

Assessing the Impact of Enhanced Handwashing Techniques Using Kirkpatrick's Model

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Abstract:

Handwashing is a basic yet important habit that has a big impact on public and personal health, especially in school environments. This study aimed to assess the impact of handwashing techniques on students in Medical Technology, Radiologic Technology, Pharmacy, Physical Therapy, Midwifery, and Nursing at DMC College Foundation, Inc., a La Salle supervised school located in Dipolog City, Zamboanga del Norte in Northwestern Mindanao. The study's respondents are students enrolled in the first semester of 2023–2024 who are officially enrolled in Levels 2–4 of these programs. These levels are frequently exposed to working with patients and materials in hospital and laboratory environments. Objectively, Kirkpatrick's Model was employed in the study where four of its main domains are measured namely, reaction, learning, behavior, and results. Descriptive statistics was utilized with frequency and percentage distribution, means and standard deviation, and ANOVA to treat the data. The results revealed that the design and execution of hand hygiene training programs in medical science education will be significantly impacted by the study's findings. It is advised to modify instructional tactics considering the participants' identified areas of strength and weakness to increase the efficacy of subsequent interventions. Additionally, maintaining beneficial behavioral changes over time requires regular evaluations and continuous reinforcement. This study offers a methodological framework for assessing educational interventions in the larger context of health sciences, in addition to adding to our current understanding of hand hygiene practices. Thus, this study highlights the significance of a thorough evaluation approach by employing Kirkpatrick's Four Stages Evaluation Model. It provides insightful information for educators, policymakers, and healthcare professionals who want to improve hand hygiene practices and reduce the risk of infectious diseases in the educational landscape.

Keywords: Kirkpatrick's Evaluation Model, Enhanced Handwashing Techniques, reaction, learning, behavior, results

Introduction:

In the realm of human health, controlling infections emerges as a pivotal element within healthcare and public health strategies, aiming to curb the transmission of contagious diseases. This involves a spectrum of practices and protocols meticulously crafted to reduce the risk of infections not only in healthcare settings but also within broader contexts. At the core of infection control is the advocacy for strict adherence to hand hygiene, achieved through regular handwashing and the application of hand sanitizers. Equally vital is the proper utilization of personal protective equipment (PPE), including masks, gloves, and gowns, which act as a crucial shield for both healthcare professionals and patients. To confine the spread of contagious ailments, isolation precautions are instituted, complemented by thorough environmental cleaning and disinfection practices to sustain a hygienic setting. Education and training initiatives ensure healthcare workers possess a profound understanding of infection control measures, nurturing a safety-oriented culture. Surveillance and monitoring systems are established to swiftly detect and respond to potential outbreaks, while vaccination campaigns actively contribute to averting vaccine-preventable diseases. By steadfastly adhering to these all-encompassing measures, the endeavors in infection control strive to forge safer healthcare environments and advance public health on a broader spectrum.

Oliver Wendell Holmes came to an independent conclusion in 1843 that healthcare workers were the ones who transmitted puerperal fever (Rotter, 1999 cited by CDC). Despite outlining steps that could be taken to stop its spread, his suggestions had little effect on that time's obstetric practices. However, because of the groundbreaking

research conducted by Semmelweis and Holmes in 1946, handwashing has gradually come to be recognized as one of the most crucial steps in preventing the spread of pathogens in healthcare settings. In 1961 the United States Public Health Service created a training video that showed healthcare workers (HCWs) how to wash their hands according to recommended protocols. Recommendations at the time stated that staff members wash their hands two minutes before and after using soap and water on the hands for patient interaction. Using an antiseptic to rinse hands was thought to be less efficient than washing the hands, and it was only advised in dire situations or places without sinks. To comprehend the goals of various methods for hand washing, understanding the typical bacterial skin flora is crucial for cleaning. Human skin normally has bacteria on it; however, different body parts have different total aerobic bacterial counts (for instance, on the scalp, 1×10^6 colony forming units (CFUs)/cm², four times as many CFUs/cm² on the axilla as there are on the one $\times 10^4$ CFUs/cm² on the forearm, and the abdomen) according to the book of Selwyn, S. (1980) as cited by CDC. In 1938, bacteria recovered from the hands were divided into two categories: transient and resident. Frequent handwashing is a more effective way to get rid of transient flora, which inhabit the skin's outer layers. Healthcare workers frequently meet them when they are near patients or when they come into direct contact with contaminated environmental surfaces. The most associated organisms with transient flora are infections related to healthcare. Local flora, which are affixed to the skin's deeper layers, are more resilient to deletion. Furthermore, local flora (such as coagulase-negative diphtheroid and staphylococci) is less likely to relate to these infections. HCWs may develop persistent colonization of yeast, gram-negative bacteria, or pathogenic flora (such as *S. aureus*) on their hands. Researchers have found that, while the amount of resident and transient flora varies greatly from person to person, it is frequently constant for any given individual.

At its core, handwashing emerges as a fundamental and impactful practice in upholding both personal and public health. This uncomplicated yet potent action plays a pivotal role in significantly diminishing the transmission of infectious agents. The process entails the use of soap and water to meticulously cleanse the hands, paying special attention to the areas between the fingers and beneath the nails. Effective handwashing extends beyond the removal of visible dirt; it also eradicates imperceptible pathogens that may be responsible for causing illnesses. The significance of this practice is notably apparent in healthcare settings, where it stands as a cornerstone of infection control. Beyond healthcare contexts, in our day-to-day lives, consistent handwashing serves as a crucial preventive measure against prevalent ailments like colds and flu. By seamlessly integrating this habit into our daily routines, we actively contribute to fostering a healthier community and play a part in breaking the chain of infection. This underscores the timeless wisdom that preventing a problem is more valuable than seeking a remedy after the fact. The World Health Organization (WHO) recommends seven steps in handwashing techniques as follows: 1.) Wet hands with clean, preferably running water; 2.) Apply enough soap to cover all surfaces of the hands and wrists; 3.) Lather and rub hands together briskly and thoroughly for at least 20 seconds; 4.) Scrub hands, including the backs of hands, between fingers, and under nails; 5.) Rinse hands well under clean, running water; 6.) Dry hands using a clean towel or an air dryer; and 7.) Turn off the tap using a paper towel or elbow to avoid re-contaminating hands. Additionally, the Centers for Disease Control (CDC) identified clinical indications specifically applied to the healthcare settings on when to perform proper hand hygiene. These include the following: a.) Immediately before touching a patient; b.) Before performing an aseptic task (e.g., placing an indwelling device) or handling invasive medical devices; c.) Before moving from work on a soiled body site to a clean body site on the same patient; d.) After touching a patient or the patient's immediate environment; e.) After contact with blood, body fluids, or contaminated surfaces, and d.) Immediately after glove removal.

Students studying medical science regularly meet patients, medical supplies, and different surfaces. Since medical students frequently provide direct patient care, infectious diseases may spread through their hands. One of the most important parts of the professional duty of healthcare providers, including medical students, is to follow strict guidelines regarding hand hygiene. It demonstrates a dedication to patient care, security, and the general integrity of the medical setting.

This study will assess the DMC College Foundation medical science students in their efficacy of applying enhanced handwashing techniques recommended by WHO and CDC and determine its impact on their medical practice. Since proper handwashing techniques are a sub-topic of infection control embedded in the curriculum for medical science students, it is the most important aspect of professionalism as it displays a dedication to ethical behavior, high-quality care, and patient safety. Early in their education, medical students are expected to form positive habits that they will carry into their professional lives. The objective of the research is to evaluate the effects of improved handwashing methods at different levels, as delineated by Kirkpatrick's Four-Level Training Evaluation Model:

Reaction: This stage gauges how participants respond to the improved hand-washing methods right away. The topic of proper hand washing techniques is discussed in the class as one of the sub-topics under infection control. It entails getting input on how students feel about the new techniques by utilizing the Hand Hygiene Knowledge questionnaire adapted from WHO. A video submission of the proper hand-washing techniques of each student is submitted within a week after the seminar, which will be regarded as the pre-test. The video is assessed according to the observation tool and checklist adapted from WHO and CDC.

Learning: This stage assesses the degree to which participants pick up new information and abilities regarding the improved hand-washing methods. This could entail evaluating how participants' comprehension of appropriate hand hygiene procedures during the seminar given by the school nurse. **Behavior:** This stage will determine whether participants' hand hygiene behaviors are altered because of the improved handwashing techniques. This entails seeing and evaluating actual handwashing behaviors in authentic environments. This will be evaluated by the student's one-on-one practical return demonstration of proper hand washing technique with the instructor following WHO protocol. This will be considered as the post-test.

Results: This stage will assess the wider effects of improved handwashing methods on pertinent outcomes by observing if students have applied the proper handwashing techniques recommended by WHO and CDC in their laboratory science classes and clinical exposures.

Statement of the Problem

This study fills in a significant knowledge vacuum regarding the efficacy of improved handwashing techniques in various contexts. Although it is widely acknowledged that maintaining good hand hygiene can help prevent infectious diseases, there are not many thorough evaluation frameworks designed with evaluating interventions' effects at various levels in mind. By using Kirkpatrick's Four-Level Training Evaluation Model to methodically investigate the immediate responses, learning outcomes, behavioral changes, and more general outcomes connected to improved handwashing techniques, this study seeks to close this gap. The goal of the research is to provide important insights into the creation and application of efficient hand hygiene practices in medical science students' contexts by highlighting the advantages and disadvantages of these approaches at different levels.

Specifically, the study answers the following questions:

1. What is the level of students' knowledge of appropriate hand hygiene practices?
2. What are the areas of strengths among the student participants of the enhanced handwashing techniques?
3. How do participants change their behavior after the enhanced handwashing techniques training?
4. What is the assessment of the results of the enhanced handwashing techniques with the use of the hand hygiene observation tool?

Methodology

Design

Evaluation design refers to the systematic and structured plan for assessing the merit, worth, or significance of a program, project, or intervention. It involves the careful consideration of the methods, data sources, and analysis techniques to determine the effectiveness, efficiency, and relevance of the initiative being evaluated. In this study, Kirkpatrick's Four-Level Training Evaluation Model is utilized. Kirkpatrick's Four-Level Training Evaluation Model provides a framework for assessing the effectiveness of the handwashing program at DMC College Foundation, Inc. To evaluate the impact of the enhanced handwashing techniques using Kirkpatrick's Evaluation Model, the following are followed:

Level 1: Reaction - assess participants' immediate reactions and satisfaction with the enhanced handwashing techniques training. A survey immediately after the training session was given to gauge participants' perceptions, satisfaction, and relevance.

Level 2: Learning - measures the extent to which participants acquire knowledge and skills related to enhanced handwashing techniques. A pre-and post-test was administered to check on knowledge and skills assessment before and after the training to measure the learning gain. Also, the instructors conduct direct observations of participants practicing handwashing techniques to assess the application of the learned skills.

Level 3: Behavior - evaluates the application of enhanced handwashing techniques in real-world settings. The instructors conduct on-site observations to evaluate the participants' handwashing behaviors in their regular environment.

Level 4: Results - assess the overall impact of enhanced handwashing techniques on key outcomes, such as reduced illness rates. Conduct interviews with supervisors or relevant stakeholders to gather insights into the impact on the overall workplace environment.

Environment

The study is conducted in DMC College Foundation, Inc., a La Salle-supervised school located in Dipolog City, Zamboanga del Norte in Northwestern Mindanao. The school offers allied medical health programs such as Medical Technology, Radiologic Technology, Pharmacy, Physical Therapy, Midwifery, and Nursing. Students from Level 2 to Level 4 of these programs, who are officially enrolled in the first semester, 2023-2024 are the respondents of the study. These levels are often exposed to handling patients and specimens both in the laboratories and in the hospital settings.

Instrument

Assessing hand hygiene behaviors and associated attitudes and expertise in a medical setting is a crucial component of the hand hygiene improvement plan. To measure the changes brought about by implementation and confirm that the interventions have improved the students' perceptions, knowledge, and hand hygiene practices, ongoing monitoring is highly beneficial. This study utilized two instruments adapted from the WHO's Infection Prevention and Control (IPC) Technical and Clinical Hub. The first instrument is a 21-question Hand Hygiene Knowledge questionnaire, whose main goal is to gauge student's knowledge of appropriate hand hygiene practices. This assists in identifying areas of strength and those that might benefit from additional training or education, this tool will assess the reaction stage of the Kirkpatrick Model of evaluation. The second instrument is the Hand Hygiene observation tool that focuses on seven points namely: before touching a patient, before clean/aseptic procedure, after body fluid or human samples exposure risk, after touching a patient, and after touching the patient surroundings, after touching a contaminated surface and after glove removal. To guarantee standard compliance, pinpoint areas for development, encourage continuing education, and ultimately improve patient safety and the general caliber of healthcare delivery, a hand hygiene observation tool is crucial. Moreover, a checklist is also used to assess the student's handwashing skills. The Hand Hygiene observation tool utilized during a one-on-one practical return demonstration with the instructor will serve as an instrument to measure the learning and behavior stage of the Kirkpatrick Model.

Data-Gathering Procedure

Test scores were gathered from the instructors handling the course, scores to measure students' knowledge on enhanced hand washing technique will be purely paper and pencil assessment, this result will just serve to measure the initial knowledge on the subject. The video submission before the nurse's presentation served as the pretest, as this will demonstrate how well the students follow the standard hand-washing techniques. After a week, another test was conducted, this time, a graded one-on-one practical demonstration of the handwashing technique to measure how well the students adhere to the prescribed WHO standards. To determine a student's adherence to learning, observing them continuously is a valuable method for monitoring and evaluating their commitment to learning. This approach entailed consistently and attentively tracking a student's development, conduct during their laboratory classes, and clinical and hospital exposure throughout an extended period.

Data Analysis

This study employs descriptive statistics to provide basic information about the variables and to highlight potential relationships between them. Frequency and Percentage distribution are used to measure the percentage of data on profiles. Mean and standard deviation were used to determine the data dispersion in proportion to the mean. Paired t-test was used to measure significant differences for related samples and Analysis of variance (ANOVA). The independent samples pre and post-test will utilize a t-test, examining the means of two independent groups to see if statistical evidence exists that the related population means differ significantly. A one-way ANOVA is used for three or more groups of data, that is from different year levels and programs, to gain information about the relationship between the independent and dependent variables. The level of compliance is measured in percentage.

Ethics

Maintaining integrity in the search for knowledge, prioritizing participant rights and well-being, and carrying out research responsibly all depend on the enforcement of ethical standards. Important ethical factors include getting participants' informed consent, protecting participants' privacy and confidentiality, aiming for beneficence and non-maleficence by balancing risks and benefits, respecting participants' autonomy, and keeping vulnerable respondents in mind.

Before the study is conducted, the researcher will ensure that informed consent is professionally secured to signify voluntary participation in the study. This will be accomplished during the actual conduct of the survey and for online surveys, the researcher ensures that it is reflected in the Google form. All the elements of informed consent will be clearly explained in the introductory part of the form. Only those who will agree to participate will be directed to the research survey questionnaire. To further safeguard the secrecy of the respondent's data, the researcher will ensure that any collected IP addresses will be destroyed. All responses will be removed after the survey and the resulting data file that will be used for analysis will be free from any identifiers such as IP addresses, email addresses, and related electronic identifiers.

For one-on-one interviews, the researcher will explain every detail of the questionnaire before an actual survey will be conducted. In-person, surveys will be conducted in a precise and concise manner and with the utmost confidentiality. Participants are free to leave or withdraw from the study at any time without feeling obligated to do so. They don't need to give a reason for leaving the study.

Results and Discussion

Through a meticulous examination of the results of the study, the researchers unravel the layers of knowledge acquisition, behavioral adaptation, and the practical implications that emerge from a structured approach to hand hygiene training.

Demographic Distribution of the Participants

Figure 1 illustrates the demographics of the study cohort's research respondents. Notably, the chart reveals a clear majority, with 60% of the participants identified as female, while the remaining 40% represent the male demographic.

The predominant presence of female participants in the study may be indicative of several factors, including the composition of the target population or potential variations in the willingness of individuals to participate based on gender. While the numerical distinction is apparent, it is essential to delve deeper into the implications of this distribution concerning the research objectives and potential gender-related influences of the study outcomes. Understanding gender composition provides valuable context for interpreting the study results. It prompts considerations about whether gender-based differences may influence responses to interventions or if certain aspects of the research outcomes may be gender-dependent. Additionally, this information aids in refining the generalizability of the study findings, acknowledging any potential variations that may exist within the broader population.

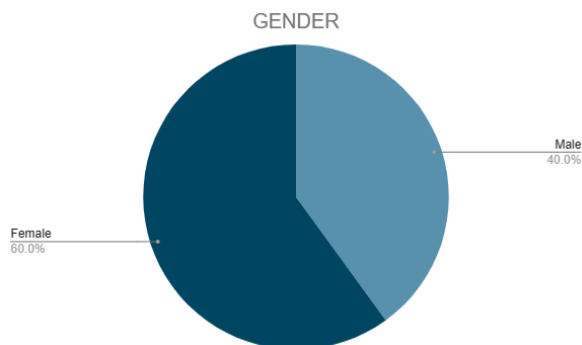


Figure 1. Demographic Profile of the Participants

Program Distribution at DMC College Foundation, Inc.

Figure 2 illustrates the distribution of the programs at DMC College Foundation, Inc. and it provides a clear snapshot of the academic landscape within the institution. Each segment represents a distinct academic program, and the proportions offer insights into the relative popularity and emphasis placed on various fields of study.

The smallest segment of Figure 2 is allocated to the Nursing program, constituting 15% of the overall distribution. This suggests that while nursing is offered as a program, it may not be a predominant focus or area of enrollment at DMC College Foundation, Inc. However, this does not diminish the significance of the nursing program, as it still represents a notable portion of the academic offerings. Both Medical Technology and Physical Therapy hold a 25% share. This suggests that DMC College Foundation, Inc. places significant importance on cultivating expertise in physical therapy, aligning with the institution's commitment to a diverse range of health-related disciplines. The largest segment of Figure 2 is dedicated to Radiologic Technology, comprising 35% of the distribution. This substantial portion suggests that radiologic technology is a focal point within the academic offerings at DMC College Foundation, Inc. The emphasis on this program may be indicative of the institution's recognition of the growing demand for professionals in radiologic technology and the critical role it plays in healthcare.

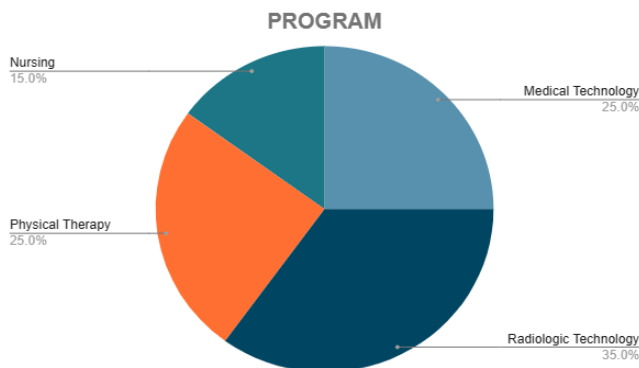


Figure 2. Program Profile of the Participants

Table 1. Pre- and Post-Test Results on Handwashing Training Material Preparation

Table 1 shows the comparison of the pre-and post-test results for the preparation of materials used in handwashing training. It provides valuable insights into the effectiveness of the training intervention. The data reveals participant assessments before and after the training, allowing the researchers to gauge the impact of the intervention on the perceived quality of the instructional materials.

During the pretest, most participants initially rated the preparation of handwashing training materials as excellent, indicating a solid foundation in the instructional content. This suggests that, before the intervention, a substantial portion of the participants had a positive perception of the materials. A notable percentage rated the materials as very good, further contributing to the overall positive sentiment but with a slightly lower level of endorsement compared to the excellent category. A smaller percentage found the materials to be good, implying that there was room for improvement in certain aspects of the instructional content. A portion of participants rated the materials as fair, signaling potential shortcomings in the preparation that required attention. Encouragingly, no participants rated the materials as poor, indicating a baseline level of quality even before the intervention. The post-test results demonstrate a substantial increase in the percentage of participants who rated the materials as excellent. This significant improvement suggests that the training intervention had a positive impact on enhancing the perceived quality of the instructional materials. Despite the slight decrease in the very good category, the overall positive trend remains, indicating that most participants continued to view the materials favorably after the training. A smaller percentage rated the materials as good after the intervention, possibly reflecting a more refined understanding of the training content among participants. The elimination of any fair ratings post-training indicates a successful addressing of potential shortcomings, resulting in a more uniformly positive perception of the materials. The absence of poor ratings persists in the post-test results, reinforcing the overall positive impact of the training intervention on the quality of handwashing training materials.

PREPARATIONS	PRE-TEST %	POST-TEST %
Excellent	65	85
Very Good	15	10
Good	10	5
Fair	10	0
Poor	0	0

Table 2. Skills Pretest Results

Table 2 outlines the pretest results for various skills and provides a detailed assessment of participants' initial proficiency levels across different areas. The scale used for evaluation ranges from 1 to 4, with specific descriptors indicating performance expectations for each skill.

Skill Q1 demonstrates a performance level that falls below expectations. This indicates that participants exhibited challenges or deficiencies in this skill area during the pretest. Like Q1, Q2 reflects a performance level below expectations. Participants exhibited shortcomings or deficiencies in this skill area during the pretest, although the performance was slightly higher than that of Q1. Skill Q3 represents a positive deviation, with performance slightly exceeding expectations. This indicates that participants demonstrated a higher level of proficiency in this skill compared to the basic expectations. Q4 signifies a performance that meets basic expectations. Participants demonstrated a satisfactory level of proficiency in this skill, aligning with the established baseline expectations. Although the performance in Q5 falls slightly below the 3.0 threshold, it still indicates that participants met the basic expectations for this skill during the pretest. Q6 reveals a performance level below expectations, suggesting that participants encountered challenges or deficiencies in this specific skill area during the pretest. Skill Q7 demonstrates a performance significantly below expectations. Participants exhibited notable challenges or deficiencies in this skill area during the pretest. Like Q1 and Q6, Q8 reflects a performance level below expectations. Participants encountered challenges or deficiencies in this skill area during the pretest. The pretest results indicate a varied proficiency level across different skills. While some skills met or slightly exceeded expectations, others fell below the anticipated performance standards. The findings highlight specific areas that may require focused attention or additional training to enhance participants' skills and bring them in line with the desired expectations. The detailed breakdown of individual skills provides valuable insights for targeted interventions and tailored improvement strategies in the subsequent training phases.

QUESTION	PRE-TEST (WM)	VERBAL INTERPRETATION
Q1	2.0	Performance is below expectations
Q2	2.5	Performance is below expectations
Q3	3.7	Performance slightly exceeds expectations
Q4	3.2	Performance meets basic expectations
Q5	2.89	Performance meets basic expectations

Q6	2.1	Performance is below expectations
Q7	1.75	Performance is below expectations
Q8	2.0	Performance is below expectations

Verbal Interpretation:

0.1-1.5-Performance is significantly below expectations; 1.51-2.75-Performance is below expectations;

2.76-3.5-Performance meets basic expectations;3.51-4.5-Performance slightly exceeds expectations;

4.51-5.0-Performance exceeds expectations

Table 3. The Pretest on Handwashing Application

Participants demonstrated a consistent performance below expectations in the initial questions (Q1 to Q5). These results suggest a need for improvement in understanding and executing handwashing techniques for these specific aspects. Q6 stands out with a significantly lower score, indicating a notable deficiency in participants' understanding and application of handwashing practices. This area may require focused attention and targeted interventions. Although the scores in Q7 to Q9 are higher, they still fall below expectations. These questions may represent areas where participants have some understanding but need refinement in their hand-washing techniques. Questions Q10 to Q13 highlight consistent and significant deficiencies in participants' handwashing application. These specific aspects require urgent attention, as participants are notably below the expected proficiency level. Q14 stands out as a positive outlier where participants met or exceeded basic expectations in handwashing applications. This indicates a certain level of proficiency in this aspect of hand hygiene. Participants exhibited a below-average performance in questions Q15 to Q18, emphasizing the need for improvement in understanding and implementing specific handwashing practices. Question Q19 indicates that participants met the basic expectations for this aspect of handwashing application, showcasing an area of relative strength. The last set of questions (Q20 to Q22) highlights a significant gap in participants' understanding and execution of specific handwashing practices, with scores significantly below expectations.

Results suggest that students exhibited a better understanding of handwashing applications after touching medical equipment and after handling patients' secretions and body fluids. However, students' performance in understanding the essentials of handwashing before wearing surgical gowns and touching medical equipment is significantly below expectations.

QUESTION	PRE-TEST (WM)	VERBAL INTERPRETATION
Q1	2.0	Performance is below expectations
Q2	2.5	Performance is below expectations
Q3	2.0	Performance is below expectations
Q4	2.0	Performance is below expectations
Q5	1.76	Performance is below expectations
Q6	1.5	Performance is significantly below expectations
Q7	3	Performance is below expectations
Q8	3	Performance is below expectations
Q9	2.5	Performance is below expectations
Q10	1.5	Performance is significantly below expectations
Q11	1.3	Performance is significantly below expectations
Q12	1.8	Performance is below expectations
Q13	1.3	Performance is significantly below expectations
Q14	3.5	Performance meets basic expectations
Q15	2.70	Performance is significantly below expectations
Q16	3.4	Performance is below expectations
Q17	1.8	Performance is below expectations
Q18	2.75	Performance is below expectations
Q19	3.0	Performance meets basic expectations
Q20	0.4	Performance is significantly below expectations
Q21	1.03	Performance is significantly below expectations
Q22	1.4	Performance is significantly below expectations

Verbal Interpretation:

0.1-1.5-Performance is significantly below expectations; 1.51-2.75-Performance is below expectations;

2.76-3.5-Performance meets basic expectations;3.51-4.5-Performance slightly exceeds expectations;

4.51-5.0-Performance exceeds expectations

Table 4. Post-test on Skills

In the post-test, participants demonstrated a performance that slightly exceeded expectations in Q1, indicating a commendable improvement compared to the pretest. This suggests enhanced understanding and execution of the corresponding handwashing skill. Q2 indicates that participants met the basic expectations for this handwashing skill. While not exceeding expectations, achieving the baseline standards represents a positive outcome post-training. Participants demonstrated a performance that slightly exceeded expectations in Q3, indicating an enhanced level of

proficiency in the corresponding handwashing skill. This suggests the successful assimilation of training content. Q4 shows that participants met the basic expectations for this specific handwashing skill. While not exceeding expectations, achieving the baseline standards post-training is a positive outcome. In Q5, participants exhibited a performance that slightly exceeded expectations, showcasing an improvement in understanding and executing the corresponding handwashing technique. Q6 stands out with a notably high score, indicating that participants exceeded expectations and demonstrated a high level of proficiency in the corresponding handwashing skill. This represents a significant improvement post-training. Q7 reflects an outstanding performance that exceeds expectations. Participants demonstrated an advanced level of proficiency in the corresponding handwashing skill, showcasing a remarkable improvement post-training. In Q8, participants exhibited a performance that slightly exceeded expectations, indicating a positive advancement in understanding and executing the corresponding handwashing technique.

Table 4 is a manifestation of a student's performance on handwashing skills after intervention by the institutional nurse. Based on the result, the post-test cumulative mean is 3.83 (Performance slightly exceeds expectations) compared to the pre-test which is 2.52 (Performance is below expectations). A significant improvement has been noted in both tests. Proficient handwashing skills are essential for individual, community, and global health. Hand hygiene practices serve as a straightforward yet potent means to prevent infections and foster overall well-being. The importance of post-tests lies in the student's capacity to offer valuable insights into how well the interventions work.

QUESTION	POST-TEST (WM)	VERBAL INTERPRETATION
Q1	3.75	Performance slightly exceeds expectations
Q2	3.5	Performance meets basic expectations
Q3	4	Performance slightly exceeds expectations
Q4	3.0	Performance meets basic expectations
Q5	3.55	Performance slightly exceeds expectations
Q6	4.25	Performance slightly exceeds expectations
Q7	4.6	Performance exceeds expectations
Q8	3.99	Performance slightly exceeds expectations

Verbal Interpretation:

0.1-1.5-Performance is significantly below expectations; 1.51-2.75-Performance is below expectations;

2.76-3.5-Performance meets basic expectations;3.51-4.5-Performance slightly exceeds expectations;

4.51-5.0-Performance exceeds expectations

Table 5. Post-test on Handwashing Application

Table 5 presents the post-test on handwashing application. Participants consistently demonstrated a commendable performance that slightly exceeded expectations in questions Q1 to Q5. This indicates a solid improvement in understanding and applying handwashing techniques across multiple aspects. The trend of slightly exceeding expectations continues in Q6 to Q8, showcasing participants' enhanced proficiency in specific handwashing skills. The consistently high scores suggest a thorough assimilation of training content. Questions Q9 to Q13 further emphasize participants' improved performance, with scores that slightly exceed expectations. This suggests a high level of proficiency in executing various handwashing techniques post-training. Q14 stands out with a notably high score, indicating that participants not only exceeded but significantly surpassed expectations in this handwashing skill. This exceptional performance showcases a mastery of the corresponding technique. Participants consistently demonstrated a performance that slightly exceeds expectations in Q15 to Q18. These scores affirm the sustained improvement in participants' understanding and execution of various handwashing practices. Q19 represents a case where participants met the basic expectations, signaling a satisfactory level of proficiency in this specific handwashing skill. The concluding questions, Q20 to Q22, reflect a high level of proficiency as participants continue to score slightly above expectations. This reinforces the positive impact of the training intervention on participants' handwashing application skills.

In accordance with findings, it is well noted that students' performance further exceeds expectations on handwashing application in various situations including after touching medical equipment (wm= 4.87). Of the twelve listed events or situations, the student's post-test results suggest that they were able to perform "slightly exceeds expectations" on the 12 of them.

QUESTION	POST-TEST (WM)	VERBAL INTERPRETATION
Q1	3.75	Performance slightly exceeds expectations
Q2	3.5	Performance meets basic expectations
Q3	3.0	Performance meets basic expectations
Q4	3.25	Performance meets basic expectations
Q5	3.9	Performance slightly exceeds expectations
Q6	4.25	Performance slightly exceeds expectations

Q7	4.0	Performance slightly exceeds expectations
Q8	3.95	Performance slightly exceeds expectations
Q9	4.22	Performance slightly exceeds expectations
Q10	3.89	Performance slightly exceeds expectations
Q11	3.66	Performance slightly exceeds expectations
Q12	3.98	Performance slightly exceeds expectations
Q13	4.25	Performance slightly exceeds expectations
Q14	4.87	Performance exceeds expectations
Q15	3.98	Performance slightly exceeds expectations
Q16	4.0	Performance slightly exceeds expectations
Q17	3.5	Performance meets basic expectations
Q18	3.87	Performance slightly exceeds expectations
Q19	3.22	Performance meets basic expectations
Q20	3.80	Performance slightly exceeds expectations
Q21	4.25	Performance slightly exceeds expectations
Q22	4.5	Performance slightly exceeds expectations

Verbal Interpretation:

**0.1-1.5-Performance is significantly below expectations; 1.51-2.75-Performance is below expectations;
2.76-3.5-Performance meets basic expectations;3.51-4.5-Performance slightly exceeds expectations;
4.51-5.0-Performance exceeds expectations**

Table 6. Level of knowledge on Handwashing Technique

In response to the question about the main route of cross-transmission of potentially harmful germs between patients in a healthcare facility, 56% of participants answered correctly. While a majority responded accurately, there is room for improvement in understanding the intricacies of cross-transmission. Participants demonstrated a higher level of knowledge (70%) in identifying the most frequent source of germs responsible for healthcare-associated infections. This suggests a strong understanding of the critical factors contributing to infection spread. The majority (65%) correctly identified the hand hygiene action that prevents the transmission of germs to the patient. This indicates a sound understanding of the specific measures necessary to protect patients. Participants exhibited a good understanding (62%) of the hand hygiene action that prevents the transmission of germs to the healthcare worker. This knowledge is crucial for safeguarding the health of healthcare professionals. A substantial proportion (59%) correctly identified true statements regarding alcohol-based hand rub and handwashing with soap and water. This suggests a reasonable grasp of the nuances related to these hand hygiene methods. The majority (71%) correctly identified the minimal time needed for alcohol-based hand rub to effectively kill most germs. This high percentage reflects a strong understanding of the practical aspects of hand hygiene. Participants demonstrated decent knowledge (61% and 59%) regarding the appropriate hand hygiene method required in specific situations and factors to avoid, showcasing an understanding of contextual hand hygiene practices. The majority (68%) correctly identified the best technique for handwashing, indicating a robust understanding of effective handwashing methods.

The post-training results in Table 6 demonstrate an overall positive outcome, with participants exhibiting a commendable level of knowledge on various aspects of handwashing techniques. While there are areas with room for improvement, particularly in Q1, Q5, and Q7, most respondents demonstrated a solid understanding of critical concepts related to hand hygiene. This suggests that the training intervention was effective in enhancing participants' knowledge and awareness of key handwashing principles and practices. The findings affirm the success of the training program in imparting essential knowledge to participants, contributing to the promotion of effective hand hygiene practices in healthcare settings.

QUESTION	PERCENTAGE OF CORRECT ANSWER	RANK
Which of the following is the main route of cross-transmission of potentially harmful germs between patients in a healthcare facility?	56%	8
What is most frequent source of germs responsible for healthcare-associated infections?	70%	2
Which of the following hand hygiene actions prevents transmission of germs to the patient?	65%	4
Which of the following statements on alcohol-based hand rub and handwashing with soap and water is true?	62%	5
What is the minimal time needed for alcohol-based hand rub to kill most germs on your hands?	71%	1
Which type of hand hygiene method is required in the following situations?	61%	6
Which of the following should be avoided, as associated with the increased likelihood of colonization of hands with harmful germs?	59%	7

Which of the following is the best technique for handwashing?	68%	3
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Table 7. Pre-test and Post-test Comparison on Skills

The paired t-test results provide valuable insights into the statistical significance of the observed improvements in handwashing skills between the pre-test and post-test phases. While some skills exhibit highly significant differences (p-values of 0.012 and 0.021), indicating a strong influence of the training intervention, others show moderate confidence that the improvements may be due to chance (p-values of 0.083 and 0.096). These findings help assess the overall impact of the training program on participants' handwashing skills and identify areas where the intervention had a statistically significant effect

Paired Samples T-Test				
Measure1	Measure 2	t	df	p
PRE1	POST 1	-1.789	19	0.090
PRE2	POST 2	-2.179	19	0.042
PRE3	POST 3	-2.373	19	0.028
PRE4	POST 4	-2.517	19	0.021
PRE5	POST 5	-2.774	19	0.012
PRE6	POST 6	-2.179	19	0.042
PRE7	POST 7	-1.831	19	0.083
PRE8	POST 8	-1.751	19	0.096

Level of significance=0.05

Table 8. Pre-test and Post-test Comparison on Handwashing Application

The paired t-test results in Table 8 consistently demonstrate statistically significant differences between pre-test and post-test scores for various aspects of handwashing application. The findings indicate that the training intervention had a significant and positive impact on improving participants' skills in these dimensions. Notably, the instances of p-values less than 0.001 underscore the strength and consistency of the training intervention's influence on enhancing participants' proficiency in handwashing application. Overall, the statistical analysis supports the conclusion that the training program effectively contributed to the improvement of participants' practical skills in handwashing application.

Paired Samples T-Test				
Measure1	Measure 2	t	df	p
PRE1	POST 1	-2.792	19	0.012
PRE2	POST 2	-2.463	19	0.024
PRE3	POST 3	-2.604	19	0.017
PRE4	POST 4	-2.795	19	0.012
PRE5	POST 5	-4.943	19	<.0001
PRE6	POST 6	-2.179	19	0.042
PRE7	POST 7	-3.111	19	0.006
PRE8	POST 8	-3.343	19	0.003
PRE9	POST 9	-3.707	19	0.001
PRE10	POST 10	-2.979	19	0.008
PRE11	POST 11	-3.707	19	0.001
PRE12	POST 12	-2.979	19	0.008
PRE13	POST 13	-3.707	19	0.001
PRE14	POST 14	3.823	19	0.001
PRE15	POST 15	-3.567	19	0.002
PRE16	POST 16	-5.446	19	<.001
PRE17	POST 17	-6.097	19	<.001
PRE18	POST 18	-7.594	19	<.001
PRE19	POST 19	-4.841	19	<.001
PRE20	POST 20	-3.489	19	0.002
PRE21	POST 21	-8.000	19	<.001
PRE22	POST 22	-7.594	19	<.001

Level of significance=0.05

Conclusion and Recommendations

This research study has successfully addressed the existing knowledge gap regarding the effectiveness of enhanced handwashing techniques in diverse contexts, particularly within the framework of medical science student education. By employing Kirkpatrick's Four Stages Evaluation Model, the study aimed to systematically evaluate the immediate

responses, learning outcomes, behavioral changes, and broader impacts associated with improved handwashing techniques. The findings of this research contribute valuable insights to the development and implementation of efficient hand hygiene practices in medical science education, shedding light on both the advantages and disadvantages of these approaches. The outcomes of this study have significant implications for the design and implementation of hand hygiene training programs in medical science education. To enhance the effectiveness of future interventions, it is recommended to tailor educational strategies based on the identified areas of strength and weakness among participants. Additionally, ongoing reinforcement and periodic evaluations are crucial for sustaining positive behavioral changes over time. This research not only contributes to the current understanding of hand hygiene practices but also provides a methodological framework for evaluating educational interventions in the broader context of health sciences. by utilizing Kirkpatrick's Four Stages Evaluation Model, this study emphasizes the importance of a comprehensive evaluation approach, offering valuable insights for educators, policymakers, and healthcare professionals aiming to enhance hand hygiene practices and mitigate the risk of infectious diseases in educational settings.

References

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Rotter M. Hand washing and hand disinfection [Chapter 87]. In: Mayhall CG, ed. Hospital epidemiology and infection control. 2nd ed. Philadelphia, PA: Lippincott Williams & Wilkins, 1999. <https://www.cdc.gov/mmwr/PDF/rr/rr5116.pdf#page=19>

Adapted Instruments:

[https://cdn.who.int/media/docs/default-source/integrated-health-services-\(ihs\)/hand-hygiene/monitoring/surveyform/observation-form.doc?sfvrsn=39b780c9_6](https://cdn.who.int/media/docs/default-source/integrated-health-services-(ihs)/hand-hygiene/monitoring/surveyform/observation-form.doc?sfvrsn=39b780c9_6)

[https://cdn.who.int/media/docs/default-source/integrated-health-services-\(ihs\)/hand-hygiene/monitoring/surveyform/hand-hygiene-knowledge-questionnaire.doc?sfvrsn=dbb4da65_2](https://cdn.who.int/media/docs/default-source/integrated-health-services-(ihs)/hand-hygiene/monitoring/surveyform/hand-hygiene-knowledge-questionnaire.doc?sfvrsn=dbb4da65_2)