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A Multi-Platform Application to Facilitate Combat Vehicle Identification Training

by Christine Lou, Kyle Lui, Enya Xing, and Benjamin T Files

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A Multi-Platform Application to Facilitate Combat Vehicle Identification Training

Christine Lou, Kyle Lui, and Enya Xing
University of California Berkeley

Benjamin T Files
Human Research and Engineering Directorate, CCDC Army Research Laboratory

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14. ABSTRACT The need to improve combat identification (CID) is recognized throughout the Army, as it is extremely important for Soldiers to quickly ID vehicles on the battlefield. The Army has created curricula and applications to teach CID, with emphasis on direct image to name correspondence practice. Rather than image to name correspondence, our focus is to improve CID through friendly and enemy distinctions while simultaneously using personalized feedback frameworks based on the user’s regulatory focus. Gamified approaches and custom feedback frameworks lead to potential benefits in practice and training through a more engaging experience. However, the amount of benefit generated is not always consistent. Just as individuals have different preferences for games and game elements, gamified training may require different combinations of elements to optimize outcomes for each learner. More specifically, prior research indicates that the type of feedback framework (gaining points, losing points, or no points) can greatly impact performance. The target audience for our project are all Soldiers requiring practice with CID. Thus, we have built a student platform where games can be played as well as an instructor platform to track student progress. Other features that we have developed include profile pages, assignment customization, performance trends visualizations, and summary statistics. We have currently built an iOS application using XCode and SwiftUI. We are now expanding to a web application using HTML, CSS, and ReactJS. A cross-platform application allows for additional accessibility and convenience for an effective training experience.					
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1. Introduction

The need to improve combat identification (CID) is recognized throughout the Army, as it is extremely important for Soldiers to quickly identify vehicles on the battlefield.¹ A key motivator to improve CID performance is to reduce fratricide: In Operations Desert Shield and Desert Storm, 80% of destroyed US M1 Abrams tanks and Bradley Fighting Vehicles were destroyed by US forces.² CID will only become more important and more difficult in the complex battlefield of the future. Novel training technologies are being developed and evaluated to improve speed and accuracy of CID,³ including the use of game-like elements to maintain engagement and focus during training (i.e., gamification) and adapting training to individual differences.

The process of CID is not one task or decision, but encompasses several different decisions with different purposes. One model identifies four decisions that constitute CID: Detection determines whether a battlefield object is or is not present; Identification determines if the object is friend or foe; Classification determines what the battlefield object is; and Action determines the correct course of action.⁴ Each of these decision points could be enhanced with training or practice. Classification (i.e., matching data about a vehicle to its name and characteristics) is critical for assessing and communicating capabilities and vulnerabilities of enemy formations. Here, we focus on the friend-or-foe identification as a critical step in reducing fratricide as a complement to existing training applications.

One such application is EquipID, a training application developed by US Army Training and Doctrine Command, where users are prompted with either an image of a vehicle or the specifications of a vehicle and are asked to select the corresponding vehicle name. We have designed and developed a multi-platform application that may supplement an application such as EquipID by facilitating practicing making vehicle identification judgments quickly and accurately. Our application uses an individualized, gamified approach to make training engaging. In general, adding game-like elements to training applications is only moderately successful, with gains in some learners offset by losses in others.⁵ Here we apply basic research findings from a similar context (a non-vehicle threat/non-threat task) that shows the effectiveness of providing feedback in terms of point gains, point losses, or without points varies according to an individual differences measure called Regulatory Focus.⁶ By applying this finding to individualize the use of game-like feedback, we hope to capture the upsides of gamification for some users without incurring the downsides for others.

The friend or foe identification judgement can be considered in the framework of signal detection theory,⁷ in which the person making a judgment can be considered to have a sensitivity (i.e., how effectively they gather and use available evidence) and bias (i.e., the relative amount of evidence they require for friend and foe judgements, respectively). Tactical situations induce a strong bias toward foe judgements, both because enemies are expected and because of the consequences of failing to identify a foe.^{2,8} Successfully responding quickly and accurately to a foe while also maintaining the capability to override the pre-potent foe judgment when faced with a friend requires a type of executive function called inhibitory control.⁹ Inhibitory control training has been shown to be effective in reducing critical shooting errors in both simulation¹⁰ and live-fire exercises.¹¹ In addition to a balanced friend or foe judgment training mode, the application we developed includes an imbalanced go/no-go mode, which induces a bias toward foe judgments and trains inhibitory control in a CID context.

In this technical report, we describe the training software, detailing the features of the iOS application and the web application, including both the student and instructor views. We also describe possible directions for further development to add additional features and functionality to the iOS platform, web platform, and other platforms. This source code is thoroughly documented with setup instructions and is publicly available at <https://github.com/enyaxing/arl-gamified-training> (iOS) and <https://github.com/enyaxing/arl-gamified-training-web> (web).

2. iOS Platform

Our iOS platform includes features integral to the training experience of both trainers and trainees. From the home page, students access the questionnaire, training sessions, and tutorials, as well as their personal profiles and settings (Fig. 1). Other functions include the ability to sign out, select feedback framing, change settings, and view profile. In the future, feedback framing may not be selectable, but it is currently selectable for demonstration purposes. Instructors (Fig. 2), on the other hand, have the option to divide students into classes and create personalized assignments for a group of students. Currently, all training sessions are expected to be completed individually. However, we also see value in including a teaming system in the future that would allow multiple users to collaborate and complete training sessions and make judgments as a group. Possible implementations could include a multiplayer option where one user could create a room and have others join by room code. They could then team up face-to-face and complete a joint session.

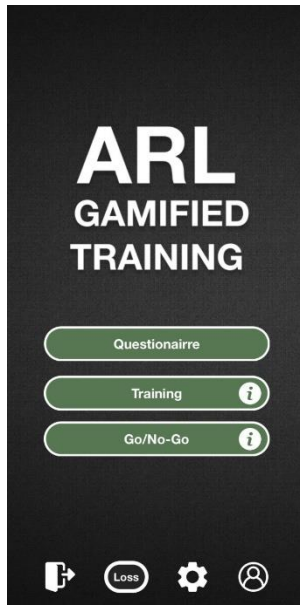


Fig. 1 Student home page: the info icon accesses a tutorial for your format of choice. From bottom left to bottom right, the icons represent sign-out, feedback framing, settings, and profile. Note: ARL Gamified Training is a placeholder name.

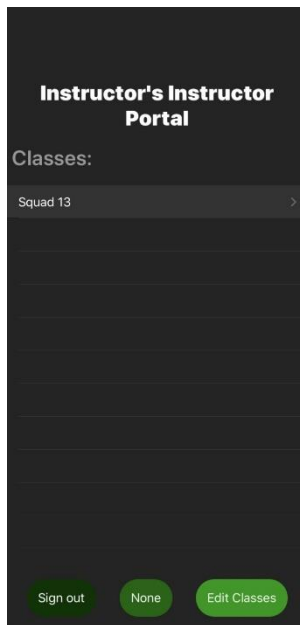


Fig. 2 Instructor home page: from bottom left to bottom right, instructors may sign out and edit how many classes they have

2.1 Questionnaire

When students first enter the app (Fig. 3), they must first take the regulatory focus questionnaire.¹² There are 11 questions that students can answer on a five-point Likert scale to determine their promotion and prevention scores. These scores are used to select the feedback framing using a model derived from previous work.⁶

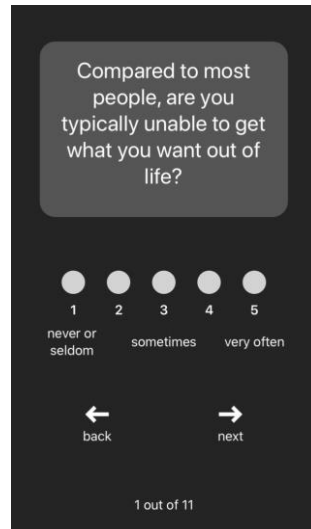


Fig. 3 Questionnaire: students select an option from a scale of one to five pertaining to each question

2.2 Settings

The primary function of the settings view is to create and modify practice assignments. Students may select which vehicles to classify as friendly/enemy in a training session (Fig. 4). Instructors may specifically create and save assignments, in which they can select which vehicles to classify as friendly/enemy and assign the task to a specific class.

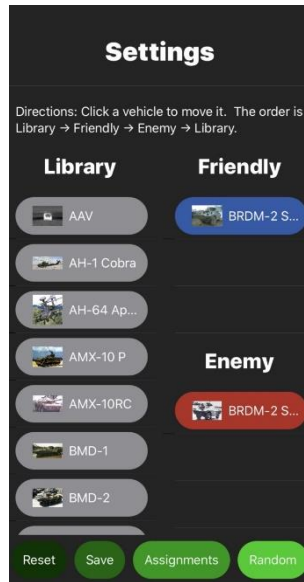


Fig. 4 Settings: users must click and drag a vehicle from the library to either friendly or enemy

The reset button resets to the default assignment, the save button saves the current assignment, the random button generates a random assignment, and the assignments button lists specific assignments created by the instructor. Future work will enable automated assignment generation based on vehicle category and target difficulty.

The assignment creation tool includes names and an example image of the vehicle. In the training session, multiple images of the vehicle will be used, including from multiple viewpoints, with the vehicle in multiple situations (traveling, still, etc.), and using multiple viewing formats (day optics, thermal imaging, etc.). Currently, the software randomly selects an image of the given vehicle, but future development could allow a subset of image types to be selected at assignment creation (e.g., only show frontal images of the vehicle in motion).

Future development could also include an enhanced tagged image library that includes a greater variety of vehicle photos than what is currently available. Detailed image tags could provide valuable insight as to what types of images or vehicles students struggle with most (e.g., thermal images or night vision images). This could then be utilized by an instructor to pinpoint gaps in knowledge that they could then address through a unit review and further instruction.

2.3 Training

There are two formats for training sessions: forced choice and go/no-go (Fig. 5). The forced choice format allows users two options (friendly/enemy) when an image

of a vehicle appears. The session will not proceed unless the user responds to the current image. The go/no-go format allows users only one option (enemy) when an image appears. If the user does not respond within 3 s, the app assumes the user has selected to identify the vehicle as friendly. The session then proceeds to the next question. There are also three feedback frames that users can choose to play in: gain, loss, or neutral. In the gain frame, students are awarded points for correct answers. In the loss frame, students are penalized points for incorrect answers. In the neutral frame, students do not receive any points for their responses. The total points accumulated for each question are broken down into time and accuracy points in a 50/50 split. Accuracy points are accumulated from correctness, while time points are accumulated when the response time by the user is below certain thresholds. Students receive feedback for their performance in both accuracy and time (Fig. 6).

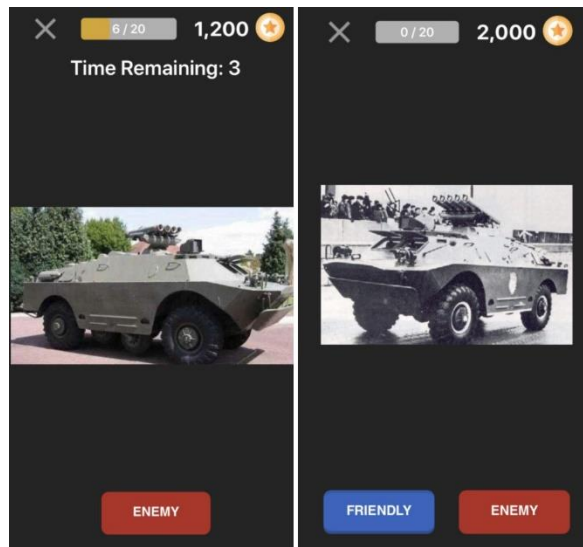


Fig. 5 Training sessions: from left to right, go/no-go and forced choice

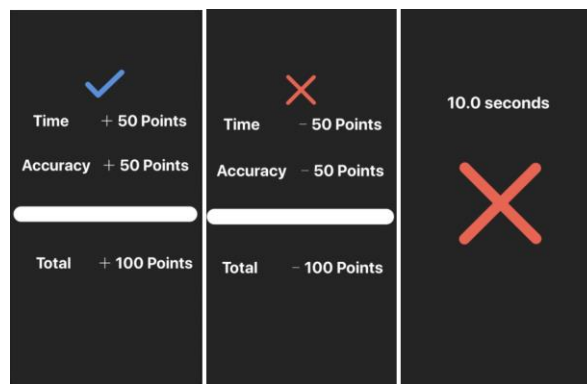


Fig. 6 Frame feedback: from left to right, gain, loss, and neutral frame feedback

Feedback performance can be improved with an intelligent tutor consisting of a machine learning algorithm that could automatically analyze student performance and generate appropriate assignments. The intelligent tutor would be able to design nontrivial assignments (i.e., not distinguishing a helicopter from a tank) with real world application.

2.4 Tutorial

Students also have the option of going through an interactive tutorial training session in the format of their choice. In the tutorial, we introduce all the features the user sees in their selected style of training session. The tutorial is accessed from the home page.

2.5 Session Summary

After each training session, students have the opportunity to further analyze their responses to questions (Fig. 7). Students are able to see how many questions they got right and wrong, their response to each question, and the actual identification of each vehicle. There is also an option to view a 3-D model of the vehicle, either in an augmented reality or on a virtual background (Fig. 8). Currently only a few vehicles have this option, but additional models could easily be added. Future development would also include links to other instructional materials about the vehicle, including identification cues and capabilities.

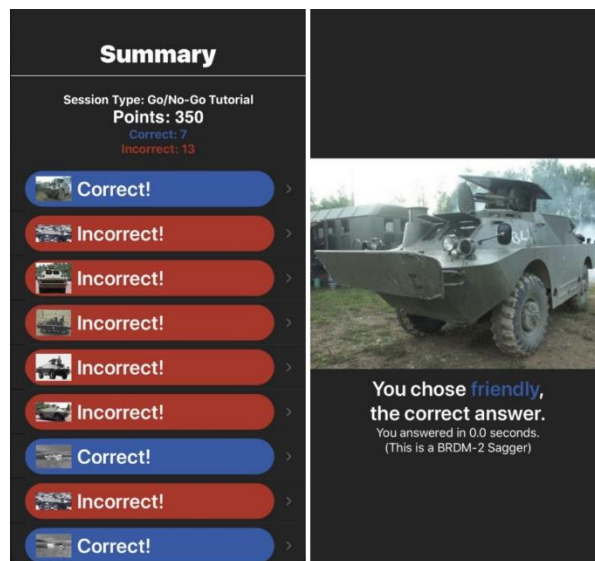


Fig. 7 Summary: from left to right, session summary and further session summary details

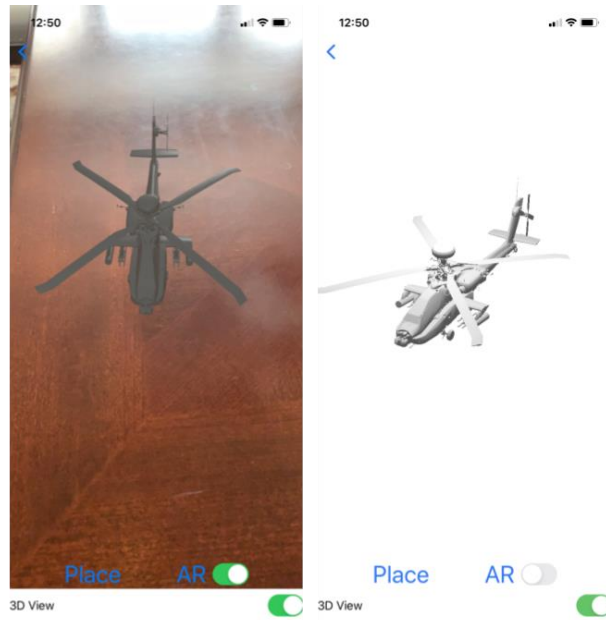


Fig. 8 Summary: from left to right, 3-D model of an AH-64 Apache displayed in augmented reality and the same AH-64 Apache displayed in a 3-D view

2.6 Student Profile

From the home page, students may access their individual profiles (Fig. 9). Features include overall performance statistics, such as average response time and sessions completed, as well as a record of all previous sessions they have completed. Students also have the option to review their performances on previous training sessions.



Fig. 9 Student profile: students may select “details” or a previous session if they would like more information about their performance

2.7 Instructor Profile

Instructors have additional capabilities to allow them to manage their trainees' assignments and monitor their progress. Instructors may add and remove students into individual classes and view any student's profile. They also have the option of creating assignments for classes (Fig. 10), in which they can choose certain vehicles to be a part of the training session and assign performance thresholds for students.



Fig. 10 Assignment details: from top to bottom, assignment name, performance requirements, and settings

3. Web Platform

The web counterpart to our app includes the recreation of several key iOS features to provide cross-platform accessibility. The web application is composed of an instructor web portal, a student web portal, and a data visualization aspect.

3.1 Instructor Web Portal

The first page of the web application is the login page. From there, an instructor can log in to their portal and access all of their classes and manage students in each class. They can view all student statistics including sessions trained, total minutes trained, average response time, and average vehicle accuracy (Fig. 11). Instructors can add students either individually or through a csv file for multiple additions. They can also create assignments and select friendly and enemy vehicles, as well as set goals for accuracy and time through a dialog box (Fig. 12).

Name	Focus	Accuracy (%)	Average Response Time (s)	Total Sessions (#)	Total Time	Edit Students
Jane Smith	neutral	76.00	1.17	34	00:47:22	Remove
John Smith	prevention	71.00	0.23	1	00:00:36	Remove

[Add Student](#)
[Add Multiple Students](#)

Fig. 11 Student tracker: Instructors may view student statistics as well as remove or add students

Assignment Name	Description	Date Assigned	Date Due	Friendly Vehicles	Enemy Vehicles	Friendly Accuracy (%)	Enemy Accuracy (%)	Time Requirement (s)
Helicopter Recognition		-	-	AH-1 Cobra Mi24 Hind-D	BMD-3 AH-64 Apache SA-342 Gazelle	90	95	90
Tank Recognition	Recognize similar looking tanks	-	-	BMD-1 BMP-1 FV-103 Spartan	BMD-3 BMP-3 Leclerc	90	85	100
name	description	-	-	CH-47 Chinook BTR-80	AAV AH-1 Cobra	90	90	100

[Create Assignment](#)

Fig. 12 Assignments: instructors may view previous assignment details as well as create new assignments

3.2 Student Web Portal

Our student portal currently shows student statistics along with the regulatory focus questionnaire. Students are able to view past training sessions with date of completion, type of training, and points earned. From there, they can view a more detailed summary of each training session and they can view whether they made the correct identification, a vehicle image, and their response time for the specific vehicle. Under profile, students can also view specific statistics for each vehicle and any relevant tagged vehicles. For example, they can see all past vehicles they have encountered in training, along with the corresponding accuracy rate and response time. They can also view accuracy rate and response time for specific vehicles.

3.3 Data Visualization

Our data visualization portion allows instructors to see class averages and individuals in relation to the average on a line plot over time. Visualization currently allows two metrics: average response time and average accuracy rate. A bold red

line on the plot displays the average and fainter gray lines represent individual student performance. Future development will bring more features that would not render well on a small mobile device. This includes more detailed trend graphs depicting performance over time, as well as allowing the instructor to change the time frame displayed. Visualization could also be enhanced by depicting specific student performance over time, assignment progress over time, and specific vehicle/tag performance over time. Furthermore, similar trend graphs can be offered on the student side of the web platform so that students are aware of their progress over time. By offering a wider variety and flexibility to trend graphs, instructors and students will be better able to focus their practice and use of the application.

4. Future Development

In addition to expanding on the features offered by the iOS and web platforms, we also envision expanding to other platforms. For example, the application could expand to Android OS, offering all the features available by the iOS platform. The application could also include an offline mode. The offline mode would not require the user to sign in and authenticate through Firebase, nor would it require a stable internet connection. Instead, it would offer a limited version of the application that still allowed the user to practice using the same library of images. Ideally, session data would be stored locally in the device until a stable internet connection is reached, at which point the application would be able to upload all saved data to the Firestore database.

Furthermore, it would be necessary to conduct user studies and user tests on the application. Such testing would ascertain which features of our application actually have a significant positive impact on combat vehicle identification performance.¹ The studies could also suggest more features that should be implemented in the application.

5. Conclusion

Identifying combat vehicles quickly and accurately is a critical skill of all Soldiers. We believe our multi-platform application will facilitate practicing how to make such distinctions by using an expansive library of vehicle images under a wide variety of environmental conditions. Through custom tailored reward framing based on the user's regulatory focus, we hope to optimize performance and growth while utilizing this application.

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List of Symbols, Abbreviations, and Acronyms

3-D	three-dimensional
ARL	Army Research Laboratory
ARL-West	Army Research Laboratory West
CCDC	US Army Combat Capabilities Development Command
CID	combat identification
NSIN	National Security Innovation Network
OS	operating system

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