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Development of a Subjective Evaluation Tool for Assessing Marksmanship Training Effectiveness

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Development of a Subjective Evaluation Tool for Assessing Marksmanship Training Effectiveness

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Executive Summary

All U.S. Marines must qualify as marksman; as a result the training demand on live fire rifle ranges is significant. Marksmanship simulators such as the Indoor Simulated Marksmanship Trainer (ISMT) may help relieve some of this pressure on traditional ranges, but the training effectiveness of such systems must be evaluated and verified. The goal of the current effort was to develop a subjective survey for evaluating marksmanship training systems, as a possible alternative to lengthy and resource-demanding training effectiveness evaluations. A task analytic approach was used to break down the marksmanship domain, as presented in the USMC Rifle Marksmanship Manual, into sub-tasks that were converted into training-task statements which were arranged into a survey format. The survey asked USMC marksmanship instructors to rate each task statement on Importance, Difficulty, Known Distance (KD) Range Training Effectiveness, and ISMT Training Effectiveness. Surveys were distributed to 39 instructors and 22 of these Subject Matter Experts (SMEs) returned completed surveys.

The interrater agreement for the survey was generally good, which is a basic requirement for this tool to have utility in assessing marksmanship trainers. Importance ratings were high, with a mean of 4.3 (all of the scales on the survey ranged from 1 to 5). This was not a surprising result since the task statements were generated from the USMC Rifle Marksmanship Training Manual. The mean Difficulty rating was 2.8, near the scale midpoint, and respondents used a fairly wide range of the available scale indicating that the SMEs were able to successfully rate tasks relative to each other and in a meaningful manner. The mean KD Range training effectiveness rating was 4.4, which was significantly greater than ISMT's mean of 2.9. Although it scored lower than the KD Range, ISMT's score indicates that it is still a moderately effective trainer, at least. Response patterns indicated that some instructors do not use ISMT to train certain categories of marksmanship, such as ballistics and zeroing tasks.

Based on the survey results, the following conclusions and recommendations are offered: 1) The survey exhibited favorable characteristics as a marksmanship trainer evaluation tool, but an important future step would be to compare the subjective effectiveness ratings from this survey to objective training results, as they become available. 2) The survey identified a clear SME preference for the KD Range over ISMT as a training tool for marksmanship qualification. 3) Despite this preference, the SMEs still viewed ISMT as a useful training tool. 4) Based on the response patterns and associations between training effectiveness, task importance, and task difficulty, the KD Range should be used to train items that are more important and difficult, such as aiming tasks. When KD Range time is particularly scarce, a good use of limited assets would be to divert less important and less difficult marksmanship tasks, such as Weapons Handling items, to ISMT. 5) There was some disagreement among SMEs regarding whether or not ISMT was used to train certain tasks (e.g., Ballistics and Zeroing tasks). It would probably be useful for USMC training experts and decision-makers to specifically look into which ISMT features are used and how they are used, and conversely, which features are not used, and why they are not used. Perhaps some ISMT features are underutilized, and/or simple improvements can be made to improve ISMT's ability to train certain tasks, ultimately easing the demand on KD Ranges.

INTRODUCTION

Marksmanship is a fundamental skill for all Marines to master. Ongoing military operations require the United States Marine Corps (USMC) to train Marines as rapidly and effectively as possible, but the opportunity to train on live fire ranges is limited. Marksmanship simulators such as the Indoor Simulated Marksmanship Trainer (ISMT) may help relieve some of this pressure on traditional live fire ranges, (a.k.a., Known Distance (KD) ranges). Simulators can offer several advantages over the traditional KD range. Some simulators are compact and portable enough to allow Marines to train in settings such as ships or embassies that are too confined for a KD Range (Training and Education Command, 2010). Simulators are typically less expensive to operate because they save on the cost of ammunition, targets, and other supplies (Training and Education Command, 2010). The ability to place sensors on the trainee's weapon also allows instructors to provide more specific feedback compared to a KD Range, where the instructor may not be able to pinpoint deficiencies in technique so quickly and easily.

Despite these potential benefits, determining whether simulators offer training that is comparable or even superior to a KD Range can be difficult. A full training effectiveness evaluation (TEE) comparing a new system to an established training method often requires a substantial amount of time and resources, and can disrupt training schedules. Current demands on the training pipeline make such evaluations even more challenging. The amount of time required to evaluate a new system can approach the time required to design and build it, meaning that new systems come online before the old system has been evaluated. As a result, improvement can be sluggish and trainers are implemented without a full understanding of the new system's effectiveness or advantages over the system being replaced. The USMC requires a method to evaluate training systems that is faster, less expensive, and less disruptive while also being applicable to a wide range of simulators.

The goal of this effort is to determine if task analytic and survey techniques can be used to evaluate the effectiveness of training systems when time and resources do not permit a full-fledged TEE. This report describes the development, administration, and results of a survey comparing the KD Range and ISMT as marksmanship training systems. The results of the survey, which was administered to marksmanship subject matter experts (SMEs), will eventually be compared to objective training outcomes from a companion study, as those results become available. That comparison will ultimately determine the utility of this type of survey-based evaluation for assessing a training system's effectiveness.

METHOD

The survey developed in this project is called the Marksmanship Training Survey (MTS). The MTS is based upon an analysis of the Marine Corps Rifle Marksmanship Manual (USMC, 2001) focusing on both the KD Range and ISMT as facilities for training marksmanship. Each facility is described below.

Known Distance Range

The KD Range is a rifle range with targets at predetermined, fixed distances (see Figures 1a and 1b). Trainees receive marksmanship instruction in training phases known as "tables". Training progresses through the following tables:

> *Fundamental Rifle Marksmanship (Training Table 1/1A)* – This table trains Marines in the fundamental knowledge, skills, and attitudes necessary to fire the rifle safely and accurately. Table 1 serves as the foundation upon which more advanced training is based. Marines learn to shoot from various firing positions (prone, kneeling, and standing) and to engage targets at a sustained rate of fire.
>
> *Basic Combat Rifle Marksmanship (Training Table 2)* – This table begins the transition from fundamental marksmanship skills to combat marksmanship. Marines learn to execute different weapon carries and reloads, and to engage targets using controlled pairs of shots. Marines also begin to engage moving targets.

More advanced marksmanship skills such as using combat optics, engaging targets while the Marine is moving, shooting at night, and engaging targets at unknown distances are trained during Intermediate Combat Rifle Marksmanship (Training Table 3) and Advanced Combat Rifle Marksmanship (Training Table 4). These training tables are not conducted on a KD Range, however, so we did not include them in our evaluation.

On the KD Range, trainees fire live rounds at targets in order to practice the skills necessary for Table 1 and Table 2 qualification. Target distances for the M-16 include 25, 100, 200, 300, and 500 yards, depending on the training table being conducted. One instructor is assigned for every four trainees on the KD Range (W. Becker, personal communication, August 23, 2012).

Figure 1a and 1b. Images of Known Distance Ranges.

ISMT

ISMT is a weapons training simulator built for indoor use (see Figure 2). The training system consists of modified M-16 rifles, a firing line, an instructor station, and an audio/visual system for displaying simulated targets. While ISMT is compatible with a wide range of weapon systems for training marksmanship skill, shoot/no-shoot judgment, and weapons tactics (Training and Education Command, 2010; Indoor Simulated Marksmanship Trainer – Enhanced, 2008), the current effort focuses on ISMT as used for Training Tables 1 and 2 with the M-16 rifle. For training purposes, the rifles are modified to fire laser light instead of live ammunition. Trainees occupy positions along the firing line, and a large display screen is located 20 feet "downrange", upon which the simulated targets are projected. When the trainee fires at the target, ISMT registers and records the point of impact of the simulated round with an accuracy of two minutes of angle (Yates, 2004). Point of impact and important marksmanship variables that can affect it, such as point of aim, trigger pressure, buttstock pressure, and barrel cant, can be displayed immediately to the instructor and student. Trainee scores can be tracked over time and ISMT can replay a trace of the shooter's point of aim prior to and immediately after firing the weapon, providing feedback to the trainee. This type of immediate feedback is designed to help instructors correct trainees' errors and improve their technique. Training in ISMT is typically conducted with one instructor per group of approximately eight trainees, but the size of a group varies based on the size of the ISMT facility (W. Becker, personal communication, August 23, 2012).

Figure 2. The ISMT training system.

ISMT is able to reproduce the KD Range training necessary for qualification in Training Tables 1 and 2, with the exception of zeroing the weapon. Trainees cannot zero in ISMT because the system's software adjusts for any bias in the weapon automatically, and because the distance between the display screen and the shooter is too small to allow for proper training in zeroing the weapon (W. Becker, personal communication, August 23, 2012).

Marksmanship Training Survey (MTS)

We developed the MTS as a tool for SMEs to rate both ISMT and KD Range facilities on their abilities to train marksmanship tasks. The MTS can be found in Appendix A. The survey was developed by analyzing the Marine Corps Rifle Marksmanship Manual and dividing the marksmanship domain into tasks, secondary tasks, and tertiary tasks. Chapter titles from the Marksmanship Manual served as tasks (e.g., Introduction to Rifle; Weapons Handling; Fundamentals of Marksmanship). These tasks were the highest level in the task hierarchy. Chapter sections served as secondary tasks (e.g., trigger control, breath control, aiming). Topics within the chapter sections were identified as tertiary tasks (e.g., sight alignment, sight picture). Tertiary tasks were identified as the actual actions carried out by Marines firing a weapon. An example of a full hierarchical classification from task, to secondary task, to tertiary task would be:

Fundamentals of marksmanship – Aiming – Sight alignment

The Marine Corps Rifle Marksmanship Manual contains fairly detailed descriptions of tertiary tasks. These lengthy descriptions were converted to simple action statements in order to make them more suitable for inclusion in the survey. With sight alignment, for example, we translated "Sight alignment is the relationship between the front sight post and rear sight aperture and the aiming eye" into a survey item that read "Establish the correct sight alignment". Survey participants could, however, recover the detailed descriptions of each item if they wanted more information, as follows. The MTS was constructed as a worksheet in an Excel workbook; by hovering the mouse cursor over an item, its detailed description would appear in a pop-up box.

In addition to the survey worksheet, the workbook contained a worksheet for Instructions, Informed Consent, Privacy Act, and Marksmanship Experience. The Marksmanship Experience worksheet (refer to Appendix A) contained questions about which weapons the SMEs trained others to use, amount of experience as an M-16 rifleman and as an M-16 instructor, and amount of ISMT experience. It also provided space for general open-ended comments.

Long surveys tend to have low response rates and suffer from poor response quality (Galesic & Bosnjak, 2009). In order to manage the length of the MTS, we excluded items from the Marine Corps Rifle Marksmanship Manual that were not directly related to the shooter accurately engaging a target. For example, we excluded items about learning the specifics of how the rifle's gas system operates, rifle maintenance, loading and storing magazines, or rifle carry and transport positions. We enlisted the help of a local SME, who has qualified in marksmanship at the expert level, to eliminate these types of items and to ensure the use of proper terminology. The final version of the MTS (see Appendix A) contained 48 tertiary task statements, plus two questions about the overall effectiveness of ISMT and KD Range for training marksmanship.

Each of the 48 tertiary survey items was rated on the following four dimensions:

1) ***Importance for Accuracy***, defined in the survey instructions as "The degree to which incorrect performance of the task would result in reduced ability to place rounds effectively". *Importance* was rated from 1 (not important) to 5 (extremely important), or not applicable (NA).

2) ***Difficulty to Learn***, defined as: "Difficulty to learn reflects the total amount of time and effort required to learn to perform a task successfully and independently, relative to all other marksmanship training". *Difficulty* was rated from 1 (one of the easiest tasks to learn) to 5 (one of the most difficult to learn of all tasks), or NA.

3) ***ISMT Effectiveness***, defined by the question: "How effective is ISMT in training the Marine to perform this task?". *ISMT effectiveness* was rated from 1 (not effective) to 5 (extremely effective), or NA (the task is not trained using this method).

4) ***KD Range Effectiveness***, defined by the question: "How effective is the KD Range in training the Marine to perform this task?". *KD Range effectiveness* was rated from 1 (not effective) to 5 (extremely effective), or NA (the task is not trained using this method).

Each of the 48 items also provided space for general open-ended comments.

The two final questions on the survey asked participants to rate the overall effectiveness of ISMT, as well as the overall effectiveness of the KD Range, for training marksmanship. The effectiveness of each method was rated from 1 (not effective) to 5 (extremely effective). The entire set of instructions with all of the response options can be found in the MTS in Appendix A.

Survey Administration Procedure

With prior agreement and arrangement, an electronic copy of the survey was e-mailed to a point of contact (POC) at the Weapons Training Battalion Quantico, Virginia. The POC then forwarded the survey to 39 USMC M-16 marksmanship SMEs (instructors). After reading through the "Instructions", "Informed Consent", and "Privacy Act" worksheets, the SMEs continued on to fill out the "Marksmanship Experience" and "Survey" worksheets. The SMEs then sent completed surveys back to the POC, who in turn forwarded them to the research team at NAMRU-D.

Participants

Twenty-six of the 39 marksmanship instructors completed and returned the MTS, for a response rate of 67%. Three surveys were dropped due to a probable file-saving-error that resulted in identical responses on each of 194 answers. One additional survey was dropped because the SME reported no experience with ISMT. The remaining 22 SMEs had a mean of 6.0 years of experience with the M-16 rifle, and had been training others to use the M-16 for an average of 2.6 years. SMEs had an average of 2.2 years of experience working with ISMT.

ANALYSES AND RESULTS

In order to facilitate interpretation of this large dataset, we grouped the 48 tertiary items into the following six marksmanship categories: Weapons Handling, Firing Positions, Aiming, Trigger Control, Ballistics, and Zeroing. These groups were guided by, and corresponded well to, chapter sections within the Marine Corps Rifle Marksmanship Manual. These six categories and the tertiary tasks that they contain are listed in Appendix B.

Interrater Agreement

The MTS data were first analyzed to gauge interrater agreement, since the usefulness of a subjective assessment tool like this one is limited by the extent to which expert raters can agree upon task ratings. A high degree of disagreement would indicate that the outcome of the assessment will be dependent on the particular sample of raters selected, limiting the utility of the evaluation tool. Assessing agreement can be facilitated by the use of multiple methods, as different indices tend to yield convergent results (LeBreton & Senter, 2008). Although the choice of index is largely a matter of personal preference (LeBreton & Senter, 2008), we used the r_{wg} and Average Deviation (AD) indices of agreement per item following the advice of Burke, Finkelstein, and Dusig (1999). The r_{wg} statistic examines the distribution of raters' responses compared to a hypothetical null distribution. We used a null distribution composed of uniform random responses because we lacked a sound basis to identify subgroups of raters a priori (LeBreton & Senter, 2008) or determine the nature of any potential ratings bias and could not otherwise model the response variability (Burke, Finkelstein, & Dusig, 1999). Interrater agreement was tested at the $p = .05$ level.

The AD statistic evaluates the average deviation of each rater from the mean or median of all raters. We computed the AD statistic as an additional measure of agreement to strengthen our interpretation of the r_{wg} statistic. Significance of agreement was tested at the $p = .05$ level for individual items using established critical values (Dunlap, Burke, & Smith-Crowe, 2003).

The AD statistic can be computed based on either mean rating scores or median rating scores. For the purposes of measuring agreement, we computed the AD statistic using median rating scores because these values can be more robust and sensitive in detecting agreement than values computed using the mean (Burke et al., 1999). Appendix C presents both the r_{wg} and AD values for each item, as well as the critical values to reach significance at the $p = .05$ level.

To evaluate aggregated marksmanship categories, we examined the number of individual items showing agreement out of the total number of items in that category. There is no widely accepted significance test for the r_{wg} and AD statistics at the aggregated level.

In our MTS dataset we found that SMEs agreed in their task ratings as a whole, but agreement varied between marksmanship categories and on different dimensions (*Importance, Difficulty, ISMT*

Effectiveness, and *KD Range Effectiveness*). These variations can affect the interpretability of the findings and will be discussed in the appropriate section of the results.

Overall Results

To gain a composite picture of the *Importance* and *Difficulty* ratings for the 48 tertiary tasks, we calculated the overall mean for each of these two ratings. Across the 48 items, the 22 SMEs gave *Importance* a mean rating of 4.31 (*SD* = 0.33). The mean rating for *Difficulty* was 2.84 (*SD* = 0.58). The "Top Five" and "Bottom Five" items for *Importance* and *Difficulty* are rank ordered in Tables 1 and 2, respectively. The entire rank orderings for *Importance* and *Difficulty* are presented in Appendices D and E, respectively.

Table 1

Items Rated Most Important for Accuracy and Least Important for Accuracy

Importance Rank	Item #	Task statement	Category	Mean
1	35	Establish battlesight zero	Zeroing	4.91
2	12	Apply marksmanship fundamentals until the round exits the barrel of the rifle	Aiming	4.86
3	1	Establish the correct sight alignment	Aiming	4.82
4	2	Establish the correct sight picture	Aiming	4.82
5	5	Maintain sight alignment and sight picture	Aiming	4.73
44	3	Establish proper stock weld	Aiming	3.91
45	15	Don the loop sling	Weapons handling	3.68
46	19	Use proper positioning of the right elbow	Weapons handling	3.68
47	41	Use front sight post method to determine distance to the target	Ballistics	3.59
48	11	Maintain proper interrupted trigger control	Trigger control	3.55

Table 2

Items Rated Most Difficult to Learn and Least Difficult to Learn

Difficulty Rank	Item #	Task statement	Category	Mean
1	44	Use multiple methods to determine distance to the target	Ballistics	4.14
2	48	Engage targets while wearing the field protective mask	Aiming	4.06
3	10	Maintain proper uninterrupted trigger control	Trigger control	4.05
4	37	Shift point of aim or use offset aiming when conditions do not permit mechanical sight adjustment	Aiming	3.86
5	40	Use unit of measure method to determine distance to the target	Ballistics	3.86
44	15	Don the loop sling	Weapons handling	2.27
45	19	Use proper positioning of the right elbow	Weapons handling	2.18
46	25	Assume the sitting position	Firing positions	2.18
47	3	Establish proper stock weld	Aiming	2.00
48	24	Assume the prone position	Firing positions	1.82

The two overarching questions at the end of the survey asked SMEs to provide an overall rating of *KD Range Effectiveness*, as well as *ISMT Effectiveness*. The two overall questions demonstrated good rater agreement (r_{wg} and AD were 0.61 and 0.82 for *ISMT Effectiveness*, and 0.92 and 0.41 for *KD Range Effectiveness*, respectively). The mean rating for the *KD Range Effectiveness* was 4.81 (*SD* = 0.40), versus 3.52 (*SD* = 0.87) for *ISMT Effectiveness*. A paired sample *t*-test showed that this difference was significant, $t(20) = 6.16$, $p < 0.01$.

A second way to compare *KD Range* and *ISMT Effectiveness* ratings is to look at means for these variables across all 22 respondents and all 48 tertiary tasks. When calculated in this manner, the KD Range still had the higher rating, but ratings for each facility were lower. The mean effectiveness rating for the KD Range dropped somewhat to 4.40 (*SD* = 0.24), and that for ISMT dropped to 2.92, (*SD* = 0.61). The overall mean *ISMT Effectiveness* ratings must be interpreted with caution, however, since they demonstrated poor rater agreement in the Firing Position and Ballistics task categories (discussed

below). In a later section we also apply *t*-tests to these KD Range vs. ISMT differences within each of the six marksmanship categories.

Analysis by Marksmanship Category

For each of the six marksmanship categories, we calculated the average rating of *Importance* and *Difficulty*, and these data are graphed in Figures 3 and 4, respectively. Similarly for each category, mean ratings for *KD Range Effectiveness* versus *ISMT Effectiveness* are shown in Figure 5. In all cases, means were calculated across all subjects and items within each category.

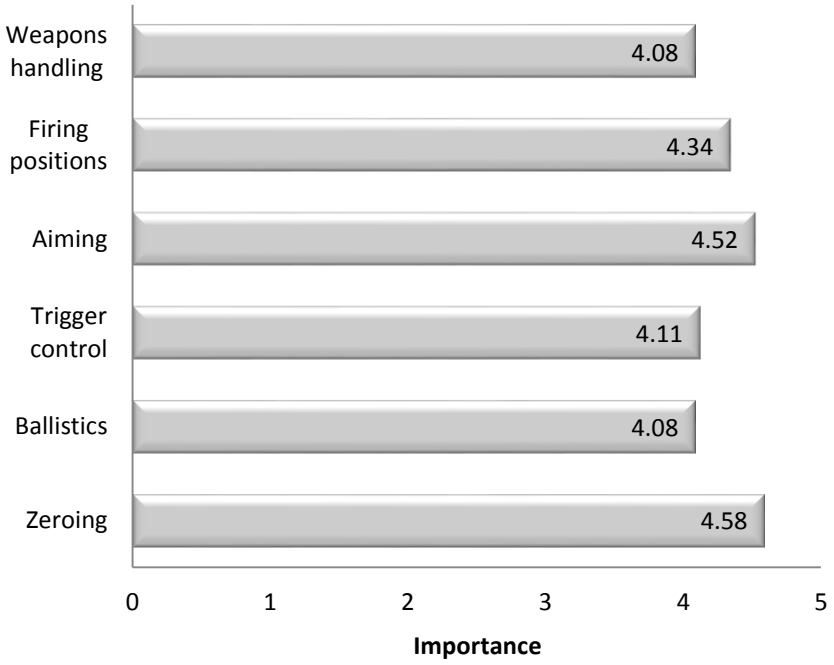

Figure 3. Average Ratings of *Importance*

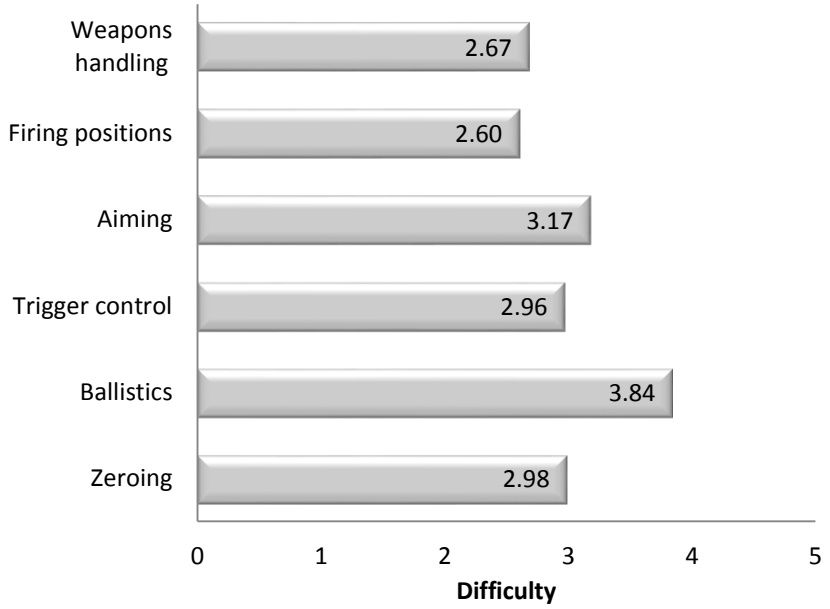

Figure 4. Average Ratings of *Difficulty*

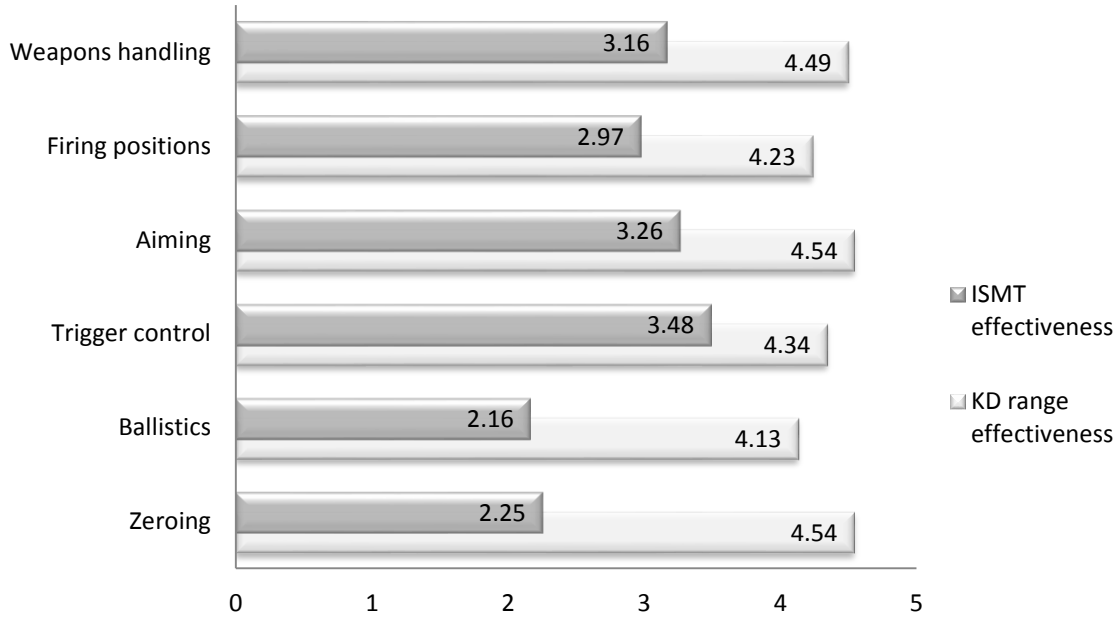

Figure 5. Average Ratings of *KD Range Effectiveness* and *ISMT effectiveness*

Each of the 48 tertiary survey items had "Not Applicable: The task is not trained using this method" as a valid response choice. Respondents invoked this choice to varying degrees, and as a result, certain questions did not receive a numeric rating from some of the respondents. NA ratings were treated as strictly qualitative data and therefore did not enter into the calculation of means, *t*-tests, etc. Figures 6

and 7 show the percentage of questions within each category that received NA responses for the *Importance* and *Difficulty* ratings, respectively. Likewise, Figure 8 shows these percentages for *KD Range Effectiveness* and *ISMT Effectiveness* ratings. NA responses were mostly reserved for *ISMT Effectiveness* ratings for the Zeroing and Ballistics categories, indicating that in the experience of some SMEs, ISMT is not used to train these components of marksmanship.

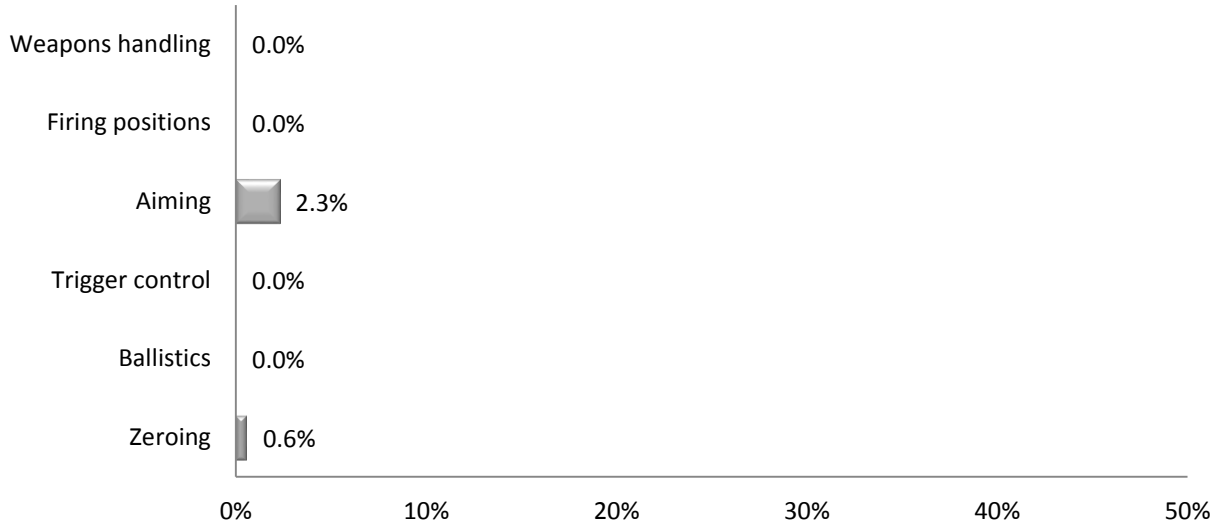

Figure 6. Percentage of NA Ratings for *Importance*

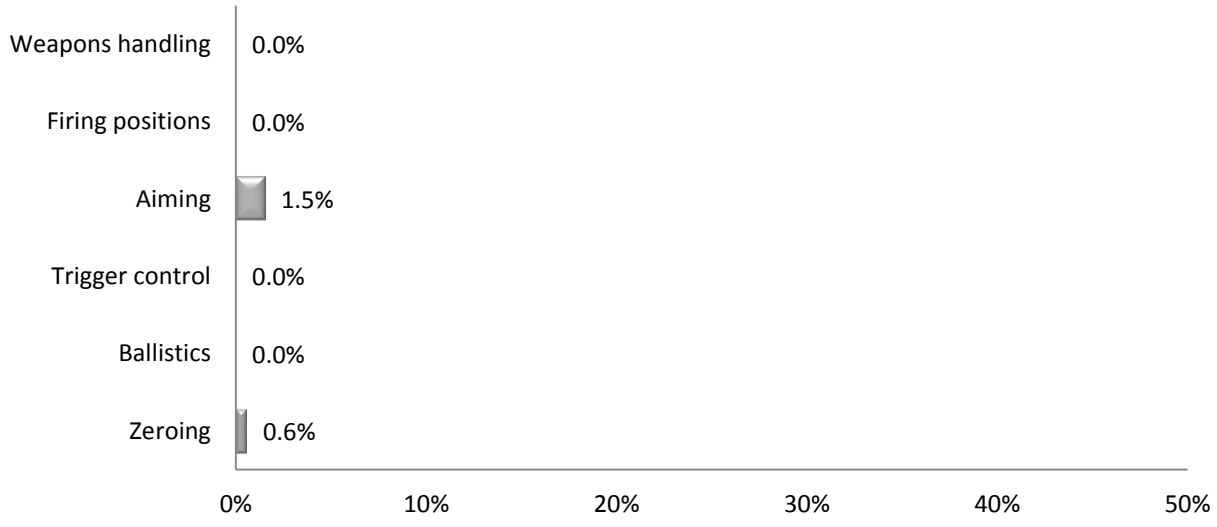

Figure 7. Percentage of NA Ratings for *Difficulty*

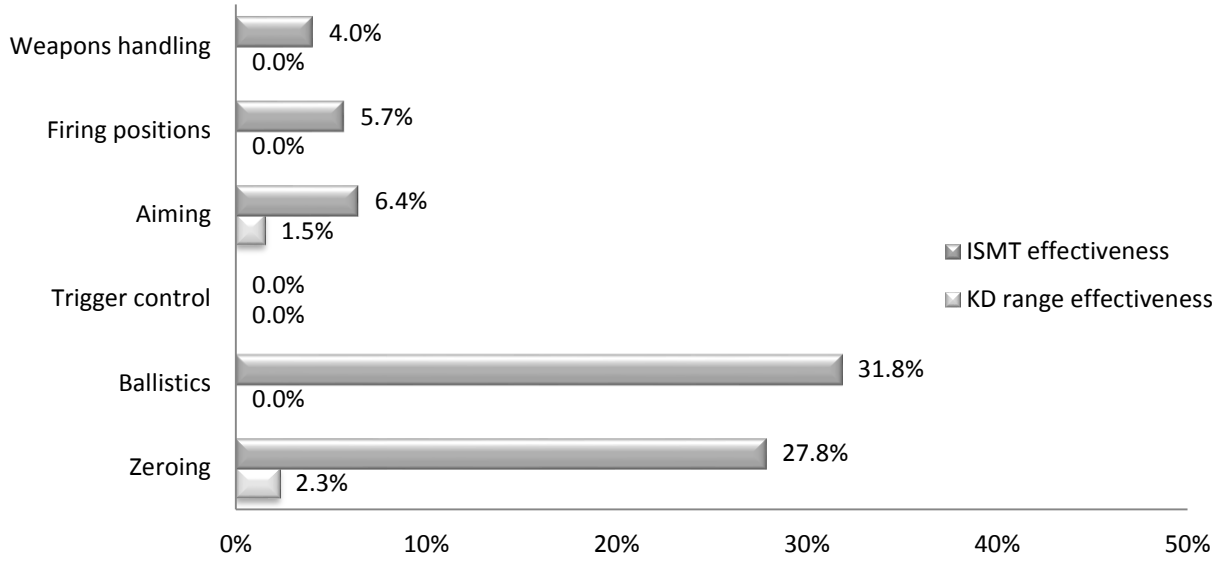

Figure 8. Percentage of NA Ratings for *KD Range Effectiveness* and *ISMT Effectiveness*

The NA ratings are informative since they are indicators of which items are not currently trained by a particular method, but they are also problematic in that they effectively become missing data for comparing training methods. This is especially true here for paired sample *t*-tests comparing ratings of *ISMT* vs. *KD Range effectiveness*. For example, there were five survey items on Ballistics, and each of the 22 participants provided a rating of KD Range training effectiveness for each item, for a total of 110 responses. None of those responses were "NA". All participants also rated each item for ISMT effectiveness, but 35 of those responses were "NA", meaning that for 35 of the response pairs (*ISMT* vs. *KD Range Effectiveness*) we could not make a meaningful comparison. That is, a paired sample *t*-test could not calculate a difference score for those particular pairs. However, 75 "valid" pairs still remained. To conduct the paired sample *t*-test, we chose a conservative approach of omitting a participant's response pair if it contained an "NA", versus another approach such as using that participant's mean (perhaps calculated from only a small number of responses) of non-NA responses within that category. This approach still allowed for comparison of 75 response pairs within the Ballistics category, and this was the "worst case" category in terms of having the highest percentage (31.8%) of omitted pairs (Figure 8).

The *KD Range Effectiveness* and *ISMT Effectiveness* ratings presented in Figure 5 were recalculated for the omitted pairs data set, and these new means are presented in Figure 9. Comparison of these two figures shows that there was little or no effect of omitting pairs except for the Zeroing and Ballistics categories, and then only for the KD Range data, where the means increased slightly. ISMT data for these two categories showed little or no change since the vast majority of NA ratings were due to ISMT, and since NA ratings were considered qualitative data they did not factor into means to begin with.

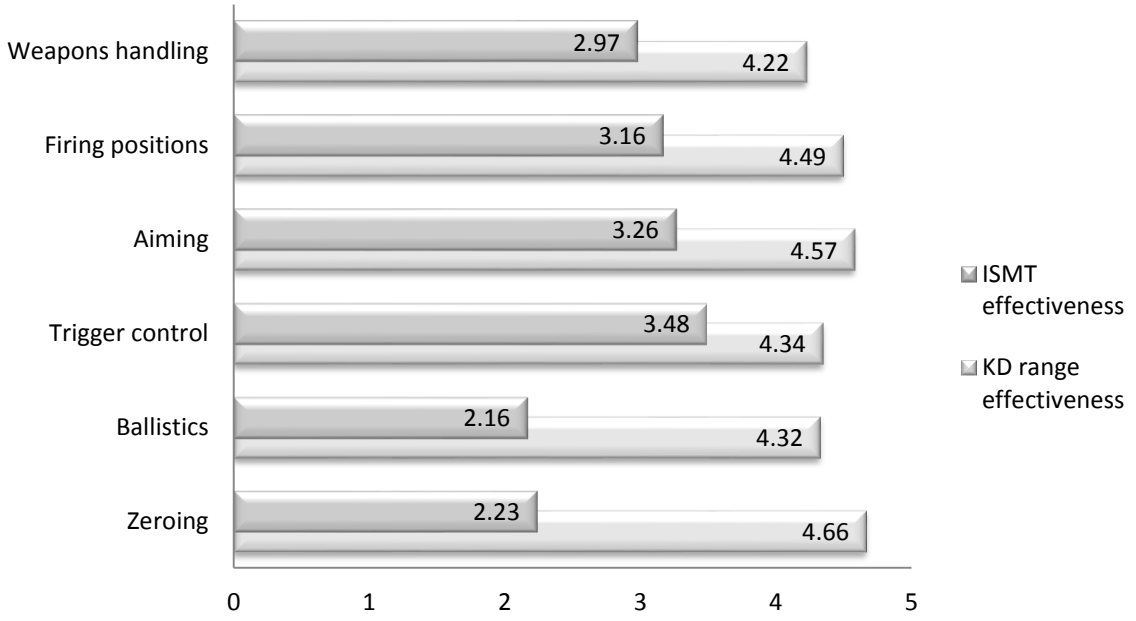

Figure 9. Average Ratings of *KD Range Effectiveness* and *ISMT effectiveness* with Missing Data Pairs Omitted

Mean *Importance*, *Difficulty*, *ISMT Effectiveness*, and *KD Range Effectiveness* means are reviewed below for each of the six marksmanship categories. Paired sample *t*-tests results are also presented to compare effectiveness ratings of KD Range versus ISMT training. Because each of the six marksmanship categories was composed of a different number of survey items, and because the number of omitted pairs varied, degrees of freedom for each *t* value vary as well. Ratings within each category demonstrated good agreement unless otherwise noted.

Weapons Handling

Weapons Handling received a mean *Importance* rating of 4.08 (*SD* = 0.86) and a mean *Difficulty* rating of 2.67 (*SD* = 0.98). Mean *Importance* and *Difficulty* ratings are shown in Figures 3 and 4, respectively. For the KD Range versus ISMT effectiveness comparison, a paired samples *t*-test demonstrated that the KD Range (*M* = 4.22, *SD* = 0.75) was rated as more effective at training Weapons Handling tasks than ISMT (*M* = 2.97, *SD* = 1.00), with $t(188) = 16.12$, $p < .001$ (see Figure 9).

Firing Positions

Firing Positions received a mean *Importance* rating of 4.34 (*SD* = 0.89) and a mean *Difficulty* rating of 2.60 (*SD* = 1.23). Only four out of eight items demonstrated good agreement for *Difficulty* ratings on both r_{wg} and AD, with an additional item showing good agreement on the AD index but not r_{wg}. *Difficulty* ratings for Firing Positions as a category therefore demonstrate only modest agreement and should be interpreted carefully. Regarding effectiveness ratings, a paired samples *t*-test demonstrated that the KD Range (*M* = 4.49, *SD* = 0.73) was rated as more effective at training Firing Position tasks than ISMT (*M* = 3.16, *SD* = 1.24), with $t(165) = 11.78$, $p < .001$ (see Figure 9). These results should be interpreted with

caution, however, since none of the eight items in the Firing Positions category demonstrated agreement among the SMEs on *ISMT Effectiveness* ratings.

Aiming

Aiming received a mean *Importance* rating of 4.52 (*SD* = 0.85) and a mean *Difficulty* rating of 3.17 (*SD* = 1.12). For the Effectiveness comparison, a paired samples *t*-test demonstrated that the KD Range (*M* = 4.56, *SD* = 0.67) was rated as more effective at training Aiming tasks than ISMT (*M* = 3.28, *SD* = 1.15), with $t(246) = 16.23$, $p < .001$ (see Figure 9).

Trigger Control

Trigger Control received a mean *Importance* rating of 4.11 (*SD* = 0.97) and a mean *Difficulty* rating of 2.96, (*SD* = 1.08). A paired samples *t*-test demonstrated that the KD Range (*M* = 4.34, *SD* = 0.77) was rated as more effective at training Trigger Control tasks than ISMT (*M* = 3.48, *SD* = 1.02), with $t(131) = 9.44$, $p < .001$ (see Figure 9).

Ballistics

Ballistics received a mean *Importance* rating of 4.08, *SD* = 0.94 and a mean *Difficulty* rating of 3.84, *SD* = 0.90. A paired samples *t*-test demonstrated that the KD Range (*M* = 4.32, *SD* = 0.84) was rated as more effective at training Ballistics tasks than ISMT (*M* = 2.16, *SD* = 1.23), with $t(74) = 12.80$, $p < .001$ (see Figure 9). *ISMT Effectiveness* ratings should be interpreted with caution, as only one out of five Ballistics items demonstrated good agreement.

Zeroing

Zeroing received a mean *Importance* rating of 4.58, *SD* = 0.76 and a mean *Difficulty* rating of 2.98, *SD* = 1.13. A paired samples t-test demonstrated that the KD Range (*M* = 4.66, *SD* = 0.61) was rated as more effective at training Zeroing tasks than ISMT (*M* = 2.23, *SD* = 1.10), with $t(124) = 20.02$, $p < .001$ (see Figure 9).

Correlations

In an exploratory effort to identify any associations between the dimensions of item *Importance*, *Difficulty*, *ISMT Effectiveness*, and *KD Range Effectiveness*, we constructed the correlation matrix for these four dimensions. This matrix is shown in Table 3. The significant positive correlation between *Importance* and *KD Range Effectiveness* was fairly strong ($r = .68$, $p < .001$); items rated higher in *Importance* also tended to be rated high for *KD Range Effectiveness*. The negative correlation between *Difficulty* and *ISMT Effectiveness* was moderate but not quite significant at the $p = .05$ level ($r = -.41$, $p = .06$), indicating that more difficult items tended to receive lower *ISMT Effectiveness* ratings. There was some indication of an association between *Importance* and *Difficulty* ratings, but it was not statistically significant ($r = .37$, $p = .10$). None of the other correlations approached significance.

Table 3

Correlations between Importance, Difficulty, KD Range Effectiveness, and ISMT Effectiveness

	Importance	Difficulty	KD Range Effectiveness
Difficulty	0.37		
KD Range Effectiveness	-0.20	-0.41	
ISMT Effectiveness	0.68***	-0.01	-0.29

***$p < .001$, two-tailed

Open-Ended Comments

Five SMEs provided a total of 11 general open-ended comments. The comments were wide-ranging and included suggestions for useful teaching aids, general areas of difficulty for students (e.g., sight alignment, eye relief), and areas where ISMT might be improved (e.g., more realistic recoil, ability to teach various shooting positions). All of the comments are presented in Appendix F.

DISCUSSION

The goal of this effort was to determine the utility of a quickly administered subjective evaluation tool for assessing the effectiveness of marksmanship trainers and as a possible alternative to comprehensive TEE's. Using a task analytic approach, marksmanship training materials, and SME input, we developed a survey which instructors and SMEs could complete in under 30 minutes. Twenty-two USMC marksmanship instructors returned valid surveys and we discuss those results here. These data will eventually be analyzed further to see if they are predictive of the objective training results of a companion study comparing the effectiveness of ISMT and KD Range training methods, when those results become available.

Interrater Agreement

Overall interrater agreement was good, indicating reliable results, with a few exceptions. Agreement was low for *ISMT Effectiveness* ratings within the Firing Positions and Ballistics categories, which makes those results more difficult to interpret. Although low agreement makes system evaluation more challenging, it does not necessarily mean that an item is not informative. Low agreement could indicate legitimately different groups of raters, as would result from different instructors using the system differently, for example. Perhaps some SMEs used ISMT to train some tasks while other SMEs did not. SMEs who did not use ISMT to train certain tasks may have rated it poorly or NA, while SMEs who used ISMT rated it highly. This explanation seems plausible given the high agreement among SMEs on KD

Range effectiveness, but low agreement among the same SMEs in certain categories on ISMT effectiveness. There may be some inconsistencies in ISMT's use, leading to different training depending on a particular instructor or facility. Future work should investigate how ISMT is actually used by different instructors in order to identify best practices to improve standardization and training effectiveness.

Agreement was also low for *Difficulty* ratings for Firing Positions, but it is not clear why. One possible explanation is again that instructors are using the systems differently. These differences could have caused some trainees to learn the tasks more easily than others, depending on how instructors used the systems.

Agreement scores must also be interpreted with special care for items or categories with a high number of NA responses, as was the case with *ISMT Effectiveness* ratings for the Ballistics and Zeroing categories. Numerous NA responses in the presence of other ratings may indicate poor agreement despite good values for r_{wg} and AD. Any follow on work should try to determine why some SMEs feel that certain items are NA, whereas other SMEs have no problems in evaluating those same items.

Importance Ratings

Overall, the 48 survey items, or tertiary tasks, received high ratings for *Importance*. The mean *Importance* rating across all items was 4.31, and the mean rating for each of six categories was above 4 (see Figure 3), which corresponded to "Highly Important". High *Importance* ratings are not surprising here since all items on the survey can be traced back to the Marine Corps Rifle Marksmanship Manual, which focuses on tasks important to marksmanship. The top five items for *Importance* (see Table 1) were all from the categories of Zeroing or Aiming. This result makes sense since a rifle that is not properly zeroed and properly aimed cannot be expected to place a round accurately on target (especially the first round, when there is not yet any feedback on point of impact). The item with the highest *Importance* rating, "Establish battlesight zero", had a mean rating of 4.91.

The bottom five items for *Importance* in Table 1 were a bit more heterogeneous, originating from the categories of Weapons Handling, Trigger Control, Ballistics, and Aiming. It is worth noting that even the item with the lowest rank order *Importance* rating, "Maintain proper interrupted trigger control", still received a mean rating 3.55. This falls approximately midway between the descriptors "3 - Moderately Important" and "4 - Highly Important", again indicating that all of the survey items were viewed as important for marksmanship.

Difficulty Ratings

The overall mean *Difficulty* rating was 2.84, or just below the midpoint descriptor "3 - Approximately half the tasks are easier to learn and half are more difficult to learn". The item rated as most difficult, "Use multiple methods to determine distance to the target", had a mean rating of 4.14. A rating of "4" corresponded to "Harder to learn than most other tasks". The item with the lowest *Difficulty* rating was "Assume the prone position", which received a mean rating of 1.82, or close to a rating of "2 - Easier to learn than most other tasks". For *Difficulty* ratings, SMEs used a fairly wide range of the available scale,

and their average rating was close to the scale midpoint. These two characteristics of the data indicate that with the exception of Firing Position *Difficulty* ratings as discussed above, the SMEs were able to successfully rate tasks relative to each other and in a meaningful manner.

The top five items for *Difficulty* (see Table 2) were from the categories of Ballistics, Aiming, and Trigger Control. Items in the Ballistics category involved making distance judgments, which is known to be a difficult perceptual task (Allen & Rashotte, 2006). The Aiming and Trigger Control categories contained challenging items that require fine motor control and precise hand-eye coordination, so it is logical that these items and categories were rated among the most difficult.

The bottom five items for *Difficulty* in Table 2 were from the categories of Firing Positions, Aiming, and Weapons Handling. These five items involved fairly gross motor movement and positioning tasks (e.g., "Assume the prone position"). It is likely that the gross motor and fairly simple procedural nature of these tasks (especially as compared to the five most difficult items) resulted in their lower *Difficulty* ratings.

ISMT vs. KD Range Ratings

Overall Effectiveness Ratings

When SMEs were asked to provide one overall rating for *KD Range Effectiveness* and one for *ISMT Effectiveness*, they clearly rated the KD Range (M = 4.81) as more effective than ISMT (M = 3.52). The same pattern of results emerged when *Effectiveness* means were calculated across all 48 tertiary tasks. The mean for the KD Range was 4.40 while that for ISMT was 2.92. It is unclear exactly why ratings were lower when means were calculated across the 48 individual tertiary items. Perhaps the increased detail and specificity at the item level prompted SMEs to think more thoroughly and critically in their ratings. What is clear is that the SMEs consistently rated the KD Range as more effective.

There are at least two potential explanations for the higher *KD Range Effectiveness* ratings. First, since Marines are tested on the KD Range itself, not ISMT, for their marksmanship qualification, the KD Range is certainly a good choice for learning and practicing the required skills. For example, on the KD Range Marines learn to deal with real world weather effects (e.g., wind, atmospheric obscuration, etc.) and experience the actual noise and recoil of firing live ammunition in their own weapons. While the weapons converted for ISMT do produce some recoil, it is only about one-third as strong as that produced by live ammunition, and one SME did comment on the non-realistic recoil provided by ISMT. Thus it may be argued that tasks like re-establishing sight alignment and sight picture are not as challenging or realistic with ISMT, and therefore the KD Range produces better training for qualification.

A second factor that may have contributed to a higher rating for the KD Range is a subjective preference or bias for firing actual, versus simulated, weapons and ammunition. Simply put, live fire is probably more rewarding and fun for the Marines than ISMT, and this may be a bias that affects their ratings.

One point that should be kept in mind is that even though ISMT received lower mean *Effectiveness* ratings than the KD Range, it still received intermediate to favorable ratings. ISMT's mean rating of 2.92 across the 48 items is slightly below, but still close to, a rating of" 3 – Moderately Effective". ISMT's mean score of 3.52 for the overall question is a favorable rating, falling between "Moderately Effective" and "Highly Effective". The SMEs still see ISMT as a useful training tool.

Effectiveness Ratings by Marksmanship Categories

In addition to the overall *KD Range Effectiveness* versus *ISMT Effectiveness* ratings, we analyzed the effectiveness ratings within each of the six marksmanship categories (Figure 9). Reflecting the overall ratings, SMEs rated the KD Range as being more effective than ISMT in all six cases, and these differences were all statistically significant. Also for each of the six categories, mean ratings for the KD Range were above 4, which corresponds to "Highly Effective". Clearly then, SMEs rate the KD Range high in *Effectiveness* in absolute terms, and as compared to ISMT. But again, even though ISMT was not rated as highly, it still fared reasonably well. For three of the six categories, Aiming, Trigger Control, and Firing Positions, ISMT scored above 3 (Moderately Effective), and nearly so for a fourth category, Weapons Handling, with a mean of 2.96. So for these four categories, SME instructors felt that ISMT trained marksmanship tasks in manner that was close to moderately effective or better.

Looking more closely at these four categories and at ISMT characteristics, these generally favorable results are not surprising. ISMT uses actual M-16 rifles that are converted for simulated use. The sights and trigger mechanisms are the same as those used for qualification, so Aiming and Trigger Control tasks can be trained fairly well. The size and weight of the rifle is the same, so ISMT should be expected to train Firing Positions and Weapons Handling tasks adequately. Thus in the opinion of the SMEs, ISMT is fairly effective at training tasks in these categories, but not as effective as the KD Range. One possible explanation as to why ISMT ratings fell short of KD Range ratings may be related to factors mentioned earlier such as decreased recoil of the ISMT rifles and its training effects on re-establishing sight alignment/sight picture. Another reason may be the perceptual and visual system differences involved in aiming at simulated, projected targets versus real, physical targets.

For two categories, Zeroing and Ballistics, ISMT scored poorly in effectiveness with mean ratings of 2.23 and 2.16, respectively. These means were close to a rating of 2, corresponding to "Slightly Effective". These categories also had the highest percentage of NA ratings (see Figure 8) with Zeroing at 27.8% and Ballistics at 31.8%. Taken together, the data for these two categories indicate SMEs felt that ISMT either trained the tasks poorly, or that it was not used to train the tasks at all. The response patterns also indicate that there is some disagreement among the SMEs about whether or not ISMT is used to train tasks within these categories. It may be the case that some instructors choose not to use certain features of ISMT, such as introducing wind effects, if they believe it is ineffective in training how to compensate for the wind. Although this reasoning is speculative it would help explain why some chose to rate certain items as NA while others assigned low ratings. This is an area that USMC training

experts may want to examine further, both for standardization purposes, and possibly for improving the way certain features of ISMT are used.

In the previously mentioned companion study, a separate project team has plans to collect objective data on KD Range and ISMT training *Effectiveness*. In that effort, two groups of Marines will each participate in a different method of training. One group will train traditionally on the KD Range exclusively, while the other group will replace some KD Range sessions with ISMT sessions. After training, the marksmanship qualifying scores of the two groups will be compared. Those results will also be compared to the results from the current survey to see to what degree, if any, our SME ratings are predictive of qualification scores.

By several measures, SMEs in the present study rated the KD Range as the more effective training tool. In the planned companion study, if the group trained exclusively on the KD Range has reliably higher qualification scores, those results would be an indicator that the MTS has potential merit as a predictor of training system effectiveness. The future project is to be conducted on a "not-to-interfere" basis, and extremely busy training schedules have not yet afforded the opportunity for data collection. Provided that study can be completed we will work with that project team to combine the results of our efforts.

Correlations

When correlation coefficients were calculated among the dimensions of *Importance, Difficulty, ISMT Effectiveness*, and *KD Range Effectiveness*, the only significant association was between *Importance* and *KD Range Effectiveness* (see Table 3). Tasks that SMEs viewed as high in *Importance* were rated highly in terms of *KD Range Effectiveness* as well. So not only did SMEs rate the KD Range as more effective, they saw it as particularly effective for more important items. Although not quite significant at the $p = .05$ level, there was also a trend in the opposite direction for the correlation between *Difficulty* and *ISMT Effectiveness* ($r = -.41$, $p = .057$), indicating that ISMT was viewed as less effective in training the more difficult tasks. A recommendation emerging from these results would be to give KD Range priority to tasks rated as more important and difficult. A review of Tables 1 and 2 shows that Aiming tasks tended to fall into this category.

One other interesting correlation result was that between task *Importance* and *Difficulty* ($r = .37$, $p = .095$). Although not statistically significant, there was some tendency for items rated as important to also be rated as difficult. One simple explanation would be that the important items are indeed more difficult. Another possible explanation is that the structure of the survey may have induced a confound between the dimensions of *Importance* and *Difficulty*, as follows. The most efficient way to complete the survey was to read the task statement, and then rate it in terms of *Importance, Difficulty, ISMT Effectiveness*, and *KD Range Effectiveness*. The fact that *Importance* was immediately followed by *Difficulty* may have caused the former rating to bias the latter in the same direction. If follow on work were to be conducted it may be worthwhile to investigate new methods of survey administration, such as having the SMEs rate all items on one dimension before moving on to the next. More data on this topic may provide a clearer picture about any relationship between *Importance* and *Difficulty*.

CONCLUSIONS

Several conclusions and recommendations that can be drawn from this study are listed below.

- The survey exhibited favorable characteristics as a marksmanship trainer evaluation tool, but an important future step would be to compare the subjective effectiveness ratings from this survey to objective training results, as they become available.
- The survey identified a clear SME preference for the KD Range over ISMT as a training tool for marksmanship qualification.
- Despite this preference, the SMEs still viewed ISMT as a useful training tool. Depending on how the data were analyzed, ISMT received mean ratings that ranged from just below "Moderately Effective" to ratings that fell between "Moderately Effective" and "Highly Effective".
- Based on the response patterns and associations between training effectiveness, task importance, and task difficulty, the KD Range should be used to train items that are more important and difficult, such as aiming tasks. When KD Range time is particularly scarce, a good use of limited assets would be to divert less difficult and less important tasks, such as Weapons Handling items, to ISMT.
- There was some disagreement among SMEs regarding whether or not ISMT was used to train certain tasks, particularly Ballistics and Zeroing tasks. It would probably be useful for USMC training experts and decision-makers to specifically look into which ISMT features are used and how they are used, and conversely, which features are not used, and why they are not used. Perhaps some ISMT features are underutilized, and/or simple improvements can be made to improve ISMT's ability to train certain tasks, ultimately easing the demand on KD Ranges.

References

Allen, G.A. & Rashotte, M.A. (2006). Training metric accuracy in distance estimation skill: pictures versus words. *Applied Cognitive Psychology, 20*, 171-186.

Burke, M.J., Finkelstein, L.M., & Dusig, M.S. (1999). On average deviation indices for estimating interrater agreement. *Organizational Research Methods, 2(1),* 49-68.

Dunlap, W.P., Burke, M.J., & Smith-Crowe. (2003). Accurate tests of statistical significance for *r*wg and average deviation interrater agreement indexes. *Journal of Applied Psychology, 88(2),* 356-362.

Galesic, M & Bosnjak, M. (2009). Effects of questionnaire length on participation and indicators of response quality in a web survey. Public Opinion Quarterly, 73(2), 349-360.

Indoor Simulated Marksmanship Trainer – Enhanced (ISMT-E) (2008). Retrieved from http://www.marines.mil/unit/pandr/Documents/Concepts/2008/PDF/CP08Ch3P7_Indoor_Simulated_Marksmanship_Trainer%E2%80%93Enhanced.pdf on January 6, 2012.

LeBrenton, J.M. & Senter, J.L. (2008). Answers to 20 questions about interrater reliability and interrater agreement. *Organizational Research Methods, 11(4),* 815-852.

United States Marine Corps (2001). Rifle Marksmanship. Retrieved from https://www.google.com/url?q=http://www.everyspec.com/USMC/download.php%3Fspec%3DMCRP_3-01A_29MAR2001.013708.pdf&sa=U&ei=_IKrULDGHcmx0AG7jIDQBA&ved=0CA8QFjAE&client=internal-uds-cse&usg=AFQjCNHCc3tps8PVlBKg4AYI1OT0uSWoGA on May 17, 2010.

Training and Education Command (2010). Concept of operations for the Indoor Simulated Marksmanship Trainer.

Yates, W. (2004). A training transfer study of the Indoor Simulated Marksmanship Trainer. Unpublished Master's thesis. Retrieved from http://www.personal.psu.edu/krm10/Live%20Fire%20Project/ISMT%20transfer.pdf on January 6, 2012.

Appendix A

Survey instructions

NOTE: This survey is presented in an Excel workbook (see the multiple colored tabs below). Be sure to read the brief "Informed Consent" information and the "Privacy Act Statement", and to fill out the short "Marksmanship Experience" worksheet as well. Please save the file often so you don't lose your work. Finally, if you have any questions, call Henry Williams (937-938-3880), Cristina Kirkendall (937-938-3913), or Eric Robinson (937-938-3919). They will be happy to help with any problems.

You will probably find it helpful to print out these instructions and rating scales and refer back to them as you fill out the survey. You can also see the ratings scales by hovering the cursor over cells in the top row on the "Survey" worksheet.

On this survey, you will see a variety of tasks related to marksmanship. We would like you to provide ratings for each task statement using the scales provided below. Hovering the cursor over a task statement cell will give you additional detail about that item. Please review all task statements and type the number corresponding to your rating in the appropriate column. If you think that a task is not relevant to USMC marksmanship duties, select NA.

Scales 1 & 2 concern the characteristics of the tasks themselves while Scales 3 & 4 relate to how well ISMT and the live fire range train these tasks. Please read the definitions of the scales and rating options provided below. When providing ratings for the tasks, you may also review the definitions and ratings scales by hovering the cursor over the cell containing the name of the rating scale (top row). There is also space at the end of each row for any additional comments you may have on a task.

There are two questions at the end of the survey asking you to rate ISMT and the Live Fire Range in their general ability to train marksmanship tasks. For these items please think about the overall capabilities of both training methods and choose the best response for each item from the dropdown menu.

Scale 1: Importance for accuracy

The degree to which incorrect performance of the task would result in reduced ability to place rounds effectively.

1	Not important
2	Slightly important
3	Moderately important
4	Highly important
5	Extremely important
NA	Not applicable

Scale 2: Difficulty to Learn

Difficulty to learn reflects the total amount of time and effort required to learn to perform a task successfully and independently, relative to all other marksmanship training.

1	One of the easiest tasks to learn
2	Easier to learn than most other tasks
3	Approximately half of the tasks are easier to learn and half are more difficult to learn
4	Harder to learn than most other tasks
5	One of the most difficult to learn of all tasks
NA	Not applicable

Scale 3: ISMT Effectiveness

How effective is ISMT in training the Marine to perform this task?

1	Not effective (ISMT is used to train this task, but does not train the task effectively)
2	Slightly effective
3	Moderately effective
4	Highly effective
5	Extremely effective
NA	ISMT is not used to train this task

Scale 4: Live Fire Effectiveness

How effective is the live fire range in training the Marine to perform this task?

1	Not effective (The live fire range is used to train this task, but does not train the task effectively)
2	Slightly effective
3	Moderately effective
4	Highly effective
5	Extremely effective
NA	The live fire range is not used to train this task

Marksmanship Experience

1	Please list the weapon(s) which you train others to use (e.g., M-16 rifle, M9 pistol).	
2	How long have you been an M-16 rifleman? Please provide both the Year(s) and Month(s). Enter "0" if necessary.	
	Year(s):	
	Month(s):	
3	How long have you been training M-16 marksmanship? Please provide both the Year(s) and Month(s). Enter "0" if necessary.	
	Year(s):	
	Month(s):	
4	How long have you worked with ISMT? Please provide both the Year(s) and Month(s). Enter "0" if necessary.	
	Year(s):	
	Month(s):	
5	Other comments or notes that you would like to add:	

Marksmanship Survey

	Task Statement	Importance for Accuracy	Difficulty to Learn	ISMT Effectiveness	Live Fire Range Effectiveness	Additional Comments (Optional)
1	Establish the correct sight alignment.					
2	Establish the correct sight picture.					
3	Establish proper stock weld.					
4	Establish proper eye relief.					
5	Maintain sight alignment and sight picture.					
6	Fire at the appropriate point in the breath cycle.					
7	Establish the proper trigger grip.					
8	Establish the proper trigger finger placement.					
9	After firing, reset the trigger.					
10	Maintain proper uninterrupted trigger control.					
11	Maintain proper interrupted trigger control.					
12	Apply marksmanship fundamentals until the round exits the barrel of the rifle.					
13	Bring the rifle sights back on target for additional shots.					
14	Select and assume a firing position based on mobility, stability, and observation of the target.					
15	Don the loop sling.					
16	Use proper left hand position.					
17	Use proper placement of the rifle butt in the pocket of the shoulder.					

18	Use proper grasp on the pistol grip.					
19	Use proper positioning of the right elbow.					
20	Maintain firm and consistent placement of the cheek against the stock from shot to shot.					
21	Use skeletal structure to support rifle's weight when using the loop sling.					
22	Relax the muscles when using the loop sling.					
23	Adjust the body to achieve proper point of aim when using the loop sling.					
24	Assume the prone position					
25	Assume the sitting position					
26	Assume the kneeling position					
27	Assume the high kneeling position					
28	Assume the medium kneeling position					
29	Assume the low kneeling position					
30	Assume the standing position					
31	Use the front sight post to adjust for elevation.					
32	Use the rear sight elevation knob to adjust the sight for a specific range to the target.					
33	Use the windage knob to adjust the strike of the round right or left.					
34	Establish initial sight settings to serve as the starting point for initial zeroing and subsequent adjustments.					
35	Establish BZO.					
36	Rezero in order to compensate for the effects of wind, temperature, precipitation, and light.					

37	Shift point of aim or use offset aiming when conditions do not permit mechanical sight adjustment.					
38	If the strike of the round is known, aim the next shot an equal distance from center mass in the opposite direction to compensate.					
39	Use environmental features to support the weapon.					
40	Use unit of measure method to determine distance to the target.					
41	Use front sight post method to determine distance to the target.					
42	Use visible detail method to determine distance to the target.					
43	Use bracketing method to determine distance to the target.					
44	Use multiple methods to determine distance to the target.					
45	Use environmental cues to estimate wind direction, angle, and velocity.					
46	Use the angle between a flag and the flagpole in order to estimate wind velocity.					
47	Execute a controlled pair to a target.					
48	Engage targets while wearing field protective mask.					
49	Overall, how effective do you think ISMT is at training marksmanship tasks in general? Please click on the cell to the right and choose one option from the dropdown menu.					
50	Overall, how effective do you think the Live Fire Range is at training marksmanship tasks in general? Please click on the cell to the right and choose one option from the dropdown menu.					

Appendix B

Tertiary Tasks by Category

Category	Item #	Task Statement
Firing positions	14	Select and assume a firing position based on mobility, stability, and observation of the target
	24	Assume the prone position
	25	Assume the sitting position
	26	Assume the kneeling position
	27	Assume the high kneeling position
	28	Assume the medium kneeling position
	29	Assume the low kneeling position
	30	Assume the standing position
Weapons handling	15	Don the loop sling
	16	Use proper left hand position
	17	Use proper placement of the rifle butt in the pocket of the shoulder
	19	Use proper positioning of the right elbow
	20	Maintain firm and consistent placement of the cheek against the stock from shot to shot
	21	Use skeletal structure to support the rifle's weight when using the loop sling
	22	Relax the muscles when using the loop sling
	23	Adjust the body to achieve proper point of aim when using the loop sling
	39	Use environmental features to support the weapon
Aiming	1	Establish the correct sight alignment
	2	Establish the correct sight picture
	3	Establish proper stock weld
	4	Establish proper eye relief
	5	Maintain sight alignment and sight picture
	6	Fire at the appropriate point in the breath cycle
	12	Apply marksmanship fundamentals until the round exits the barrel of the rifle
	13	Bring the rifle sights back on target for additional shots
	37	Shift point of aim or use offset aiming when conditions do not permit mechanical sight adjustment
	38	If the strike of the round is known, aim the next shot an equal distance from center mass in the opposite direction to compensate
	47	Execute a controlled pair to a target
	48	Engage targets while wearing the field protective mask
Trigger control	7	Establish the proper trigger grip
	8	Establish the proper trigger finger placement

	9	After firing, reset the trigger
	10	Maintain proper uninterrupted trigger control
	11	Maintain proper interrupted trigger control
	18	Use proper grasp on the pistol grip
Ballistics	40	Use unit of measure method to determine distance to the target
	41	Use front sight post method to determine distance to the target
	42	Use visible detail method to determine distance to the target
	43	Use bracketing method to determine distance to the target
	44	Use multiple methods to determine distance to the target
Zeroing	31	Use the front sight post to adjust for elevation
	32	Use the rear sight elevation knob to adjust the sight for a specific range to the target
	33	Use the windage knob to adjust the strike of the round right or left
	34	Establish initial sight settings to serve as the starting point for initial zeroing and subsequent adjustments
	35	Establish BZO
	36	Rezero in order to compensate for the effects of wind, temperature, precipitation, and light
	45	Use environmental cues to estimate wind direction, angle, and velocity
	46	Use the angle between a flag and the flagpole in order to estimate wind velocity

Appendix C

r_{wg} and AD statistics for each item, by category
Shaded values not significant at the p = .05 level

		Importance			Difficulty to Learn			ISMT Effectiveness			KD Range Effectiveness		
Category	Item	*N*	r_{wg}	AD	*N*	r_{wg}	AD	*N*	r_{wg}	AD	*N*	r_{wg}	AD
Weapons Handling	Don the loop sling.	22	0.27	1.05	22	0.47	0.64	22	0.20	1.09	22	0.48	0.77
	Use proper left hand position.	22	0.68	0.64	22	0.49	0.82	22	0.68	0.45	22	0.74	0.64
	Use proper placement of the rifle butt in the pocket of the shoulder.	22	0.65	0.68	22	0.78	0.59	22	0.58	0.64	21	0.83	0.59
	Use proper positioning of the right elbow.	22	0.79	0.50	22	0.73	0.45	22	0.66	0.64	22	0.76	0.45
	Maintain firm and consistent placement of the cheek against the stock from shot to shot.	22	0.64	0.68	22	0.65	0.59	22	0.64	0.73	22	0.79	0.50
	Use skeletal structure to support rifle's weight when using the loop sling.	22	0.72	0.55	22	0.45	0.77	22	0.80	0.45	22	0.79	0.50
	Relax the muscles when using the loop sling.	22	0.72	0.59	22	0.49	0.73	22	0.57	0.59	22	0.79	0.41
	Adjust the body to achieve proper point of aim when using the loop sling.	22	0.78	0.59	22	0.64	0.73	22	0.61	0.73	22	0.79	0.50
	Use environmental features to support the weapon.	22	0.58	0.73	22	0.60	0.68	14	0.57	0.64	22	0.64	0.73
Firing Positions	Select and assume a firing position based on mobility, stability, and observation of the target.	22	0.79	0.50	22	0.60	0.59	16	0.28	1.00	22	0.68	0.45
	Assume the prone position	22	0.68	0.55	22	0.64	0.64	22	0.15	1.05	22	0.77	0.45
	Assume the sitting position	22	0.73	0.45	22	0.30	0.91	22	0.18	1.05	22	0.73	0.55

	Assume the kneeling position	22	0.68	0.55	22	0.27	0.95	22	0.19	0.95	22	0.77	0.50
	Assume the high kneeling position	22	0.69	0.64	22	0.35	0.91	22	0.15	1.05	22	0.83	0.41
	Assume the medium kneeling position	22	0.60	0.68	22	0.35	0.91	22	0.22	1.05	22	0.73	0.59
	Assume the low kneeling position	22	0.53	0.77	22	-0.07	1.27	22	0.18	1.05	22	0.59	0.64
	Assume the standing position	22	0.14	1.00	22	0.20	0.95	18	0.27	1.06	22	0.77	0.45
Aiming	Establish the correct sight alignment.	22	0.83	0.18	22	0.30	1.00	22	0.64	0.55	22	0.79	0.32
	Establish the correct sight picture.	22	0.92	0.18	22	0.67	0.45	22	0.56	0.64	22	0.90	0.27
	Establish proper stock weld.	22	0.48	0.82	22	0.57	0.82	22	0.51	0.77	22	0.72	0.59
	Establish proper eye relief.	22	0.77	0.50	22	0.72	0.41	22	0.34	0.86	22	0.69	0.59
	Maintain sight alignment and sight picture.	22	0.85	0.27	22	0.71	0.45	22	0.43	0.64	22	0.73	0.50
	Shift point of aim or use offset aiming when conditions do not permit mechanical sight adjustment.	22	0.54	0.41	22	0.32	0.95	19	0.52	0.84	22	0.94	0.14
	If the strike of the round is known, aim the next shot an equal distance from center mass in the opposite direction to compensate.	22	0.64	0.36	22	0.38	0.95	19	0.84	0.32	22	0.85	0.27
	Fire at the appropriate point in the breath cycle.	22	0.38	0.77	22	0.45	0.82	22	0.32	0.95	22	0.73	0.55
	Apply marksmanship fundamentals until the round exits the barrel of the rifle.	22	0.94	0.14	22	0.71	0.45	21	0.27	1.00	22	0.89	0.32
	Bring the rifle sights back on target for additional shots.	22	0.73	0.45	22	0.75	0.45	22	0.36	0.86	22	0.73	0.50
	Execute a controlled pair to a target.	20	0.76	0.50	22	0.45	0.82	19	0.22	1.00	22	0.74	0.32
	Engage targets while wearing field protective mask.	18	0.03	0.94	18	0.50	0.72	15	0.44	0.93	18	0.58	0.61

Trigger Control	Establish the proper trigger grip.	22	0.79	0.41	22	0.49	0.68	22	0.39	0.91	22	0.74	0.55
	Establish the proper trigger finger placement.	22	0.55	0.77	22	0.73	0.59	22	0.38	0.86	22	0.86	0.32
	After firing, reset the trigger.	22	0.64	0.64	22	0.44	0.77	22	0.44	0.73	22	0.46	0.68
	Maintain proper uninterrupted trigger control.	22	0.68	0.55	22	0.60	0.68	22	0.60	0.59	22	0.68	0.50
	Maintain proper interrupted trigger control.	22	0.01	1.18	22	0.57	0.77	22	0.54	0.77	22	0.67	0.68
	Use proper grasp on the pistol grip.	22	0.70	0.68	22	0.52	0.73	22	0.68	0.50	22	0.78	0.59
Ballistics	Use unit of measure method to determine distance to the target.	22	0.69	0.59	22	0.32	0.95	15	0.40	0.87	22	0.62	0.64
	Use front sight post method to determine distance to the target.	22	0.49	0.77	22	0.56	0.77	15	0.30	1.07	22	0.49	0.82
	Use visible detail method to determine distance to the target.	22	0.46	0.86	22	0.74	0.50	15	0.22	1.07	22	0.62	0.68
	Use bracketing method to determine distance to the target.	22	0.56	0.77	22	0.74	0.55	15	0.13	1.13	22	0.67	0.68
	Use multiple methods to determine distance to the target.	22	0.73	0.50	22	0.60	0.68	15	0.01	1.20	22	0.64	0.64
Zeroing	Use the front sight post to adjust for elevation.	22	0.78	0.41	22	0.51	0.77	16	0.54	0.75	22	0.68	0.55
	Use the rear sight elevation knob to adjust the sight for a specific range to the target.	22	0.79	0.32	22	0.39	0.91	16	0.65	0.44	22	0.83	0.41
	Use the windage knob to adjust the strike of the round right or left.	22	0.79	0.32	22	0.49	0.82	17	0.63	0.59	22	0.89	0.32
	Establish initial sight settings to serve as the starting point for initial zeroing and subsequent adjustments.	22	0.63	0.50	22	0.32	0.95	16	0.70	0.50	20	0.83	0.45

	Establish BZO.	22	0.96	0.09	22	0.39	0.91	17	0.38	0.94	21	0.87	0.19
	Rezero in order to compensate for the effects of wind, temperature, precipitation, and light.	21	0.33	0.67	21	0.50	0.67	17	0.38	0.88	20	0.78	0.57
	Use environmental cues to estimate wind direction, angle, and velocity.	22	0.68	0.45	22	0.35	0.82	14	-0.22	1.14	22	0.60	0.68
	Use the angle between a flag and the flagpole in order to estimate wind velocity.	21	0.72	0.77	21	0.42	1.05	13	-0.04	1.36	22	0.68	0.55
		N	r_{wg}	AD									
Overall Scores	Overall, how effective do you think ISMT is at training marksmanship tasks in general?	21	0.61	0.82									
	Overall, how effective do you think the Live Fire Range is at training marksmanship tasks in general?	21	0.92	0.41									

Shaded values are not significant at the p = .05 level.

Critical Values of the r_{wg} and AD statistics

N	r_{wg} (*a* = 0.05)	AD (*a* = 0.05)
3	≥ 1.00	≤ 0.00
4	≥ 1.00	≤ 0.00
5	≥ 0.85	≤ 0.40
6	≥ 0.72	≤ 0.56
7	≥ 0.67	≤ 0.61
8	≥ 0.61	≤ 0.69
9	≥ 0.57	≤ 0.72
10	≥ 0.53	≤ 0.74
11	≥ 0.47	≤ 0.79
12	≥ 0.44	≤ 0.82
13	≥ 0.43	≤ 0.83
14	≥ 0.41	≤ 0.85
15	≥ 0.40	≤ 0.87
16	≥ 0.38	≤ 0.88
17	≥ 0.37	≤ 0.89
18	≥ 0.35	≤ 0.91
19	≥ 0.34	≤ 0.91
20	≥ 0.33	≤ 0.92
25	≥ 0.30	≤ 0.96
30	≥ 0.27	≤ 0.98

Critical values are based on a 5-category rating scale

Appendix D

Items Ranked by Importance Rating

Importance Rank	Item #	Task Statement	Category	Mean
1	35	Establish BZO.	Zeroing	4.90
2	12	Apply marksmanship fundamentals until the round exits the barrel of the rifle.	Aiming	4.85
3	1	Establish the correct sight alignment.	Aiming	4.80
4	2	Establish the correct sight picture.	Aiming	4.80
5	5	Maintain sight alignment and sight picture.	Aiming	4.70
6	32	Use the rear sight elevation knob to adjust the sight for a specific range to the target.	Zeroing	4.65
7	33	Use the windage knob to adjust the strike of the round right or left.	Zeroing	4.65
8	38	If the strike of the round is known, aim the next shot an equal distance from center mass in the opposite direction to compensate.	Aiming	4.60
9	31	Use the front sight post to adjust for elevation.	Zeroing	4.55
10	37	Shift point of aim or use offset aiming when conditions do not permit mechanical sight adjustment.	Aiming	4.55
11	13	Bring the rifle sights back on target for additional shots.	Aiming	4.50
12	25	Assume the sitting position	Firing positions	4.50
13	45	Use environmental cues to estimate wind direction, angle, and velocity.	Zeroing	4.50
14	4	Establish proper eye relief.	Aiming	4.45
15	10	Maintain proper uninterrupted trigger control.	Trigger control	4.45
16	34	Establish initial sight settings to serve as the starting point for initial zeroing and subsequent adjustments.	Zeroing	4.45
17	44	Use multiple methods to determine distance to the target.	Ballistics	4.45
18	47	Execute a controlled pair to a target.	Aiming	4.44

19	24	Assume the prone position	Firing positions	4.40
20	26	Assume the kneeling position	Firing positions	4.40
21	46	Use the angle between a flag and the flagpole in order to estimate wind velocity.	Zeroing	4.37
22	23	Adjust the body to achieve proper point of aim when using the loop sling.	Weapons handling	4.35
23	9	After firing, reset the trigger.	Trigger control	4.30
24	27	Assume the high kneeling position	Firing positions	4.30
25	36	Rezero in order to compensate for the effects of wind, temperature, precipitation, and light.	Zeroing	4.26
26	14	Select and assume a firing position based on mobility, stability, and observation of the target.	Firing positions	4.25
27	17	Use proper placement of the rifle butt in the pocket of the shoulder.	Weapons handling	4.25
28	18	Use proper grasp on the pistol grip.	Trigger control	4.25
29	28	Assume the medium kneeling position	Firing positions	4.25
30	6	Fire at the appropriate point in the breath cycle.	Aiming	4.15
31	16	Use proper left hand position.	Weapons handling	4.15
32	22	Relax the muscles when using the loop sling.	Weapons handling	4.15
33	29	Assume the low kneeling position	Firing positions	4.15
34	7	Establish the proper trigger grip.	Trigger control	4.05
35	20	Maintain firm and consistent placement of the cheek against the stock from shot to shot.	Weapons handling	4.05
36	42	Use visible detail method to determine distance to the target.	Ballistics	4.05
37	43	Use bracketing method to determine distance to the target.	Ballistics	4.05
38	21	Use skeletal structure to support rifle's weight when using the loop sling.	Weapons handling	4.00
39	39	Use environmental features to support the weapon.	Weapons handling	4.00
40	40	Use unit of measure method to determine distance to the target.	Ballistics	3.95

41	48	Engage targets while wearing field protective mask.	Aiming	3.94
42	30	Assume the standing position	Firing positions	3.90
43	8	Establish the proper trigger finger placement.	Trigger control	3.85
44	3	Establish proper stock weld.	Aiming	3.80
45	11	Maintain proper interrupted trigger control.	Trigger control	3.80
46	15	Don the loop sling.	Weapons handling	3.75
47	19	Use proper positioning of the right elbow.	Weapons handling	3.65
48	41	Use front sight post method to determine distance to the target.	Ballistics	3.45

Appendix E

Items Ranked by Difficulty Rating

Difficulty Rank	Item #	Task Statement	Category	Mean
1	10	Maintain proper uninterrupted trigger control.	Trigger control	4.10
2	44	Use multiple methods to determine distance to the target.	Ballistics	4.10
3	48	Engage targets while wearing field protective mask.	Aiming	4.06
4	41	Use front sight post method to determine distance to the target.	Ballistics	3.80
5	37	Shift point of aim or use offset aiming when conditions do not permit mechanical sight adjustment.	Aiming	3.75
6	40	Use unit of measure method to determine distance to the target.	Ballistics	3.75
7	12	Apply marksmanship fundamentals until the round exits the barrel of the rifle.	Aiming	3.70
8	5	Maintain sight alignment and sight picture.	Aiming	3.70
9	38	If the strike of the round is known, aim the next shot an equal distance from center mass in the opposite direction to compensate.	Aiming	3.65
10	45	Use environmental cues to estimate wind direction, angle, and velocity.	Zeroing	3.65
11	42	Use visible detail method to determine distance to the target.	Ballistics	3.65
12	43	Use bracketing method to determine distance to the target.	Ballistics	3.60
13	30	Assume the standing position	Firing positions	3.50
14	46	Use the angle between a flag and the flagpole in order to estimate wind velocity.	Zeroing	3.47
15	11	Maintain proper interrupted trigger control.	Trigger control	3.35
16	23	Adjust the body to achieve proper point of aim when using the loop sling.	Weapons handling	3.30
17	6	Fire at the appropriate point in the breath cycle.	Aiming	3.30
18	35	Establish BZO.	Zeroing	3.20

19	22	Relax the muscles when using the loop sling.	Weapons handling	3.05
20	2	Establish the correct sight picture.	Aiming	3.00
21	36	Rezero in order to compensate for the effects of wind, temperature, precipitation, and light.	Zeroing	3.00
22	14	Select and assume a firing position based on mobility, stability, and observation of the target.	Firing positions	2.95
23	21	Use skeletal structure to support rifle's weight when using the loop sling.	Weapons handling	2.95
24	18	Use proper grasp on the pistol grip.	Trigger control	2.90
25	31	Use the front sight post to adjust for elevation.	Zeroing	2.80
26	29	Assume the low kneeling position	Firing positions	2.80
27	4	Establish proper eye relief.	Aiming	2.75
28	34	Establish initial sight settings to serve as the starting point for initial zeroing and subsequent adjustments.	Zeroing	2.75
29	13	Bring the rifle sights back on target for additional shots.	Aiming	2.70
30	26	Assume the kneeling position	Firing positions	2.70
31	39	Use environmental features to support the weapon.	Weapons handling	2.65
32	1	Establish the correct sight alignment.	Aiming	2.60
33	9	After firing, reset the trigger.	Trigger control	2.60
34	28	Assume the medium kneeling position	Firing positions	2.60
35	16	Use proper left hand position.	Weapons handling	2.55
36	27	Assume the high kneeling position	Firing positions	2.50
37	32	Use the rear sight elevation knob to adjust the sight for a specific range to the target.	Zeroing	2.45
38	33	Use the windage knob to adjust the strike of the round right or left.	Zeroing	2.40
39	47	Execute a controlled pair to a target.	Aiming	2.40

40	17	Use proper placement of the rifle butt in the pocket of the shoulder.	Weapons handling	2.35
41	7	Establish the proper trigger grip.	Trigger control	2.35
42	20	Maintain firm and consistent placement of the cheek against the stock from shot to shot.	Weapons handling	2.35
43	8	Establish the proper trigger finger placement.	Trigger control	2.35
44	25	Assume the sitting position	Firing positions	2.30
45	19	Use proper positioning of the right elbow.	Weapons handling	2.20
46	15	Don the loop sling.	Weapons handling	2.10
47	3	Establish proper stock weld.	Aiming	2.05
48	24	Assume the prone position	Firing positions	1.90

Appendix F

Open-ended comments from the demographics questionnaire and survey

Item	Task Statement	Comment	SME
NA	(Demographics)	I like to shoot	4
NA	(Demographics)	ISMT is helpful and can help anyone that uses this	5
NA	(Demographics)	We must teach; "perfect practice makes perfect" and not "practice makes perfect"	7
1	Establish the correct sight alignment.	Lots of shooters make mistakes with this on RCO (Rifle Combat Optic)	16
		Diagrams for the coachs (sic) to keep on them to show proper aiming would greatly help	22
2	Establish the correct sight picture.	Once again the diagrams would greatly help	22
4	Establish proper eye relief.	Another problem area for many shooters	16
13	Bring the rifle sights back on target for additional shots.	ISMT doesn’t offer realistic recoil	22
24	Assume the prone position	Very important in combat scenarios	16
30	Assume the standing position	We still can not do the standing in the ISMT	22
48	Engage targets while wearing field protective mask.	I have never done this so I can not make an informed decision	22