classroom level. This added flexibility of acceptable teaching procedures should be helpful to increase religious literacy and potentially reduce social distance.

One limitation of the present study is that the equivalence classes taught did not include as comprehensive a set of stimuli as was possible. For example, Christianity has many denominations that refer to their religious leader differently (e.g., priest, pastor, minister). Because our goal was to provide a first demonstration of the benefits of EBI for increasing religious literacy, we used a restricted single exemplar of each class member type to facilitate class formation. In future studies, researchers should investigate teaching more complex classes with additional exemplars for each member to more appropriately characterize the complexities and richness of each religion. Teaching with additional exemplars may also increase the degree to which class-consistent responding generalizes to real-world religious stimuli and settings.

When we identified stimuli to use as class members prior to the study, we found that teaching some characteristics of a religion may be problematic for EBI because of lexical similarities between words. For example, *temple* is an appropriate

term for “place of worship” across Hinduism, Buddhism, and Judaism. Prior studies have shown that training of classes with a common stimulus can potentially result in smaller classes merging into a larger class (Mackay, Wilkinson, Farrell, & Serna, 2011; Sidman, 1994; Sidman, Kirk, & Willson-Morris, 1985). To reduce the likelihood that different religion classes merged in the present study, we ensured that class members were disparate across the classes. This is the reason “house of worship” was not used as one of the class members. In future studies, however, it may be possible to bring particular religious stimuli that belong to different classes under contextual control (e.g., Rehfeldt, 2003). Such an outcome would more closely approximate the complexities of real-world religion characteristics.

In the present study, we were also unable to measure the degree to which participants were exposed to religious literacy instruction in settings outside of their public schools (e.g., Sunday school, religious courses) prior to their participation. It is possible that if such instruction occurred and was not controlled for, it may have affected the likelihood that class-consistent responding emerged for participants in one group relative to the other. For example, it is possible that participants in the EBI group scored higher during the posttests than participants in the lecture group because they may have had a more extensive preexperimental history with religious literacy instruction. Such a potential confound, however, seems unlikely based on the similar pretest scores across the two groups. Regardless, future researchers should consider identifying the degree to which prior religious school instruction may affect the later acquisition of religious literacy under controlled experimental conditions.

Because this study was the first to teach religious literacy, less verbally complex class members were used. Future research should seek to extend the findings of the present study to the more complex nuances of religion (e.g., how a religion interacts with its community, information about the belief systems, or even specific regional variations of a religion), as recommended by the American Academy of Religion’s Religion in the Schools Task Force (2010) and the Harvard Divinity School Religious Literacy Project (2016b). Finally, a future study may also seek to expand the classes by using multiple exemplars of each class member using religious stimuli identified as most commonly encountered and stimuli that the general public would most likely not readily identify with a religion.

In a prior study, Fienup and Critchfield (2011) asserted that it is important to demonstrate the transportability of EBI technologies from the laboratory to applied settings. EBI procedures similar to those used in the present study could be easily developed in schools across numerous formats, including those that are both low-tech (e.g., binders, flashcards) and high-tech (e.g., PowerPoint, online instructional/quiz software). Capitalizing on the feasibility and effectiveness of

EBI in schools may allow behavior analysts to more effectively teach socially valued academic content, such as the religious literacy achieved in the present study.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflicts of interest.

Ethical approval All procedures performed in this study involving human participants were in accordance with the ethical standards of the Caldwell University Institutional Research Board and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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