

EFFECTS OF VIDEO MODELING AND VISUAL FEEDBACK ON HANDWASHING IN  
PRESCHOOL-AGE CHILDREN

By

Rachel L. Jess

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Chairperson, Claudia L. Dozier, Ph.D.

---

Florence D. DiGennaro Reed, Ph.D.

---

Jomella J. Watson-Thompson, Ph.D.

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The Thesis Committee for Rachel L. Jess  
certifies that this is the approved version of the following thesis:

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## **Abstract**

Young children who attend out-of-home care (e.g., preschool and daycare) are more susceptible to infections than children who do not attend out-of-home care (Bylinsky, 1994). Previous research suggests handwashing is effective in reducing risk of infection and illness (Larson, 1988). However, research suggests that, in general, individuals do not routinely wash their hands using methods that healthcare agencies, such as the Centers for Disease Control and Prevention, have determined best practice (Witt & Spencer, 2004). The purpose of this study was to evaluate the effects of a video-modeling and visual-feedback intervention package on preschool-aged children's handwashing using a multiple-baseline-across-groups design. Furthermore, to increase intervention effects even more, we implemented visual feedback plus in-situ feedback during handwashing sessions. We measured the percentage of correct handwashing steps and compared the cleanliness of participants' hands pre- and post-handwashing. Results show that the video modeling and visual feedback intervention was effective at increasing both correct handwashing and cleanliness of participants' hands, and the addition of in-situ feedback slightly increased these effects.

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Young children who attend out-of-home care (e.g., preschool and daycare) come into close contact with multiple other individuals, which makes them more susceptible to infections than children who do not attend out-of-home care (Niffenegger, 1997). Specifically, children who attend out-of-home care are 18 times more likely to contract infectious pathogens, such as bacteria and viruses that may lead to upper respiratory illness, than children who do not attend daycare or preschool programs (Bylinsky, 1994). The increased likelihood of infections at out-of-home care are due to various variables including repeated contact across numerous individuals and the likelihood of young children putting items that have been touched by others or their hands in their mouth (Au, Suen, & Kwok, 2009; Gehlbach, MacCormack, Drake, & Thompson, 1973; Pickering, 1986). Given this, it is not surprising that the common cold, which spreads primarily through contact with hands of infected individuals, is the most common health problem that keeps children home from school (Day, Arnaud, & Monsma, 1993; Neuzil, Hohlbein, & Zhu, 2002).

Missing school, even at an early age, can result in delays in skill acquisition and disrupt a child's routine (Lamdin, 2010). The University of Chicago Consortium on School Research (2013) found that more than half of a child's days missed in preschool are due to the child being sick. Furthermore, the researchers examined the effects of absenteeism on learning outcomes across eight Chicago preschool programs and found a correlation between the numbers of days missed and scores on end-of-year kindergarten-readiness tests. Specifically, the more days of preschool a student missed during the year, the lower they scored on all readiness tests (controlling for entering skills), which included early math skills, letter recognition, pre-literacy skills, and social-emotional development. Overall results suggested that reducing the risk of infection and illness in children would prevent more than half a child's absences from school.

Researchers have shown handwashing is considered the most important procedure for preventing infection and illness (Aiello, Coulborn, Perez, & Larson, 2008; Larson, 1988; Steere & Mallison, 1975). Correctly washing hands with soap and water can remove bacteria and viruses on the hands, which may prevent infection from such pathogens (Au et al., 2009; Rabie & Curtis, 2006). However, research suggests that, in general, individuals do not routinely wash their hands using methods that healthcare agencies such as the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) have determined best practice (Borchgrevink, Cha, & Kim, 2013; Witt & Spencer, 2004). These agencies have determined that the most important components of handwashing include using soap, vigorously scrubbing the hands, and ensuring that all parts of the hands (i.e., tops, palms, in between fingers, and fingernails) are scrubbed for at least 20 seconds (CDC, 2015; WHO, 2009).

Some studies addressing handwashing in young children have included only a rationale and education of proper handwashing (e.g., discussing the importance of handwashing and telling children how to wash hands). For example, Guinan, McGuckin, and Ali (2002) trained elementary school students on the importance of handwashing, when to wash their hands, and when to remind peers to wash their hands during a 10-min assembly. The experimenters also showed a video on disease transmission. Following the video, the experimenters provided booklets with handwashing-related coloring pages and word searches. In another study, Harrison (2012) implemented a curriculum consisting of a PowerPoint presentation about germs, posters listing steps of proper handwashing, and stickers describing other ways to avoid getting sick (e.g., cough and sneeze into your elbow and keep hands away from your mouth). Finally, Rosen et al. (2006) taught preschool-age children the importance of handwashing through a puppet show, handwashing-related games, and a video about germs.

Overall, studies using only a rationale and education have not shown robust effects. For example, Rosen et al. (2006) showed small changes in the percentage of children who washed their hands and no changes in the percentage of illness-related absences following the intervention. Similarly, Guinan et al. (2002) demonstrated a small difference in the number of absences between test and control classrooms; however, the lack of baseline data makes it unclear whether behavior changed due to the intervention. Another limitation of these studies is that most (e.g., Carabin et al., 1999; Guinan et al., 2002; Harrison, 2012, Ponka, Poussa, & Laosmaa, 2004; Roberts et al., 2000) did not directly measure the children's handwashing behavior; thus, it is unknown if the interventions had any effect on their accuracy or occurrence of their handwashing practices. Another limitation is that few studies (e.g., Harrison, 2012; Guinan et al., 2002; Ponka et al., 2004) assessed ongoing maintenance of the children's handwashing. Therefore, it is unknown whether small behavior changes would have maintained over time with or without the intervention in place. It is possible that additional procedures such as modeling correct handwashing and child practicing handwashing would have increased the efficacy of the rationale and education interventions. A final limitation is that, in many of the studies involving only a rationale and education (e.g., Carabin et al., 1999; Guinan et al., 2002; Roberts et al., 2000), experimenters trained teachers or staff on the intervention components to implement in the schools or day care centers. Of the studies involving teacher or staff implementation of the intervention, most did not collect or report data on treatment integrity (e.g., Harrison, 2012; Ponka et al., 2004); thus, it is unknown whether the teachers or staff implemented the intervention correctly. This is important because treatment integrity of interventions is associated with treatment effects (Gresham, Gansle, Noell, Cohen, & Rosenblum, 1993); that is, high levels of treatment integrity have been shown to result in greater

treatment effects than low levels of treatment integrity (Fiske, 2008). It is possible that the studies would have shown greater treatment effects if the experimenters ensured correct intervention implementation.

Other studies have involved additional or other components to address handwashing in young children. One component is the use of models or demonstrations of handwashing. For example, Early et al. (1998) provided first- and fourth-graders with a video presentation of a clown doing a handwashing demonstration, as well as posters showing the steps of proper handwashing and stickers for participation. The experimenters also taught the children a song that emphasized the steps of handwashing. In addition, Rosenberg, Schwartz, and Davis (2010) compared two video models (i.e., one commercially available video and one customized video) to teach children with autism correct handwashing. Finally, Au, Suen, and Kwok (2009) implemented a structured program to teach handwashing skills to children. The structured program consisted of handwashing-related stories, songs, and coloring pages, as well as a demonstration of correct handwashing. Overall, these studies demonstrated more robust effects on handwashing than studies that only implemented a rationale and education; however, there are some limitations to these studies. Although all studies assessed for maintenance of handwashing skills, only one (i.e., Rosenberg et al., 2010) demonstrated maintenance of handwashing skills during a 1-month follow-up probe. Early et al. (1998) assessed for maintenance of handwashing 3- and 6-weeks following the intervention; however, results show that the increased frequency of handwashing did not maintain over time. Au et al. (2009) conducted follow-up probes of handwashing once a month for four months following intervention and showed an immediate return to baseline levels of handwashing. Another limitation of these studies is that it is unknown whether children were attending to the handwashing model or demonstration. Because

these studies did not involve data collection on on-task behavior during the model or demonstration, it is possible that some children did not attend to the presentation of the proper handwashing steps. A final limitation is that two studies (i.e., Au et al., 2009; Early et al., 1998) only provided one demonstration of proper handwashing for the children. Thus, it is possible had they provided multiple experiences with demonstration of proper handwashing, more robust initial and maintenance effects would have been observed.

Another component involves having the children practice correct handwashing. For example, Day, St. Arnaud, and Monsma (1993) taught first-grade children the importance of washing hands at certain times (i.e., after toileting, after sneezing, after handling dirty objects, and before eating) and provided a demonstration of correct handwashing. Following the handwashing demonstration, the children practiced the handwashing skills for the experimenters and received a stamp for correct demonstrations. In another study, Niffenegger (1997) implemented a three-day lesson on germs and handwashing with preschool-age children. The lesson was introduced with a discussion on the importance of handwashing, the teacher demonstrating how to wash hands, and the children practicing the handwashing steps while the teacher observed. The experimenters then conducted hands-on activities, including the use of petroleum jelly and nutmeg to represent germs that the children needed to wash off. Finally, Witt and Spencer (2004) used a five-component intervention to teach preschool children how to properly wash their hands. One component of the intervention involved the experimenters showing the children proper handwashing techniques, asking the children to practice proper handwashing, and providing the children a small bar of soap following proper demonstration. Other components of the intervention involved teaching a handwashing-related song, showing

hands illuminated by Glo-Germ following handwashing, and presenting a handwashing-related story.

Overall, studies involving children practicing handwashing did not show robust effects. For example, Nandrup-Bus (2009) found that, following an intervention involving children practicing correct handwashing, there were more absences per student at the test school as compared to the control school. Similarly, following the intervention, Niffenegger (1997) found a higher frequency of colds in the test school as compared to the control school. Another limitation to these studies is that few evaluated maintenance of handwashing skills (e.g., Nandrup-Bus, 2009; Randle et al., 2013; Witt & Spencer, 2004). Another limitation of studies involving children practicing handwashing is that many studies did not have children practice handwashing multiple times. For example, some studies (i.e., Day et al., 1993; Witt & Spencer, 2004; Nandrup-Bus, 2009) only required children to practice correct handwashing one time during the intervention. One instance of handwashing practice may not have been enough for some children to adequately learn the correct handwashing steps. Another limitation of these studies is that few involved feedback on correct handwashing. Some studies (e.g., Day et al., Nandrup-Bus, 2009; Witt & Spencer, 2004) provided feedback for correct handwashing in the form of a tangible item (e.g., certificate, stamp); however, experimenters often did not provide corrective feedback to the children for incorrect handwashing. During some of these interventions in which children were rewarded with tangible items (e.g., Day et al., 1993; Witt & Spencer, 2004), these rewards were not provided for correct handwashing following the intervention when handwashing observations took place. It is possible that handwashing decreased following the intervention and did not maintain over time due to extinction. That is, if the stamps or stickers were positive reinforcers for handwashing, the immediate discontinuation

of the rewards may have resulted in a decrease in handwashing. Other studies (e.g., Niffenegger, 1997) did not provide any feedback regarding correct or incorrect handwashing during the intervention.

In addition to the limitations of the procedures evaluated for addressing handwashing, there are limitations in measurement procedures across studies. That is, some studies used outcome measures such as the incidence of illness or infection (e.g., Nandrup-Bus, 2009; Ponka, Poussa, & Laosmaa, 2004; Roberts et al., 2000) rather than directly measuring the occurrence of handwashing. For example, Ponka et al. (2004) measured the number of days children were absent from a preschool program due to infections (i.e., upper respiratory infection, ear infection, pink eye, and diarrhea). Some studies used outcome measures such as the level of fecal contamination on hands (e.g., Carabin et al., 1999; Randle et al., 2013). For example, Carabin et al. (1998) measured the average number of fecal coliforms (i.e., bacteria found in fecal matter) per pair of hands and per toy in a child care center by rinsing hands and toys in a saline solution and then filtering and incubating the saline solution to identify the particle colonies per ml. One limitation to using an outcome measure is that it is possible that variables other than handwashing may influence the outcome measure. For example, the number of infections that result in a child being absent from school may be caused by other variables than lack of handwashing. Another limitation is that experimenters did not directly observe the children during handwashing; therefore, it is unknown whether children were washing their hands correctly or more often. Other studies have used process measures, such as the frequency of handwashing (e.g., Early et al., 1998; Rosen et al., 2006); however, it is unclear how accurate children were in washing their hands with respect to best practices. Additionally, increases in the frequency of handwashing in which multiple best-practice steps are missing or done

incorrectly likely will not have any influence on infections or the cleanliness of hands. Thus, it is important to measure both the degree of cleanliness and the accuracy of handwashing.

Another limitation of previous research is that most studies have used group and pre-post designs to determine the effects of interventions on handwashing (e.g., Au et al., 2009; Day et al., 1993; Early et al., 1998). Therefore, individual effects of the intervention are unknown and repeated measures of the effects were not evaluated. Some studies (i.e., Hagiwara & Myles, 1999; Kissel, Whitman, & Reid, 1983; Luke & Alavosius, 2011; Rosenberg, Schwartz, & Davis, 2010; Walmsley, Mahoney, Durgin, & Poling, 2013) have used single-subject designs (i.e., multiple-baseline-across-participants designs) to evaluate the effects of handwashing interventions; however, many of these studies attempted to increase handwashing in adults. Therefore, additional research should be completed using single-subject-design methodology to determine effects of handwashing interventions in young children.

The purpose of our study was to evaluate the effects of a treatment package that initially included modeling (via video), children practicing the correct steps of handwashing, and visual feedback on correct handwashing. In addition, we measured the cleanliness of hands as an additional measure to determine how well children washed their hands. Finally, to increase handwashing to higher levels, we implemented visual feedback plus in-situ feedback in which children were provided with vocal feedback, a model, and additional rehearsal of correct handwashing for incorrect handwashing steps.

## **Method**

### **Participants, Setting, and Materials**

Participants were 16 typically developing children who ranged in age from 3-years-old to 6-years-old and attended a university-based preschool program. All participants could follow

multi-step instructions (e.g., “stand up and walk to the sink”) as reported by classroom supervisors. This study was approved by the Institutional Review Board (IRB) at the University of Kansas, which is called the Humans Subjects Committee (HSC). All participants’ caregivers signed HSC-approved consent forms (see Appendix A) for their children to be involved in the study. The participants were assigned to one of four groups (i.e., three experimental groups and one control group) prior to the beginning of the study. The lead experimenter quasi-randomly assigned 10 of the older participants (ages 4 to 6) to the first two groups by placing the participants’ names in a bowl and assigning the first five names pulled to Group 1 and the remaining five names to Group 2. The four younger participants (ages 3 to 4) were assigned to Group 3. The remaining two participants were assigned to the control group; these participants’ caregivers provided consent to participate in the study except for the use of Glo-Germ and UV-light. Thus, there were five participants in Group 1, five participants in Group 2, four participants in Group 3, and two participants in the control group. Regardless of the number of participants in a group present, the experimenters conducted one to two handwashing sessions with each group every day the preschool classrooms were open. There were at least two children present for every handwashing session across all groups.

Experimenters conducted sessions in the library area and handwashing areas in one of the university-based preschool classrooms. Prior to some handwashing sessions, the experimenters presented an instructional video to participants using a laptop computer in the library area. During all sessions, experimenters provided a “waiting box” that contained toys and activities commonly available in the classroom (e.g., paper and crayons, toy cars, and action figures) to the participants while they waited in the library area to wash their hands. The handwashing area of the classroom contained one child-sized sink, an automatic soap dispenser, one paper towel

dispenser, and one trashcan. The experimenters used Glo-Germ, a non-hazardous clear cosmetic gel that illuminates under UV light, during each session with Groups 1, 2, and 3. Glo-Germ contains ingredients formulated to simulate germs commonly found on hands prior to handwashing; the amount of effort required to remove Glo-Germ during handwashing is equal to that of removing most bacteria from the hands.

Experimenters used an alcohol-based hand sanitizer to remove remaining Glo-Germ on participants' hands following experimental sessions. The Glo-Germ and hand sanitizer were stored in a locked cabinet to prevent unsupervised child exposure. The lead experimenter built a UV-light box to illuminate the Glo-Germ and take pictures of participants' hands. The UV-light box was 33 cm x 24 cm x 24 cm with (a) an opening in the front for participants to place their hands, (b) a UV light inside to illuminate the Glo-Germ, (c) an opening at the top of the box for the camera, and (d) a metric ruler on the interior bottom to calibrate the photo (See Appendix B depicting each of these components).

### **Response Measurement and Interobserver Agreement**

The primary dependent variable was each group's mean percentage of correctly completed handwashing steps. A trained observer collected data on correct handwashing steps completed by each participant using a pencil and the Handwashing Checklist (see Appendix C). The Handwashing Checklist was based on recommendations by the National Association for the Education of Young Children (NAEYC) and the CDC who recommend that proper handwashing should include using water and soap to vigorously scrub all areas of the hands (i.e., tops, palms, fingernails, and between fingers) for at least 20 seconds. The data collector stood in the handwashing area of the classroom to observe each participant washing his or her hands. The data collector recorded whether the participants correctly completed each step as described on

the Handwashing Checklist on a step-by-step basis. For steps 2, 4-7, and 9-10, the participant was required to complete that step for both hands for the step to be scored as correct. For example, if a participant lathered the fingernails of his right hand but not his left hand, that step would be scored as incorrect on the Handwashing Checklist. To calculate the percentage of correctly completed handwashing steps for each participant, the experimenter divided the total number of handwashing steps (i.e., 10) by the number of handwashing steps completed correctly. To calculate each group's mean percentage of correct handwashing steps, the experimenter added together each group participant's percentage of correct handwashing steps and divided by the number of participants present for that session.

Data collectors also measured each group's mean percentage of hands illuminated by Glo-Germ using the visual-editing software, ImageJ (ImageJ, 2017; see Appendix D). That is, after applying Glo-Germ to the participants' hands, the experimenter took a photo of the participants' hands under UV light prior to and following handwashing (Appendix D, Picture 1), uploaded the images using ImageJ, and adjusted the software's measurement settings to the correct pixel-to-centimeter ratio as determined by the cm ruler in the photo. To calculate the surface area (cm<sup>2</sup>) of the entire hands, the experimenter used the software to draw around the perimeter of the hands (Appendix D, Picture 2) and selected the "Measure" setting on the software to analyze the area inside the drawn perimeter (Appendix D, Picture 3). To calculate the surface area (cm<sup>2</sup>) of the illuminated areas of the hands, the experimenter automatically adjusted the threshold settings of the image to only show the illuminated areas of the hands and selected the "Measure" setting to analyze the visible areas of the picture (Appendix D, Picture 4). The experimenter divided the surface area of the illuminated areas by the surface area of the entire hand and multiplied by 100% to calculate the percentage of each group participant's hands

illuminated by Glo-Germ. To calculate each group's mean percentage of hands illuminated by Glo-Germ, the experimenter added together each group participant's percentage of hands illuminated and divided by the number of participants present for that session.

During all sessions that included video modeling, data collectors measured participants' on-task behavior (i.e., the participant looking toward the screen while the video was playing or physically rehearsing the handwashing step with the video model when the video directed the children to rehearse the step shown) using a 30-s momentary time sample (MTS) procedure. To do so, they used a data sheet (see Appendix E) that listed each group participant's name in the first column, a time stamp denoting the end of every 30-s interval in the observation in each column across the top, and a space below each interval to record whether each participant was on task at the end of each interval for each participant. Observers used synchronized stopwatches starting when the video began to cue intervals. At the end of an interval, data collectors observed each participant in the group and recorded whether each participant was engaging in on-task behavior by marking an "X" on the data sheet. Each group participant's percentage of intervals with on-task behavior was calculated by dividing the number of intervals with on-task behavior by the total number of intervals in the session and multiplying by 100%. To calculate the group's mean percentage of on-task behavior, the experimenter added together each group participant's percentage of on-task behavior and divided by the number of participants present for that session.

A second observer simultaneously but independently collected data during at least 30% of sessions across the four groups. To calculate interobserver agreement (IOA) for correct handwashing, we divided the number of steps with agreement (i.e., both observers scored the same response for a step) by the total number of steps and multiplied by 100%. To determine

IOA for on-task behavior, we divided the number of intervals with agreement (i.e., both observers scored the occurrence or non-occurrence of on-task behavior in the same interval) by the total number of intervals and multiplied by 100%. Mean IOA for Group 1 was 94% (range, 90%-100%) for correct handwashing and 86% (range, 73%-97%) for on-task behavior. Mean IOA for Group 2 was 95% (range, 83%-100%) for correct handwashing and 86% (range, 47%-100%) for on-task behavior. Mean IOA for Group 3 was 96% (range, 87%-100%) for correct handwashing and 92% (range, 85%-100%) for on-task behavior. Mean IOA for the control group was 98% (range, 90%-100%) for correct handwashing. Low IOA percentages (i.e., less than 80%) for on-task behavior only occurred in three sessions, which occurred because of few opportunities for scoring behavior in a session (i.e., there were only five intervals in which to score on-task behavior). For example, if data collectors disagreed during two intervals for one participant, IOA for on-task behavior for that participant would be 60%. When IOA for on-task behavior during a session was below 80%, the lead experimenter reviewed the operational definition of on-task behavior with data collectors to ensure understanding for future sessions.

### **Treatment Integrity**

Data collectors collected data on experimenter behavior (i.e., delivery of feedback during and praise following handwashing) for at least 30% of sessions across all phases. Data collectors recorded whether the experimenter delivered feedback following each handwashing step.

*Feedback* was defined as the experimenter providing a statement identifying the incorrect step performed, instructing the participant how to correctly complete the step, and providing a model of how to correctly complete the step. Feedback delivery was only programmed during the visual feedback + in-situ feedback phase. During visual feedback + in-situ feedback sessions, data collectors scored correct feedback implementation for each handwashing step if the

experimenter delivered feedback within 3 s of the participant incorrectly completing a step, correctly completing a step out of sequential order, or failing to complete a step of the Handwashing Checklist within 3 s of the previous step. During all other sessions, data collectors scored correct feedback implementation for each handwashing step if the experimenter did not provide feedback, regardless of participant responding. We calculated treatment integrity of the experimenter's delivery of feedback by dividing the total number of correct feedback implementations by the total number of handwashing steps and multiplied by 100%. Data collectors also recorded whether the experimenter provided praise following handwashing. *Praise* was defined as the experimenter delivering a statement describing the participant completing all handwashing steps correctly (e.g., "Great job washing your hands! You did every step right!"). Praise was programmed to occur in all phases during sessions in which a participant completed all handwashing steps correctly. Data collectors scored correct praise delivery if the experimenter either delivered praise following 100% correct handwashing or did not provide praise if the participant incorrectly completed any handwashing steps. Treatment integrity for all groups across all phases was 100%.

## **Procedures**

Prior to each session, the experimenters instructed all participants in a group to walk toward the library area of the classroom. The experimenters provided the participants with the waiting box and allowed the participants to engage with the items in the box while they waited to wash their hands. The experimenters called one child at a time to walk to the sink area for their session. To determine participant session order, experimenters selected a number from a cup that corresponded to five pre-made data sheets that listed the order of participants. The order of participants across data sheets was different and was created using a random-list generator.

Before each participant washed his or her hands, the experimenter dispensed a dime-sized drop of Glo-Germ on both hands of the participant and rubbed the Glo-Germ on all areas of both hands (i.e., between fingers, on fingernails, and on tops and palms of hands). Following the application of Glo-Germ, the experimenter instructed the participant to place his or her hands into the UV light box with the right palm facing up and the left palm facing down. If a participant failed to comply with these procedures following the first instruction, the experimenter provided a model prompt for the participant to comply. That is, the experimenter showed the participant how to comply with the instruction by doing it herself. The experimenter turned on the UV light and took a photo of the participant's hands using the camera affixed to the top of the UV light box. Across all phases, if a participant correctly completed all steps of handwashing, the experimenter delivered a statement of praise to the participant following completion of handwashing (e.g., "Great job washing your hands! You did all the steps right!"). Following the participant washing his or her hands, the experimenter took the post-handwashing picture using the procedures described above. To ensure complete removal of Glo-Germ after the session (i.e., after the post-handwashing picture), the experimenter dispensed a dime-sized drop of hand sanitizer on the participant's hands and instructed them to rub both hands together. After delivering hand sanitizer, the experimenter instructed the participant to return to the library area of the classroom.

We used a multiple-baseline-across-groups design to demonstrate the effects of the interventions; however, we collected data on individual participant behavior to determine individual effects. Phases included (a) baseline, (b) video modeling + visual feedback (VM+VF), (c) visual feedback + in-situ feedback, and (d) maintenance.

**Baseline.** During each session in this phase, the experimenters did not provide any additional instruction or feedback to the participants during handwashing (except praise if they were to complete all handwashing steps correctly).

**Video modeling + visual feedback.** During each session in this phase, immediately following the participants coming to the library area of the classroom, the experimenter presented a 2.5-min video to all participants in the group. The video (see Appendix F) was narrated by an adult familiar to the participants (i.e., the lead experimenter) and provided a rationale for correct and frequent handwashing and a model for correct handwashing as described by the Handwashing Checklist.

In the video, the narrator described why correct and frequent handwashing is important (e.g., “Washing your hands will remove germs that may get you sick!”). The video then showed images of Glo-Germ-illuminated hands before proper handwashing (i.e., tops, bottoms, and between fingers of both hands completely illuminated) while the narrator explained that the illuminated areas depict germs that need to be washed off. The narrator described each handwashing step portrayed in child-appropriate language while engaging in that step at a sink. The narrator instructed the participants to rehearse the steps depicted and described in the video following the presentation of each step. The experimenters rehearsed each step alongside the video and verbally prompted the participants to physically rehearse each step the video depicted. If the participants physically rehearsed the steps with the video, the experimenter intermittently provided descriptive praise to the participants (e.g., “Great job pretending to wash your hands!”). The experimenters did not provide any other attention to the participants during the video.

Following the instruction of all handwashing steps, the narrator in the video taught a 20-s song set to the tune of “Frere Jacques” that lasts the duration of correct handwashing and

describes what areas of the hands the participants should wash (see Appendix G). The video then showed the adult singing the song while washing her hands according to the steps that were previously described; the narrator in the video prompted the participants to sing along with the song. Following the presentation of handwashing steps and the handwashing song, the video displayed Glo-Germ-illuminated hands following proper handwashing (i.e., tops, bottoms, and between fingers of hands were be minimally illuminated) while the narrator explained that the illuminated areas depicted germs that were not washed off during handwashing.

The experimenter provided the waiting box to the participants after presenting the video. After taking a participant's pre-handwashing picture, the experimenter showed the picture to the participant. While presenting the pre-handwashing picture, the experimenter pointed out the areas of the participant's hands that were illuminated by Glo-Germ and explained that the illuminated areas represent germs that the participant needed to wash off. For example, the experimenters might have said, "Let's see what your hands look like before you wash your hands. There are germs all over the tops and bottoms of your hand. When you wash your hands, make sure you wash the germs off those areas." The experimenter then instructed the participant to wash their hands. During handwashing, the experimenters did not provide any feedback to the participant except if they were to do all steps correctly.

Following handwashing, the experimenter instructed participants to place their hands back into the UV-light box to take the post-handwashing picture. The experimenter showed the post-handwashing picture to the participant and provided descriptive feedback regarding the amount of remaining illuminated Glo-Germ in the post-handwashing picture. That is, the experimenter described the areas of the hand that were still illuminated by Glo-Germ and explained to the participant that they did not wash the germs off those areas. For example, the

experimenter might have said, “Look at the picture of your hands after you washed them. There are less germs than before you washed your hands, but there are still germs between your fingers and under your nails.”

Prior to session 22, we modified the procedures prior to and during VM+VF sessions and subsequent phases. That is, based on several Group 1 participants not dispensing soap (Step 3) or singing the handwashing song (Step 8), we made two changes. First, prior to handwashing, we provided a reminder to use soap. That is, the experimenters said, “Walk to the sink and wash your hands. Remember to use soap!” Second, we had the experimenters sing the handwashing song while the participants washed their hands. These changes occurred during the VM+VF condition for Group 1; both changes were included from the beginning of the VM+VF phase for Groups 2 and 3. These changes did not apply to any baseline or maintenance sessions for any groups.

**Visual feedback + in-situ feedback.** During this phase, procedures were similar to VM+VF phases (i.e., experimenter provided the rule to use soap, experimenter sang handwashing song during handwashing, and participants viewed pre- and post-handwashing pictures) with a few exceptions. First, experimenters no longer presented the handwashing video prior to handwashing. Second, during sessions, experimenters provided vocal feedback and a model for correct handwashing following incorrect handwashing behavior. That is, if a participant incorrectly completed a step or failed to complete a step of the Handwashing Checklist within 3 s of the previous step, the experimenter immediately interrupted the participant’s handwashing to provide feedback. The experimenter delivered an instruction of how to correctly complete the step and provided a model of how to complete the step while singing the line of the handwashing song that corresponded to that step, if applicable. For

example, the experimenter might have said, “No, watch me. Scrub your nails on your hand like this,” and then scrubbed her nails on the palm of her hand while singing, “Scrub under your nails, scrub under your nails.” Following feedback, the experimenter vocally prompted the participant to correctly complete the step (e.g., the experimenter said, “Now you show me how to do it.”). The experimenter continued to deliver feedback (e.g., providing the instruction and model of the correct step) until the participant correctly completed the handwashing step.

**Maintenance.** In this phase, procedures were identical to baseline. That is, following the pre-handwashing picture, the experimenter instructed the participant to wash their hands and did not provide any feedback regarding incorrect handwashing.

## Results

Figure 1 depicts the mean correct handwashing steps and on-task data during the VM+VF phase for all groups. Figure 2 depicts the mean percentage of hands-illuminated data for the three experimental groups (i.e., Groups 1, 2, and 3). Figures 3 to 6 depict the mean individual participant data in each group for each phase. The top panels of Figures 3 to 6 depict the mean correct handwashing steps data for individual participants in all groups; the bottom panels of Figures 3 to 5 depict the mean percentage of hands-illuminated data for individual participants in the three experimental groups.

Figure 1 shows that correct handwashing occurred at low to moderate rates in baseline (BL) phases for all groups. That is, the mean level of correct handwashing for Group 1, 2, and 3 was 32.3% (range, 28%-35%), 31.4% (range, 23%-37.5%), and 33.4% (range, 24%-42.5%), respectively. The mean level of correct handwashing for the control group was 60% (range, 55%-65%). Following the initial introduction of VM+VF for Group 1, the mean percentage of correct handwashing steps increased slightly from BL, but decreased to BL levels in the last two

sessions; the mean percentage of correct handwashing was 39.8% (range, 28%-47.5%) in this phase. The participants in Group 1 also engaged in moderate to high rates of on-task behavior during initial VM+VF sessions in which the handwashing video was presented. After this phase was modified to include a brief reminder to use soap and inclusion of the experimenter singing the handwashing song during handwashing sessions, Groups 1, 2, and 3 demonstrated an increase in correct handwashing, which maintained throughout the phase for all groups. That is, the mean level of correct handwashing for Group 1, 2, and 3 was 62% (range, 46%-80%), 59.3% (range, 40%-70%), and 50.5% (range, 35%-62.5%), respectively. Over time, all groups demonstrated a decrease in the percentage of on-task behavior while the handwashing video was presented. To determine if we could increase correct handwashing more, we added in-situ feedback during handwashing sessions. In the visual feedback + in-situ feedback phase, all experimental groups showed an increase in correct handwashing. That is, the mean level of correct handwashing for Group 1, 2, and 3 was 71.5% (range, 54%-85%), 75% (range, 56%-90%), and 58% (range, 37%-80%), respectively. We were only able to conduct three sessions in this phase for Group 3 because it was the end of the school year; however, across the three sessions, the mean percentage of correct handwashing steps quickly increased from 37% to 80%. During maintenance sessions, Group 1 showed maintained high levels of correct handwashing; the mean level of correct handwashing was 72% (range, 67%-85%). We only assessed maintenance of correct handwashing for Group 1 because it was the end of the school year.

Figure 2 shows that prior to handwashing (pre-handwashing), the mean percentage of hands illuminated by Glo-Germ was high in each phase for all experimental groups. That is, the mean percentage of hands illuminated pre-handwashing across all groups was 91.4% (range, 83%-96%). During BL, the percentage of hands illuminated post-handwashing decreased only

slightly from pre-handwashing levels. That is, the mean level of hands illuminated post-handwashing for Group 1, 2, and 3 was 77.3% (range, 72.6%-79.9%), 74.4% (range, 55.6%-77.7%), and 67.5% (range, 43.5%-79.5%), respectively. Following the initial introduction of VM+VF for Group 1, the percentage of hands illuminated post-handwashing slightly decreased from BL levels. That is, the mean percentage of hands illuminated post-handwashing during the initial VM+VF phase was 66.1% (range, 58%-73%). After the rule and song modification in this phase, all experimental groups showed a large decrease in the percentage of hands illuminated post-handwashing. The mean percentage of hands illuminated post-handwashing for Group 1, 2, and 3 was 11.2% (range, 2.1%-36.7%), 7.6% (range, 2%-14.1%), and 12.6% (range, 6.6%-22.4%), respectively. The percentages of post-handwashing illumination continued to decrease to the lowest levels during visual feedback + in-situ feedback sessions for all groups. The mean percentage of hands illuminated post-handwashing for Group 1, 2, and 3 was 1% (range, 0.2%-1.9%), 1.4% (range, 0.4%-2.7%), and 0.6% (range, 0.2%-1.2%), respectively. Group 1 showed maintained low percentages of hands illuminated post-handwashing during maintenance sessions, with a mean percentage of 2.1% (range, 1.5%-3.1%).

The top panel of Figure 3 shows that during BL, the mean percentage of correctly completed handwashing steps for Group 1 was 32.3%. The mean percentages of correctly completed handwashing steps for individual participants were 23.3%, 30% (three participants), and 40%. Following the introduction of the initial VM+VF phase, the mean percentage of correct handwashing steps for the Group 1 was 39.8%. The mean percentages of correctly completed handwashing steps for individual participants were 26%, 32%, 36%, 52.5%, and 65%. After the rule and song modification during VM+VF sessions, the mean percentage of correct handwashing steps for the group was 62%. The mean percentages of correctly completed

handwashing steps for individual participants were 47.3%, 58.8%, 60%, 65.4%, and 71.8% during this phase. During the visual feedback + in-situ feedback phase, the mean percentage of correct handwashing steps for the group was 71.5%. The mean percentages of correctly completed handwashing steps for individual participants were 50%, 62.5%, 68.9%, 85.7%, and 89.7%. These results maintained during maintenance sessions; the mean percentage of correct handwashing steps for the group was 72%. The mean percentages of correctly completed handwashing steps for individual participants were 55%, 70%, 73.3%, 80%, and 90%.

The bottom panel of Figure 3 shows that during BL, the mean percentage of hands illuminated pre- and post-handwashing for Group 1 was 90.5% and 77.3%, respectively. The mean percentages of hands illuminated pre-handwashing for individual participants were 84.2%, 88.2%, 91.7%, and 92.8% (two participants), whereas the mean percentages of hands illuminated post-handwashing for individual participants were 70%, 74.3%, 78.3%, 79.3%, and 81.2%. Following the introduction of the initial VM+VF, the mean percentage of hands illuminated pre- and post-handwashing for the group was 91% and 66.1%, respectively. The mean percentages of hands illuminated pre-handwashing for individual participants were 86.6%, 90%, 92.7%, 92.9% and 94.6% during initial VM+VF sessions, whereas the mean percentages of hands illuminated post-handwashing for individual participants were 52.1%, 59.7%, 70.4%, 73.8%, and 76.5%. After the rule and song modification during VM+VF sessions, the mean percentage of hands illuminated pre- and post-handwashing for the group was 89.7% and 11.2%, respectively. The mean percentages of hands illuminated pre-handwashing for individual participants were 89.5%, 90%, 90.4% (two participants) and 90.6%, whereas the mean percentages of hands illuminated post-handwashing for individual participants were 5.3%, 9.1%, 10%, and 38.2% (two participants). When visual feedback + in-situ feedback was in place, the mean percentage of

hands illuminated pre- and post-handwashing for the group was 92.3% and 1%, respectively. The mean percentages of hands illuminated pre-handwashing for individual participants were 90.6%, 92.3%, 92.6%, 93.1% and 93.9%, whereas the mean percentages of hands illuminated post-handwashing for individual participants were 0.6%, 0.8%, 1% (two participants), and 2.1%. During maintenance sessions, the mean percentage of hands illuminated pre- and post-handwashing for the group was 93.2% and 2.1%, respectively. The mean percentages of hands illuminated pre-handwashing for individual participants were 92.2%, 92.7%, 93%, 93.2%, and 93.9%, whereas the mean percentages of hands illuminated post-handwashing for individual participants were 0.9%, 1%, 2.5% (two participants), and 3.8%.

The top panel of Figure 4 shows that during BL, the mean percentage of correctly completed handwashing steps for Group 2 was 31.4%. The mean percentages of correctly completed handwashing steps for individual participants were 20%, 30% (two participants), 36%, and 40%. Following the introduction of VM+VF, the mean percentage of correctly completed handwashing steps for the group was 59.3%. The mean percentages of correctly completed handwashing steps for individual participants were 40.8%, 58.1%, 58.3%, 68.9%, and 71.5%. When visual feedback + in-situ feedback was in place, the mean percentage of correctly completed handwashing steps for the group was 75%. The mean percentages of correct handwashing steps for individual participants were 50%, 70%, 84%, 85%, and 86%.

The bottom panel of Figure 4 shows that during BL, the mean percentage of hands illuminated pre- and post-handwashing for the Group 2 was 91.9% and 74.4%, respectively. The mean percentages of hands illuminated pre-handwashing for individual participants were 90.6%, 91.1%, 91.9%, 93%, and 93.9%, whereas the mean percentages of hands illuminated post-handwashing for individual participants were 64.3%, 70.8%, 73%, 83.9%, and 90.2%.

Following the introduction of VM+VF, the mean percentage of hands illuminated pre- and post-handwashing for the group was 92.1% and 7.6%, respectively. The mean percentages of hands illuminated pre-handwashing for individual participants were 91.5%, 91.9%, 92.1%, 92.6%, and 95.7%, whereas the mean percentages of hands illuminated post-handwashing for individual participants were 4%, 7.9%, 8.1%, 9.4%, and 11.4%. When visual feedback + in-situ feedback was in place, the mean percentage of hands illuminated pre- and post-handwashing for the group was 93% and 1.4%, respectively. The mean percentages of hands illuminated pre-handwashing for individual participants were 91.5%, 92.8%, 93.9%, 94.2% and 94.3%, whereas the mean percentages of hands illuminated post-handwashing for individual participants were 1% (two participants), 1.3%, 2%, and 2.4%.

The top panel of Figure 5 shows that during BL, the mean percentage of correctly completed handwashing steps for Group 3 was 33.4%. The mean percentages of correctly completed handwashing steps for individual participants were 25%, 26.3%, 43.3%, and 44.3%. Following the introduction of VM+VF, the mean percentage of correctly completed handwashing steps for the group was 50.5%. The mean percentages of correctly completed handwashing steps for individual participants were 40%, 51.1%, 51.4%, and 56.7%. When visual feedback + in-situ feedback was in place, the mean percentage of correctly completed handwashing steps for the group was 58%. The mean percentages of correct handwashing steps for individual participants were 43.3%, 50%, 63.3%, and 76.7%.

The bottom panel of Figure 5 shows that during BL, the mean percentage of hands illuminated pre- and post-handwashing for Group 3 was 88.6% and 67.5%, respectively. The mean percentages of hands illuminated pre-handwashing for individual participants were 87.2%, 87.9%, 90.4%, and 90.8%, whereas the mean percentages of hands illuminated post-

handwashing for individual participants were 58.2%, 67.6%, 68.3%, and 73.9%. Following the introduction of VM+VF, the mean percentage of hands illuminated pre- and post-handwashing for the group was 91.3% and 12.6%, respectively. The mean percentages of hands illuminated pre-handwashing for individual participants were 90.9% (two participants), 91%, and 91.7% during VM+VF sessions, whereas the mean percentages of hands illuminated post-handwashing for individual participants were 7.4%, 12%, 12.3%, and 14.9%. When visual feedback + in-situ feedback was in place, the mean percentage of hands illuminated pre- and post-handwashing for the group was 92.2% and 0.6%, respectively. The mean percentages of hands illuminated pre-handwashing for individual participants were 72%, 89%, 94.5% and 95.9% during visual feedback + in-situ feedback sessions, whereas the mean percentages of hands illuminated post-handwashing for individual participants were 0.4%, 0.7%, 0.8%, and 0.9%.

Figure 6 shows that across BL sessions, the mean percentage of correctly completed handwashing steps for the Control group was 60.6%. The mean percentages of correct handwashing steps for individual participants were 32.5% and 88.8%.

### **General Discussion**

The purpose of the current study was to evaluate the effects of a video-modeling and visual-feedback intervention on the percentage of correct handwashing steps and percentage of hands illuminated by Glo-Germ following handwashing. We attempted to determine the efficacy of this intervention by evaluating group and individual handwashing data. Results of the group analysis showed that video modeling + visual feedback produced an increase in the percentage of correct handwashing steps and a decrease in the amount of illuminated Glo-Germ following handwashing with all three experimental groups. Furthermore, visual feedback + in-situ feedback produced even more of an increase in the percentage of correct handwashing steps and

decrease in amount of illuminated Glo-Germ following handwashing. These results maintained over time for Group 1 when the intervention was withdrawn. Overall, these results showed that the interventions were effective in increasing correct handwashing and decreasing the amount of germs on the hands of young children in a preschool classroom.

These results replicate previous research on the effects of video modeling on correct handwashing (e.g., Early et al., 1998; Rosenberg, Schwartz, & Davis, 2010). However, given that we implemented video modeling in conjunction with visual feedback, it is unclear whether video modeling alone would have been similarly effective. Furthermore, it is unclear what components of the video-modeling procedure may have been necessary or sufficient for behavior change. For example, the video-model procedure involved a familiar model in a familiar environment (classroom), prompts from the narrator to engage in the target handwashing steps, and praise from the experimenters for imitating the narrator in the video model.

The results of the current study also replicate previous research on the effects of visual feedback on behavior (e.g., Lancioni, Brouwer, & Markus, 1995; Sigurdsson & Austin, 2008). The visual-feedback component involved showing the participant his or her picture of Glo-Germ illuminated hands and describing the areas that the participant did not wash during handwashing. This intervention component may have been effective for a few reasons. First, the combination of visual and verbal feedback regarding areas the child did not wash may have served as a prompt for the child to wash those areas in the future. That is, following receiving visual and verbal feedback regarding certain areas of the hand, participants may have been more likely to wash those areas in the future. Second, the participants may have engaged in correct handwashing behavior to avoid receiving longer feedback during the visual-feedback component. For example, if a participant engaged in correct handwashing, there would be less

illuminated areas on the hands to describe; this would result in a shorter duration of the visual-feedback component. This negative reinforcement contingency would only operate if the implementation of visual feedback was nonpreferred or aversive to a participant.

The results of the current study also replicate previous research on the effects of in-situ feedback on young children's behavior (e.g., Dib & Sturmey, 2007; Houvouras & Harvey, 2014; Schreibman, O'Neill, & Koegel, 1983). The in-situ feedback component consisted of delivering verbal feedback, modeling the correct behavior, and having the participant rehearse the correct behavior, which has been shown to be an effective procedure in teaching children a variety of skills (e.g., Miltenberger, 2008; Poche, Brouwer, & Swearingen, 1981). Thus, it is unknown which of these components is necessary and sufficient for behavior change. Furthermore, there are several reasons why this procedure may be effective. For example, requiring the participant to practice the correct response prior to moving on in the response sequence may function as positive practice or negative reinforcement. With respect to positive practice, repeated practice of a correct response has been shown to be effective in increasing the practiced behavior (e.g., Carey & Bucher, 1981); that is, positive practice may provide more opportunities for the participant to emit the correct response under appropriate stimulus conditions, which may enhance stimulus control over correct responding in the future (e.g., Worsdell, Iwata, Dozier, Johnson, Neidert, & Thomason, 2005). For example, the participants may have engaged in correct handwashing behavior because of the additional practice of the correct responses under similar conditions. With respect to negative reinforcement, in-situ feedback may potentially include sources of negative reinforcement (e.g., Ingvarsson & Hollobaugh, 2010); that is, participants may engage in correct responding to avoid repeated practice of the correct response. For example, the participants may have engaged in correct handwashing behavior to avoid the

implementation of in-situ feedback and avoid a prolonged session. This negative reinforcement contingency would only operate if the implementation of in-situ feedback was nonpreferred or aversive to a participant.

The results of our study yielded several interesting findings. One finding is that we did not show a mean increase of correct handwashing to high levels (i.e., 90-100%) across any of our interventions; however, the mean percentage of hands illuminated data suggest drastic changes in the cleanliness of hands with moderate changes in correct handwashing. Specifically, when a group's mean percentage of correct handwashing steps reached approximately 60%, we observed a large decrease in the amount of Glo-Germ illuminated on the hands post-handwashing. The percentage of hands illuminated measure showed to be an effective way to evaluate the effects of our intervention on the cleanliness of hands following handwashing. Furthermore, this finding suggests that an individual may not need to wash his or her hands with 100% accuracy to remove most germs present on the hands.

Another interesting finding is that, during intervention sessions, many participants across all experimental groups failed to complete the same handwashing steps (i.e., steps 2, 7, and 8) correctly. That is, many participants did not wet hands before dispensing soap, lather fingernails, or sing the handwashing song during handwashing. With respect to step 2 (i.e., wetting hands before dispensing soap), participants may have failed to complete this step correctly because, prior to handwashing, the experimenter reminded the participants to use soap during handwashing. This reminder may have served as a prompt for the participants to immediately dispense soap. With respect to step 7 (i.e., lathering fingernails), many participants failed to correctly complete this step because they only lathered the fingernails of one hand. With respect to step 8 (i.e., singing the handwashing song), participants may have failed to complete this step

for a few reasons. First, the participants may not have learned all the words to the song with the video-model. That is, some participants may have needed a structured lesson in which the song was taught to learn the song. Second, singing may have been a nonpreferred activity for some participants.

Although results of this study suggest that a video modeling + visual feedback and visual feedback + in-situ feedback interventions were effective in increasing correct handwashing in preschool-age children, there are several limitations of the study. One limitation was that our criteria for correct handwashing may have been too stringent to show effects of the influence of the intervention on participants' handwashing behavior. First, according to the Handwashing Checklist, many steps (i.e., steps 2, 4-7, and 9) required the participant complete the step with both hands to be scored as correct. Thus, even if a participant completed a step correctly for one hand but not the other hand, the step would be scored as incorrect. For example, if a participant had lathered the fingernails on his or her right hand but not the left hand, that step (i.e., step 7) would be scored as incorrect. Second, the Handwashing Checklist specified that for steps 4-7 (i.e., lathering tops and bottoms of hands, between fingers, and under fingernails) to be scored as correct, the participant needed to keep the soap on his or her hands. Thus, even if a participant engaged in the correct handwashing behavior, rinsing the soap before completing that step would yield that step incorrect. For example, if the participant rinsed the soap off their hands and then scrubbed the tops of their hands, that step (i.e., step 4) would be scored as incorrect. Although best practice of handwashing includes the presence of soap on the hands during handwashing, collecting data on the occurrence of steps 4-7 with or without soap present on the hands may have showed subtle effects of our intervention on participants' handwashing behavior. In addition, singing the handwashing song was included as a step (i.e., step 8) of the handwashing

checklist, which decreased our levels of correct handwashing due to most participants failing to sing the song. With respect to the handwashing song, we included measurement of it because we assumed it might be important for increasing appropriate handwashing; however, it is not a necessary component of correct handwashing as determined by the CDC and WHO. If we were to reanalyze the data without its inclusion, we would have seen even higher levels of correct handwashing.

Another limitation of the current study was that we removed the presentation of the handwashing video-model during the visual feedback + in-situ feedback phase. We removed the presentation of the video-model in these sessions for two reasons. First, the participants had been exposed to the handwashing video prior to each session in the VM+VF phase. That is, Groups 1, 2, and 3 viewed and rehearsed with the video-model during 22, 14, and 9 sessions, respectively. Second, across all experimental groups, we observed a decrease over time in the mean percentage of on-task behavior while the video-model was presented, suggesting that the participants were no longer attending to, or rehearsing correct handwashing steps with, the video-model. Furthermore, in the last four VM+VF sessions for Group 1, participants were observed making comments regarding having seen the video multiple times. To maintain on-task behavior while the video-model was presented, we could have modified our procedures during the video presentation in two ways. First, we could have provided reinforcers (e.g., preferred edibles) for on-task behavior to increase the likelihood of participants engaging in on-task behavior. Second, we could have modified the video-model such that the video was shorter and only modeled correct handwashing with the song, rather than showing the Glo-Germ demonstration and walking the participants through each handwashing step separately. We may have seen even better effects on correct handwashing if we continued to show the video-model

during visual feedback + in-situ feedback sessions. Specifically, the participants rehearsing with the video-model may have allowed for repeated practice of the correct behavior, resulting in an increase in the percentage of correct handwashing steps.

Another limitation was that our intervention was composed of multiple components implemented at the same time. For example, the video-modeling + visual-feedback phase consisted of the experimenter providing a prompt to use soap, the experimenter singing the Handwashing Song while participants washed hands, the participants viewing a video-model showing correct handwashing, rehearsing correct handwashing steps, and viewing their pre- and post-handwashing pictures of illuminated Glo-Germ on their hands. Although the intervention package was effective in increasing correct handwashing, we do not know if the entire package was necessary or if specific components of the intervention would be sufficient in increasing correct handwashing. Thus, future research should involve a component analysis of the various intervention components (i.e., rules, song presentation, video modeling, and visual feedback) to determine the necessary and sufficient components that result in behavior change.

Another limitation was that the rule and song modification was made during the VM+VF phase for Group 1, which limits our ability to compare initial VM+VF sessions for Group 1 with VM+VF sessions for the other groups. Thus, we do not know if the initial VM+VF intervention would have been effective with Groups 2 or 3. Additionally, we do not know whether the rule and song modification would have been an effective intervention by itself. The modification may have been effective at increasing correct handwashing steps for two reasons. First, because the Handwashing Checklist requires soap to be present on the hands for steps 4-7 (i.e., lathering tops and bottoms of hands, between fingers, and under fingernails) to be scored as correct, the participants' failure to dispense soap would automatically result in those four steps being scored

as incorrect. Thus, the reminder to dispense soap could have possibly increased the percentage of correctly completed handwashing steps by 40%. Second, the experimenter singing the Handwashing Song may have served as a prompt to a participant regarding where to scrub his or her hands and for how long.

Another limitation is that we were unable to conduct all phases to stability with all experimental groups because it was the end of the school year. First, we only conducted three sessions in the visual feedback + in-situ feedback phase for Group 3. Although we observed an immediate increase in the percentage of correct handwashing steps in these sessions, we do not know if these results would continue over time. Thus, it is difficult to compare the effects of visual feedback + in-situ feedback on the percentage of correct handwashing steps across the three experimental groups. Second, we only assessed maintenance for Group 1 and we only conducted four maintenance sessions with this group. Although Group 1 demonstrated maintenance of correct handwashing across four sessions, it is unknown whether the high percentages of correct handwashing steps would maintain over a longer period. Additionally, we do not know whether correct handwashing would maintain for Groups 2 or 3. Future research should involve assessing maintenance of treatment effects when the intervention is not in place to determine the durability of the intervention over time.

Another limitation is that a graduate student conducted all handwashing sessions, which does not allow us to know whether a preschool teacher could implement the VM + VF procedures or the visual feedback + in-situ feedback procedures during a school day. For example, the average duration of conducting one VM + VF session with one participant was approximately three minutes following the presentation of the video-model. The time spent conducting one session included the experimenter delivering Glo-Germ and ensuring the lotion

covered all areas of a participant's hand, taking the pre-handwashing photo, showing the photo to the participant, the participant washing his or her hands, the experimenter repeating the picture-taking process for the post-handwashing photo, and delivering hand sanitizer to the participant. Due to the amount of time it takes to implement the intervention with one participant, future research should involve evaluation of the efficacy and feasibility our procedures with respect to teacher implementation.

Another limitation is that although we observed additional behavior change following the implementation of visual feedback + in-situ feedback, it is unknown whether in-situ feedback would be effective without a prior history with the VM+VF intervention. To address this limitation, we could have counter-balanced our conditions across groups such that some groups would experience visual feedback + in-situ feedback before the VM+VF intervention. Future research should involve evaluating the effects of in-situ feedback without a history with a video-modeling or visual-feedback intervention.

Although our results showed that interventions we evaluated were effective while experimental sessions were conducted, we did not program for or assess generalization. Furthermore, there were some factors that might have interfered with potential generalization of correct handwashing. First, the four participants from Group 3 were enrolled in an adjacent classroom that did not share the same sink that was used for handwashing sessions. Thus, we do not know if our treatment effects generalized across settings to the other classroom. Second, handwashing sessions took place at a sink that is not often used throughout the day. Because sessions occurred outside of the bathroom sinks that are typically used by the children, we do not know if correct handwashing generalized to the sinks the participants used following bathroom use. To program for generalization, we could have conducted handwashing sessions in different

settings, such as the adjacent classroom sinks, the classroom bathroom sinks, or sinks outside of the participants' classrooms. Future research should evaluate the generalization of treatment effects across various settings, including other sinks at school, the home, and community areas that participants often visit.

Overall, there are several conclusions based on the results of this study. First, the video-modeling + visual-feedback package is an effective intervention in increasing the correct percentage of handwashing steps and decreasing the amount of potential germs on hands. Second, the addition of in-situ feedback combined with visual feedback after a history of video modeling + visual feedback was effective for producing even higher levels of correct handwashing. Finally, our data suggest that missing some steps (i.e., wetting hands before dispensing soap, scrubbing fingernails, drying hands) may not influence the presence of germs, and that correctly completing only some handwashing steps (i.e., using soap, scrubbing tops and bottoms of hands, scrubbing between fingers) may remove most germs present on hands. These results suggest that this intervention could be used to keep the rate of illness low in preschool classrooms.

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## Figures

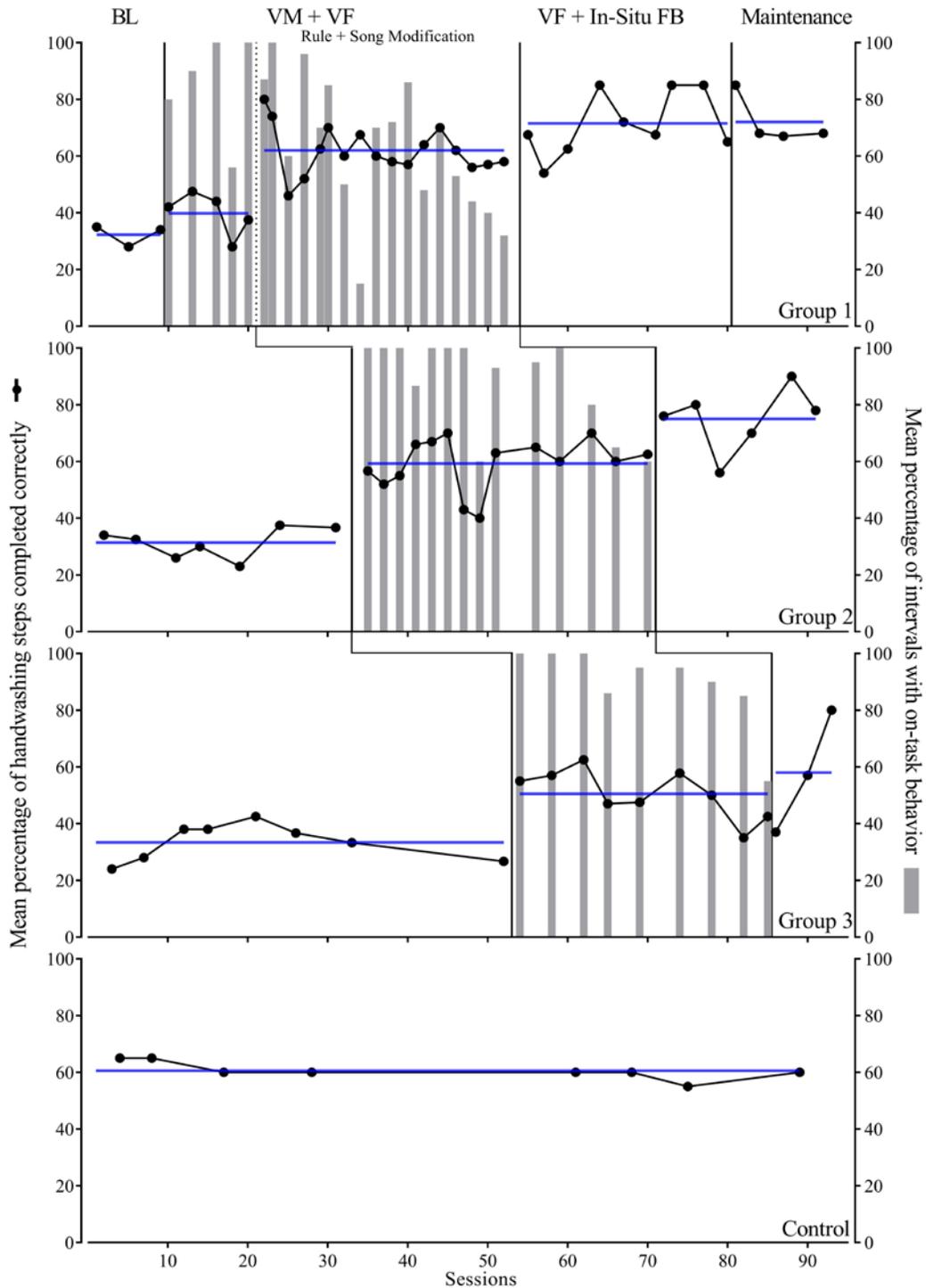


Figure 1. Mean percentage of handwashing steps completed correctly (depicted by black circles) across all sessions, average percentage of handwashing steps completed correctly across each phase (depicted by blue lines), and mean percentage of on-task behavior (depicted by grey bars) during VM+VF sessions for all groups.

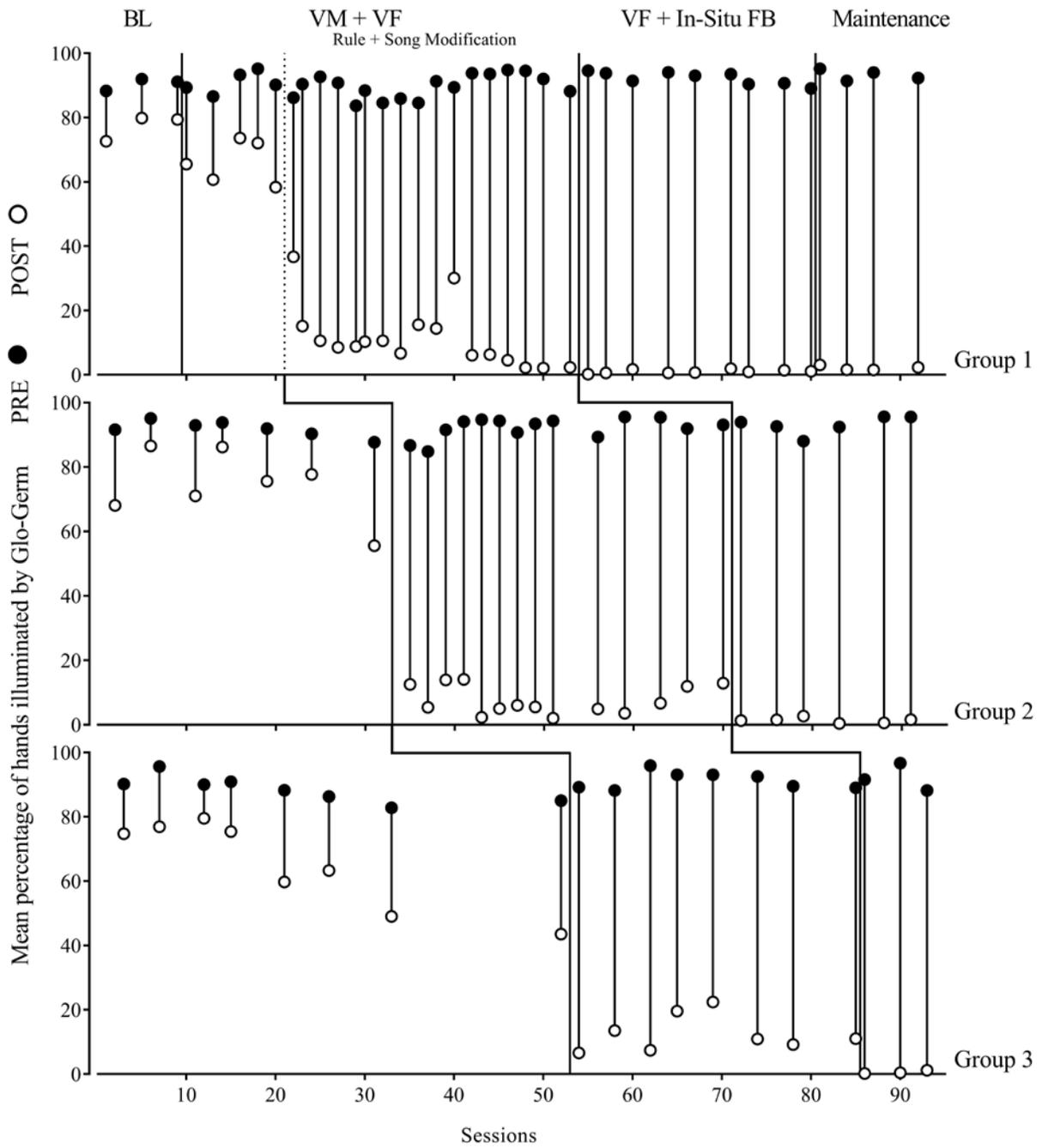


Figure 2. Mean percentage of hands illuminated by Glo-Germ pre-handwashing (depicted by closed black circles) and post-handwashing (depicted by open circles) across all sessions for Groups 1, 2, and 3.

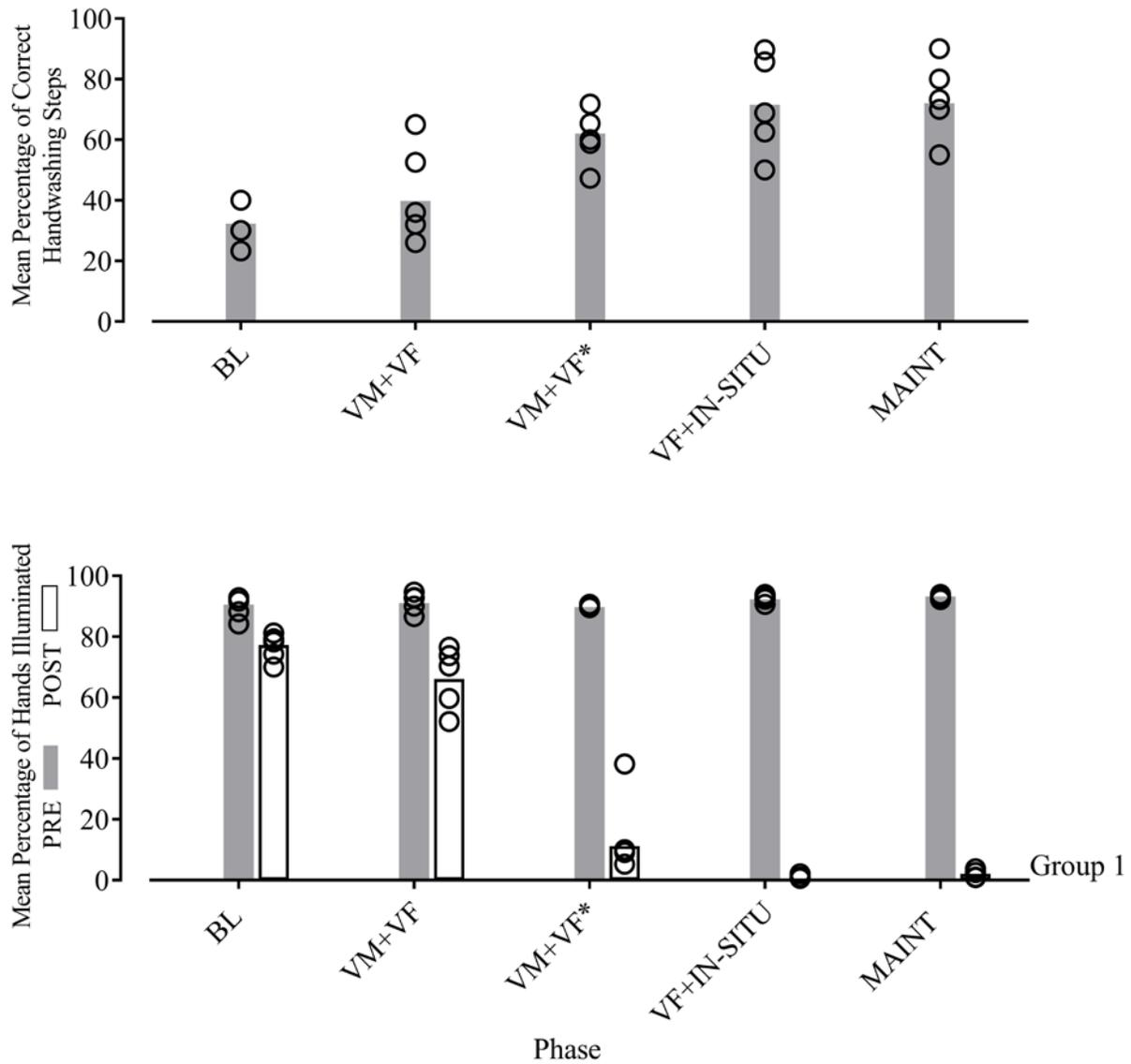


Figure 3. Mean percentage of correct handwashing steps (top panel) and mean percentage of hands illuminated (bottom panel) across all phases for Group 1. Group means are depicted by grey bars and individual participant means are depicted by open circles. The asterisk denotes VM+VF sessions following the introduction of the rule and song modification.

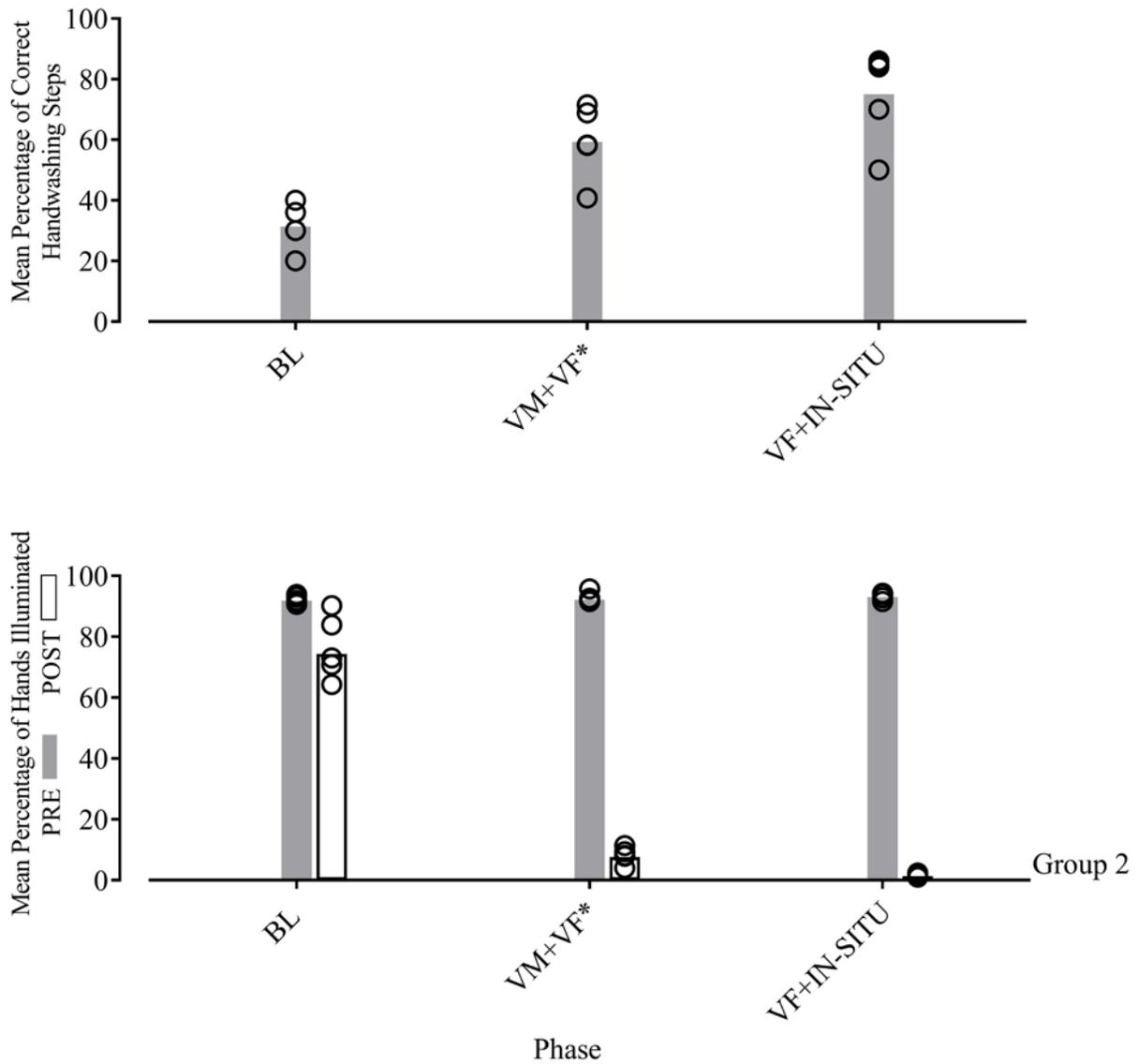
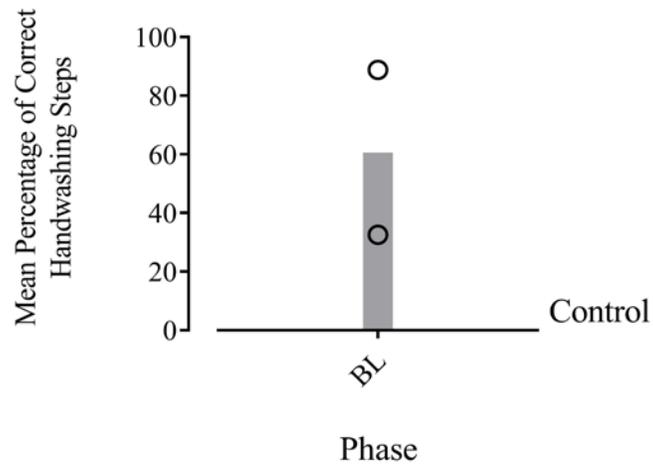


Figure 4. Mean percentage of correct handwashing steps (top panel) and mean percentage of hands illuminated (bottom panel) across all phases for Group 2. Group means are depicted by grey bars and individual participant means are depicted by open circles. The asterisk denotes VM+VF sessions including the rule and song modification.





*Figure 6.* Mean percentage of correct handwashing steps for the Control group. Group mean is depicted by the grey bar and individual participant means are depicted by open circles.

## Appendix A

### Parent/Guardian Permission to Participate in: Effects of Behavioral Skills Training on Handwashing in Preschool-Age Children **INFORMED CONSENT**

*The Department of Applied Behavioral Science at the University of Kansas supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish your child's data to be used for publication and presentation purposes. You may refuse to sign this form and not allow your child's data to be used for these purposes. Also, even if you agree to allow your child's data to be used, you can withdraw this consent at any time. If you do withdraw your consent for us to use your child's data, it will not affect your relationship with this unit, the services it may provide to you, or the University of Kansas.*

#### Purpose

The purpose of this project is to determine the effects of behavioral skills training (video modeling, practice, and feedback) on (a) correct handwashing steps completed by preschool children and (b) the cleanliness of children's hands following handwashing by comparing pre- and post-handwashing pictures of ultra-violet (UV) light-illuminated lotion (Glo-germ) on the participants' hands. We will be implementing this intervention class-wide with all children in the classroom. **This consent is to request your permission to use your child's data for publication and presentation purposes.**

#### Procedures

Your child will be participating in an activity within our classroom that is part of his or her normal classroom procedures. We are asking to use these data for research purposes. The procedures that will take place within the classroom are as follows: The first phase will be conducted to determine if behavioral skills training is effective in increasing your child's correct handwashing steps. The second phase will be conducted to determine whether your child's handwashing skills maintain over time without intervention. If behavioral skills training is ineffective, then the third phase will include a visual-feedback component in which your child will see pre- and post-handwashing pictures of his or her hands illuminated by Glo-Germ (a non-hazardous cosmetic gel that illuminates under UV light). This will be done to help explain to your child the importance of thoroughly washing their hands.

Trained undergraduate and graduate student observers will collect data on child handwashing behavior throughout the course of the study. Observations will be 5 to 10 min in length and occur 1-3 times a day, 5 days per week during normally scheduled classroom time. Sessions will be conducted at times deemed least disruptive to your child's classroom/learning experience. Sessions will occur until results are conclusive. The total project time for your child will likely be between 2 and 5 months.

#### Alternatives to Participation

I can choose not to allow my child's data to be used for publication and presentation purposes.

#### Risks

There are no risks associated with participation in this study.



### Benefits

Successful outcomes of this study may result in several general public benefits, including identifying effective and efficient methods to teach correct and independent handwashing skills to young children. By identifying effective methods to teach handwashing skills, the transmission of bacteria or viruses that can cause illness or infection may decrease. Additionally, data collected from this study may prove that these methods are efficient to teach handwashing skills to groups of children .

### Payment to participants

No payment will be made to you or your child.

### Confidentiality

All research related records and information from this study will be kept confidential. Research results will only be presented to others using participant number or alias. Be assured that your child's name will not be associated with the research findings in any way. Permission granted on this date to use and disclose your information remains in effect indefinitely. By signing this form, you give permission for the use and disclosure of your child's information, excluding your child's name, for purposes of this study at any time in the future.

Video observations of sessions conducted with your child will be kept on a locked computer that can only be accessible via password by the research team. Any other use of videos (e.g., for educational or conference presentation purposes) will not occur without signed permission from you.

### Consent refusal and withdrawal of consent

You may withdraw your consent to allow use of your child's data at any point in time for this study. You also have the right to cancel your permission to use and disclose information collected about your child, in writing, at any time, by sending your written request to: Rachel Jess (see address below). If you cancel permission to use your child's information, the researchers will stop collecting additional information about your child. However, the research team may use and disclose information that was gathered before they received your cancellation, as described above.

### Questions

I have read the information in this form. I know if I have any more questions after signing this form, I should contact Rachel Jess at (936) 522-7027 or Claudia Dozier at (785) 864-0526. If I have any questions about my son's/daughter's rights as a research participant, I may call (785) 864-7429 or write the Human Subjects Committee, University of Kansas, Youngberg Hall, 2385 Irving Hill Road, Lawrence, Kansas 66045-7563.

### Consent

The investigators gave me information about what will be done in this research study. They also told me how it will be done, what I will have to do, and how long the research will take. The investigators told me about any inconvenience, discomfort, or risks my son/daughter might experience due to this research. I agree to allow my child's data to be used for this study. I am



aware that my child may quit or refuse any part of the research study at any time. I know that if I have any more questions after signing this form, I may contact the investigator directly or the Human Subjects Committee listed above.

Rachel L. Jess, B.S.  
Principal Investigator  
Applied Behavioral Sciences  
Graduate Teaching Assistant  
University of Kansas  
4001 Dole Building  
Lawrence, KS 66045  
(936) 522-7027

\_\_\_\_\_  
Print Participants Name

\_\_\_\_\_  
Parent/guardian Signature

\_\_\_\_\_  
Date

“With my signature I acknowledge that I am over the age of eighteen, and I have received a copy of this consent form to keep.”

\_\_\_\_\_  
Investigator’s Signature

\_\_\_\_\_  
Date



## Appendix B

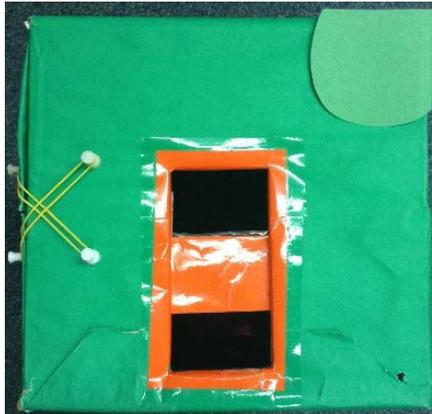
1.



2.



3.



4.



## Appendix C

Group: 1 2 3 Control

Date:

Participant:

Session #:

Condition:

Observer:

Handwashing Steps	Occurred Correctly?		Treatment Integrity (circle consequences)
	Y	N	
<b>1. Turns on water</b> Turns one or both water knobs to produce a stream of running water (any temperature) from the faucet.			FB No FB
<b>2. Wets hands under water</b> Places hands underneath stream of water and covers both hands with water such that the entirety of the hand (from wrist to fingertip) is wet.			FB No FB
<b>3. Dispenses soap</b> Places hand under soap dispenser or depresses pump on soap bottle at least once, such that at least one hand has soap.			FB No FB
<b>4. Lathers tops of hands</b> Rubs hands together such that both tops of hands have visible soap suds.			FB No FB
<b>5. Lathers bottoms of hands</b> Rubs both hands together such that both palms of hands have visible soap suds.			FB No FB
<b>6. Lathers between fingers</b> Rubs hands together such that the webs of each finger of each hand have visible soap suds.			FB No FB
<b>7. Lathers fingernails</b> Scrubs nails of both hands on palm of opposite hand such that each fingernail of each hand has visible soap suds.			FB No FB
<b>8. Sings "Handwashing Song" during steps 4-7 of handwashing</b> The total duration of handwashing (steps 4-7) is at least 20 seconds.			FB No FB
<b>9. Rinses hands under running water</b> Places hands underneath stream of water and rinses both hands clean such that no suds are visible on the hands.			FB No FB
<b>10. Dries hands using a paper towel</b> Uses a paper towel to dry the tops and bottoms of each hand. Hands do not need to be completely dry, but water should not drip off of hands after the child has left the handwashing area.			FB No FB

Experimenter deliver praise following handwashing	Y	N
# of steps completed correctly:		

**Definitions:**

Occurred Correctly (Y): participant completed step as written

Feedback (FB): experimenter delivered feedback within 3s of incorrect completion of a step

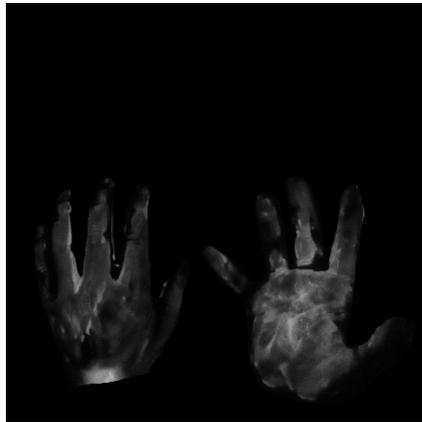
No Feedback (No FB): experimenter did not deliver feedback within 3s of incorrect completion of a step

## Appendix D

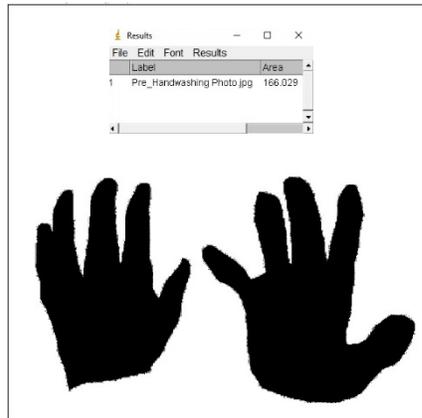
1.



2.



3.



4.



## Appendix E

Group: 1 2 3 Control

Date:

Session #:

Observer:

Condition:

On-Task Behavior Data Sheet

	Video Interval					
	00:30	01:00	01:30	02:00	02:30	
<b>Participant</b>						/ 5
						/ 5
						/ 5
						/ 5
						/ 5
						/ 5

Mark an "X" in the corresponding time-sample box if the participant is engaged in on-task behavior at the end of the specified interval.

**On-task behavior:** The participant is looking towards the screen while the video is playing or physically rehearsing the handwashing step with the video model when the video instructs the participants to rehearse the step shown.

## Appendix F

### Handwashing Video Script

Narrator: “Hi, everyone! I am here to teach you about washing your hands. We use our hands every day to do things like eat food and play with our friends! Everybody look down at your hands.”

**\*video shows a pair of hands covered in dirt and marker\***

Narrator: “Let’s look a little closer and see the germs on our hands.”

**\*video shows the pair of hands under UV light with hands completely illuminated with Glo-Germ\***

Narrator: “Do you see the stuff that’s lighting up on those hands? Those are GERMS- yucky, dirty germs that can get us sick. Do you see germs on the top of the hands? On the bottom? In between the fingers? YUCK! When we have germs on our hands, we might touch our noses and our mouths and get the germs inside our body! If those germs get inside our body, we can get really sick. What should we do to get rid of the germs on these hands?”

**\*3-s pause\***

Narrator: “That’s right! We should wash them! Let’s go over to the sink and wash our hands.”

**\*video follows Narrator to the sink and shows narrator following the steps of handwashing\***

Narrator: “First, we need to turn on the water. Everyone pretend to turn on the water with me! Now, we are going to get our hands wet in the sink. Let me see everybody get their hands wet! Then, let’s get some soap on our hands. Now that we have soap, we need to scrub, scrub scrub! I know a song we can sing while we do this... Sing with me! It goes like this: ‘Top and bottom,

top and bottom. In between, in between. Scrub under your nails, scrub under your nails. Now again, now again. Top and bottom, top and bottom. In between, in between. Scrub under your nails, scrub under your nails. Now you're clean, squeaky clean.' Now that our hands are all washed, we can rinse off our suds. Put your hands back in the water like this, and make sure all of the soap is gone. Way to go! Now let's turn off the water and dry off. Get some paper towels and get those hands dry! You guys did such a good job! Let's see if we got the germs off.

**\*video shows the pair of hands under UV light with hands minimally illuminated with Glo-Germ\***

Narrator: "We did it! We are all clean! See how we can't see any more germs on the tops of the hands? On the bottoms? Now YOU get to practice it! Your teacher will dismiss you to go wash your hands. Until next time... see you later!"

## Appendix G

### “Handwashing Song” Lyrics

“Top and bottom, top and bottom.

In between, in between.

Scrub under your nails, scrub under your nails.

Now again, now again.

Top and bottom, top and bottom.

In between, in between.

Scrub under your nails, scrub under your nails.

Now you’re clean, squeaky clean.