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KINESTHETIC LEARNING EXPERIENCE SIMULATION USING AN ONLINE INTERVENTION TO IMPROVE HANDS-ON ABILITY

David Leach
Michigan Technological University, dleach@mtu.edu

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By

David C. Leach

A REPORT

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This report has been approved in partial fulfillment of the requirements for the Degree of MASTER OF SCIENCE in Mechanical Engineering.

Department of Mechanical Engineering – Engineering Mechanics

Report Advisor:	*Dr. Michele Miller*
Committee Member:	*Dr. Nancy Barr*
Committee Member:	*Dr. John Irwin*
Department Chair:	*Dr. William Predebon*

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Abstract

Students enrolled in mechanical and manufacturing engineering programs employ differing levels of mechanical aptitude and practical hands-on ability. Many students lack practical experience tinkering with mechanical devices and mechanisms prior to entering their post-secondary years. Student attention spans in traditional classroom environments appear to be decreasing with the ever-increasing addiction to immediate gratification provided by electronic devices, gaming software, and social media platforms. The question is then raised whether or not modern engineering students have the ability to improve mechanical aptitude by simulating a kinesthetic or tactile learning experience through an online tutorial. This project describes the development and testing of an online tutorial using the operation and safety mechanisms of a GLOCK semi-automatic handgun as the training medium. Handgun knowledge, mechanical aptitude, handgun confidence, and implicit beliefs about mechanical aptitude are addressed. Sixteen mechanical engineering and four manufacturing engineering technology undergraduates of Lake Superior State University completed the tutorial in the spring semester of 2018. The study produced positive results, that it may be possible for an online virtual activity to increase the mechanical aptitude of the participant.

1 Introduction

Mechanical engineering (ME) students today are expected to have a certain level of hands-on ability. In 2008, the ASME Center for Education formed a task force entitled ASME Vision 2030, to gather input from industry and academia about the strengths and weaknesses of mechanical engineering graduates. According to this survey, “Practical Experience – how things are made/work”, was the most frequent weakness noted by industry supervisors [1]. Though these skills are inherently required by industry, ME students exhibit differing levels of hands-on ability, mechanical aptitude, and practical experience. A well-rounded ME curriculum provides students with ample opportunity to improve hands-on skills, while gaining some level of hands-on aptitude as they participate in laboratory exercises, projects, and multi-disciplinary teams. Team dynamics have shown that the practical-focused students take on a hands-on role (CAD, fabrication, testing), while the more theoretical-focused students may take on the theoretical aspects of a student project (engineering calculations, programming, planning).

Computer simulation has become a useful tool in presenting real-life situations to students while removing some of the stigma and environmental concerns of actual environments.

1.1 Confidence

In courses, labs, and project work it can be implied that students who lack confidence in their hands-on ability also lack confidence when preparing for a career in mechanical engineering. In a manufacturing processes lab course at Lake Superior State University, anecdotal evidence shows that up to 3% of enrolled students decide to change majors due to just one bad experience in a mechanical lab project. How can we prevent this from happening? Is there a tool we could use to help improve hands-on ability, while providing a safe environment? This paper describes the development of a computer-based learning intervention, to identify learning experiences that can improve student hands-on ability, while improving confidence in that ability.

1.2 Prior experience

Students who exhibit higher levels of hands-on ability generally have had prior experience, which strengthens these skills over time. Hands-on mechanical experience is often garnered by spending time in a family machine shop or farm, repairing motorized vehicles or boats, taking mechanical devices apart (toys, bicycles, mechanisms), involvement in student or civic projects (robotics team or building projects), or working for a company performing hands-on tasks – to name a few. The role of prior experience in hands-on ability has been investigated. One of the findings was a direct correlation between target shooting and mechanical aptitude test score [2]. Students who participated in routine target shooting often scored higher in mechanical aptitude tests than students who have not had shooting experience. One reason for this could be that safe gun usage requires careful maintenance and knowledge of the weapon's mechanical mechanisms and function. Based on this assertion, an online tutorial was developed which considers the GLOCK semi-automatic pistol mechanism as the main training medium, while presenting a pre-test, a training intervention with the GLOCK, and a post-test.

2 Project scope and goal

Digital workstation simulation of mechanical mechanisms is a relatively new teaching tool. Simulation of the dynamics of mechanisms used in engineering technology curricula is presently a new concept rarely studied and there is a lack of understanding of how such simulations can be used most effectively in engineering and in education [2].

The scope of this project was to improve an existing online intervention to improve hands-on ability study performed at Michigan Technological University in spring 2015, under the lead of Dr. Michele Miller. The original project was supported in part by the National Science Foundation under Grant No. EEC-0835987. The previous work produced statistically insignificant results, therefore warranting improvements to the intervention methods while asking the question if a virtual experience can produce gains in mechanical aptitude. The original project focused on the expected correlation between student experience in shooting sports and mechanical aptitude. The tutorial focused on the mechanical mechanisms of the GLOCK semi-automatic pistol. Improvements to the online intervention included changing the visual appeal and structure of the tutorial pages, adding relevant pictures and additional instructional videos, and refining the quiz questions to improve student learning and engagement. Administering the new project to a group of engineering students, we expected the following outcomes:

- Improvements in handgun confidence, pre and post-test
- Improvements in mechanical aptitude test performance
- Identifying statistically relevant positive correlation between data sets
- Evidence of student learning in the area of GLOCK operation
- Determining next steps for additional research in virtual tutorials

3 Methods & materials

For a representative study group, undergraduate engineering students from Lake Superior State University in Sault Ste. Marie, MI participated in the effect of an online intervention activity. Study groups include freshman students in EGME141 Solid Modeling, and sophomore, junior, and senior students from EGME240 Assembly Modeling and GD&T. Demographics are noted in Section 4.

3.1 Guided Track interactive web-based software

The online intervention is a web-based software program created and maintained by Guided Track (https://www.guidedtrack.com/), and allows user-defined programming for interactive training, surveys, quizzes, and other web applications. Invited users had access to a custom internet address through the use of a computer, smart phone, tablet, or other internet-connected device. For this project, students were given a direct web-link to the intervention and their input data was recorded in an excel-based file and analyzed by the administrator to determine variables such as overall statistical improvements from pre to post intervention questions, confidence, implicit beliefs index, and completion time. Additionally, data was analyzed to determine correlation between the following variables:

- Confident about gun knowledge
- Gun knowledge
- Gun ownership
- Gun use frequency
- Glock use frequency
- Gun disassembly experience

- Video pre-test score
- Video post-test score
- Mechanical aptitude implicit beliefs
- Mechanical aptitude test scores, pre and post intervention
- Pre to post change in mechanical aptitude test

3.2 Tutorial stages

Figure 2-1 shows the outline of the intervention stages of the online tutorial. The tutorial is organized into three stages: pre-test, intervention, and post-test. The pre-test records preliminary user data based on a series of questions, which can be analyzed and correlated after completion of the intervention and post-test.

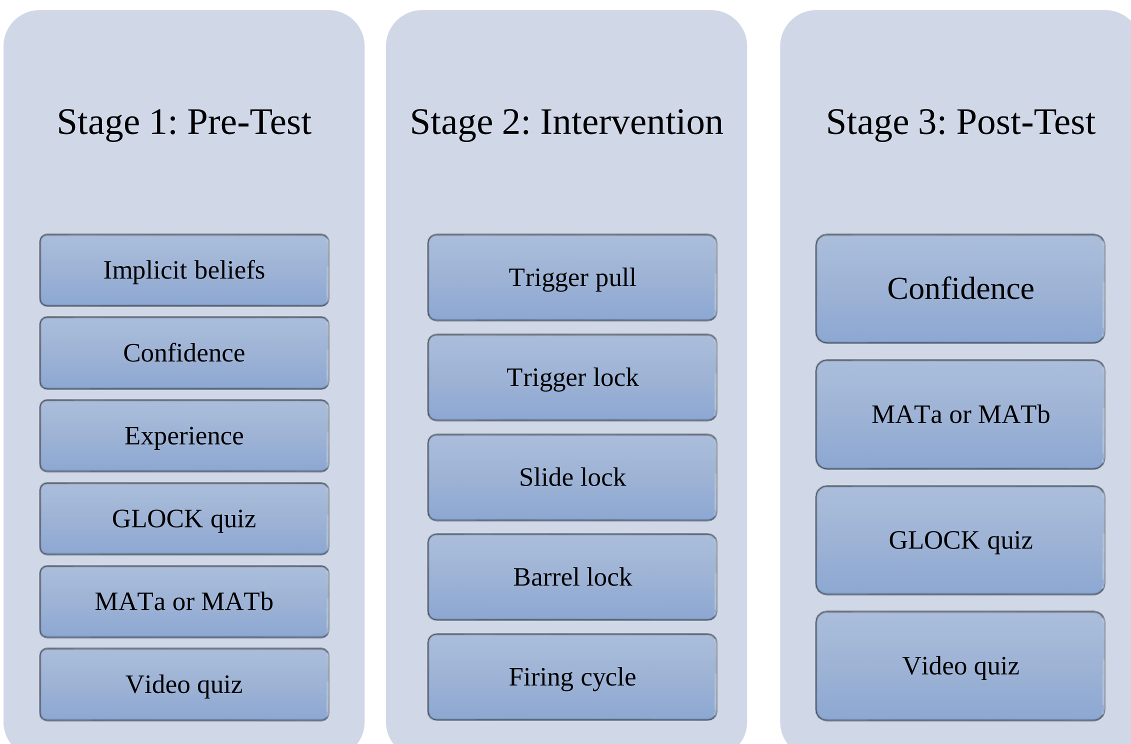

Figure 1: Tutorial stages

3.2.1 Stage 1: Pre-test

Stage 1 identified implicit beliefs of mechanical aptitude and used several similar questions to determine whether or not the person taking the test believes that mechanical aptitude is changeable. Correlation between this implicit belief and the development or improvement of mechanical aptitude is a key measurable. Additional questions in Stage 1 addressed user confidence in answering questions about guns, firearm experience, and knowledge of gun parts. A short mechanical aptitude test was then given as a form of a pre-test and was randomly chosen between Test A and Test B. The mechanical aptitude test consists of eight questions from an Armed Services Vocational Aptitude Battery (ASVAB) mechanical comprehension practice exam [3]; it is divided into two, four-question tests (an A and B test). At random, some students were administered the A test for the pre-test; and some the B test. The students were then given the next version of the test for the post-test. After the first mechanical aptitude test is taken, the students answered some questions about the operation of a GLOCK semi-automatic pistol. The question topics for the mechanical aptitude tests are shown in Figure 2.

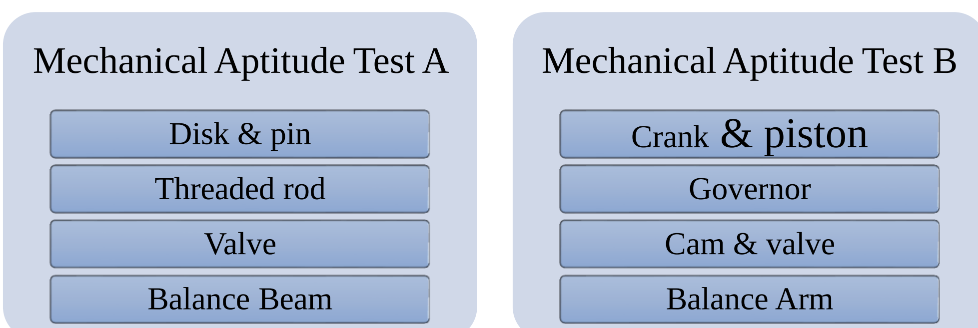

Figure 2: Mechanical Aptitude Tests A and B

3.2.2 Stage 2: Intervention

Stage 2 contained the online intervention: a collection of custom and existing online training aids, instructions, pictures, and video to guide students toward understanding the GLOCK safety and firing mechanisms. One of the main goals of the online tutorial was to teach the students about the inner-workings of a GLOCK while measuring its effect on mechanical aptitude test performance.

3.2.3 Stage 3: Post-test

Stage 3 is a post-test phase which was used to gather information to determine if the online intervention assisted in the learning process, while increasing a student's propensity for mechanical aptitude. A post-intervention gun confidence question was asked again, as well as the administering of mechanical aptitude Test A or B, depending on the user taking the A or B test during Stage 1. Final questions regarding the operation of a GLOCK were then presented, along with a video post-test. Some of the questions were the same as the pre-test, with additional video questions that focused on items taught during the tutorial/intervention stage.

4 Data collection and discussion of results

Sixteen mechanical engineering undergraduates and four manufacturing engineering technology undergraduates completed the online kinesthetic learning simulation (tutorial) during spring semester of 2018, as an extra credit assignment in a solid modeling and an advanced assembly modeling course. The study group included nine freshmen, six sophomores, two juniors, and two seniors. There were two female students and eighteen male students.

4.1 Tutorial duration

On average, students spent 58 minutes to complete the online tutorial. Figure 3-1 summarizes the tutorial completion times. Thirty to sixty minutes was the target completion time. The participants were selected from two courses and represent each class standing. The tutorial was completed outside of a scheduled class time, given the importance of hearing the videos, over a three day period. One student spent 250 minutes, while 2 others spent over 1000 minutes, with all three data points removed from the duration average. This is due to the non-classroom environment component and walking away from the tutorial and returning to it based on convenience. Students did not complain that the online intervention was too long, but rather, they expressed satisfaction of the experience. It was expected that students would lose interest after 20 to 30 minutes. This may prove that students are engaged when viewing topics that are of interest to them. For this project, key aspects were discussed ahead of time, without details, to increase the level of student interest. This proved to be an effective approach to generate interest and empathy toward the project. If you can show the glimpse of what is next to come than that also enables students to think about it [4].

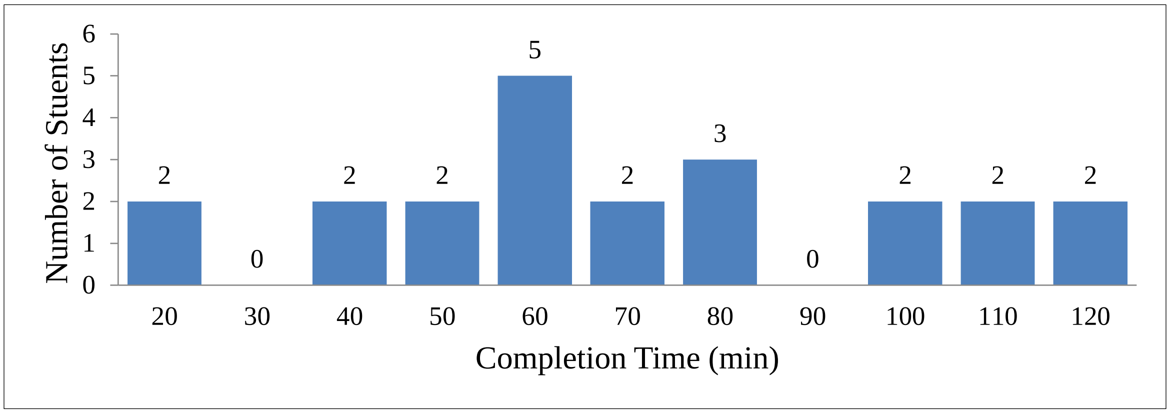

Figure 3: Completion Time

4.2 Implicit beliefs index of mechanical aptitude

The online tutorial opened with a self-assessment of mechanical aptitude. The first eight questions measured the implicit belief of whether or not the test subject believes their own mechanical aptitude can be changed or improved. The eight questions produced an average implicit belief index number, between 1 (not very true of me) and 7 (very true of me). The goal was to determine correlation between implicit belief—whether or not the student believes that learning is possible—and improvement of mechanical aptitude. A summary of the implicit belief index for 20 participants is shown in Figure 3-2. The distribution is concentrated near the confidence level mean of 4.21, with a high majority of students across the higher part of the range, with some students lacking confidence that their mechanical aptitude can be improved, while others displaying a higher level of belief in their mechanical aptitude improvement potential.

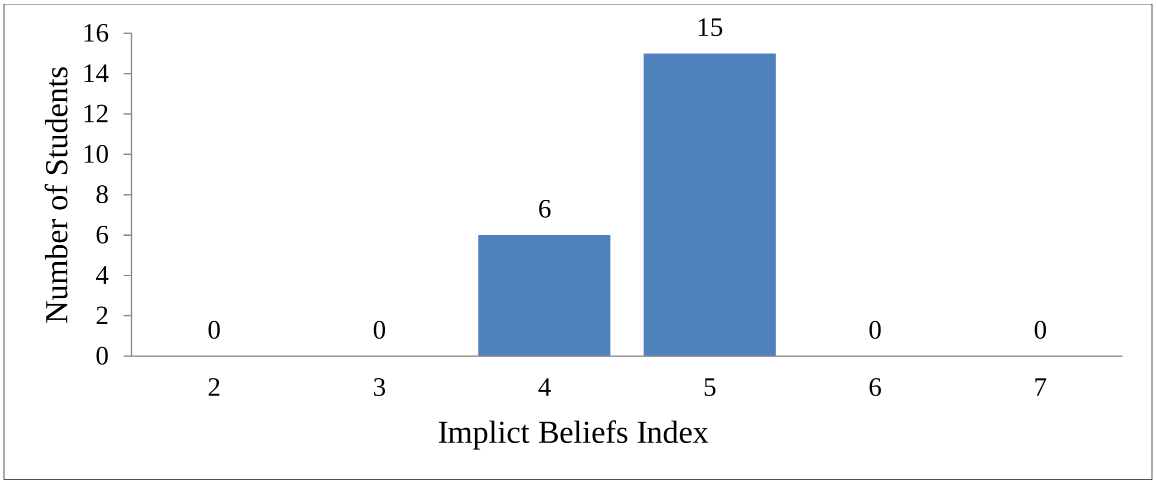

Figure 4: Implicit Beliefs Index

Using anecdotal evidence supported while teaching EGME110 Manufacturing Processes Lab at Lake Superior State University, the author has observed students who believe in themselves and believe that they have the capacity to learn, always perform better than students who have a poor sense of self-worth regarding mechanical aptitude and hands-on experience. Improving self confidence in today's engineering undergraduates presents a challenge and opportunity for educators. Students often don't hear the words 'well done', 'I believe in you', or 'I'm proud of you', especially in their home environment.

4.3 Handgun confidence

Figure 5 on the next page displays the confidence level of students in answering questions about handgun knowledge. The confidence question was presented prior to taking the intervention and after the intervention. The average pre-confidence level was a 4.7 on a scale of 1 to 7, while the average post-confidence level was 5.55. An increase in confidence level was noted after the students completed the tutorial. A positive result would be expected as the students are presented with learning materials focused on three main safety mechanisms of the GLOCK semi-automatic pistol. It was noted that one student's confidence actually decreased, after they found out how much they didn't know about the mechanisms of a handgun.

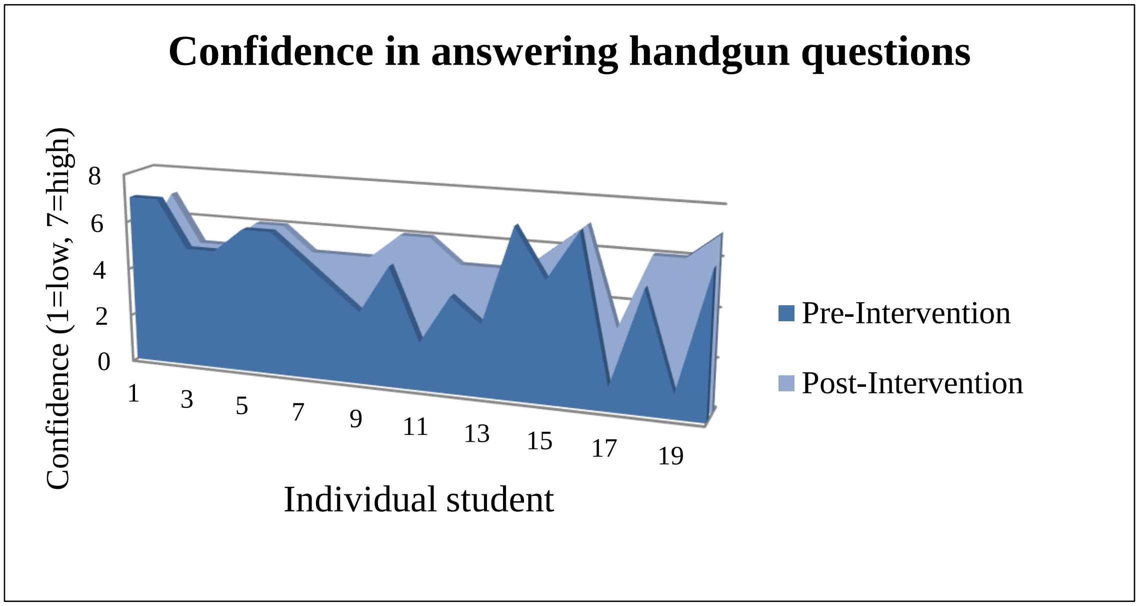

Figure 5: Confidence in answering handgun questions

4.4 Pre-test of GLOCK mechanisms

The pre-intervention section presented 15 questions about general gun knowledge and items specific to GLOCK mechanisms, before the start of the training module. In addition, 8 GLOCK video questions were presented, focusing on the firing cycle prior to the tutorial phase. The goal was to gauge the effectiveness of the intervention after reviewing the results of the post-test. Pre-test results are shown in Figure 6 on the next page. The data shows that the students are knowledgeable in answering questions about handguns, as the average score was 21 correct our of 23 total.

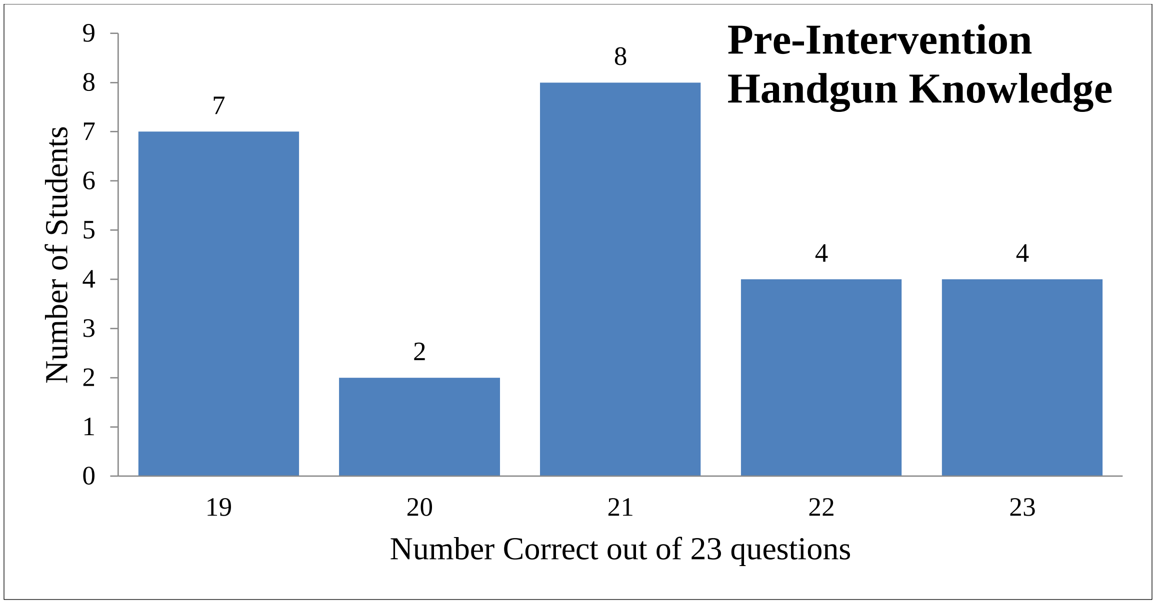

Figure 6: Pre-intervention GLOCK knowledge

4.5 MAT pre-intervention test

As part of the pre-test phase, students were administered a 4-question mechanical aptitude test. A second aptitude test with different questions was administered during the post-test phase. To prevent one test being more difficult than the other, a MATa or MATb test was randomly assigned to the students during the pre-test phase. For the first MAT test, students scored an average of 2.3 correct out of 4.

4.6 Intervention

During the intervention stage, the tutorial focuses on educating the participant on the various GLOCK mechanical mechanisms, through the use of pictures, training videos, short questions (with revealing answers), and diagrams. Primary attention is placed on three distinct mechanical mechanisms of the GLOCK Safe-Action® system: trigger lock, slide lock, and barrel lock. These three mechanisms work together to facilitate the firing cycle. The GLOCK does not have an external safety, however, it employs a trigger safety (trigger lock) that prevents premature firing. Verbal feedback included a surprising result: that the students never knew how complex this system was, and its impact on the firing cycle and overall weapon safety.

4.7 MAT post-intervention test

After the intervention and tutorial phase, student were administered the second MAT test, MATa or MATb, based on the test they were randomly assigned first. If they were assigned MATb first, they would take the MATa after the intervention. Likewise if they were assigned the MATa first, they would take the MATb second. The average score on the second MAT test was 2.6 out of 4 questions. This provided a positive increase of 0.30. For the subject students, the intervention proved to be effective, and may warrant a test with a larger sample group (see section 6.1 Sample size). Figure 7 below shows a comparison between results of the first MAT (MATa or MATb depending on assignment) and the second MAT.

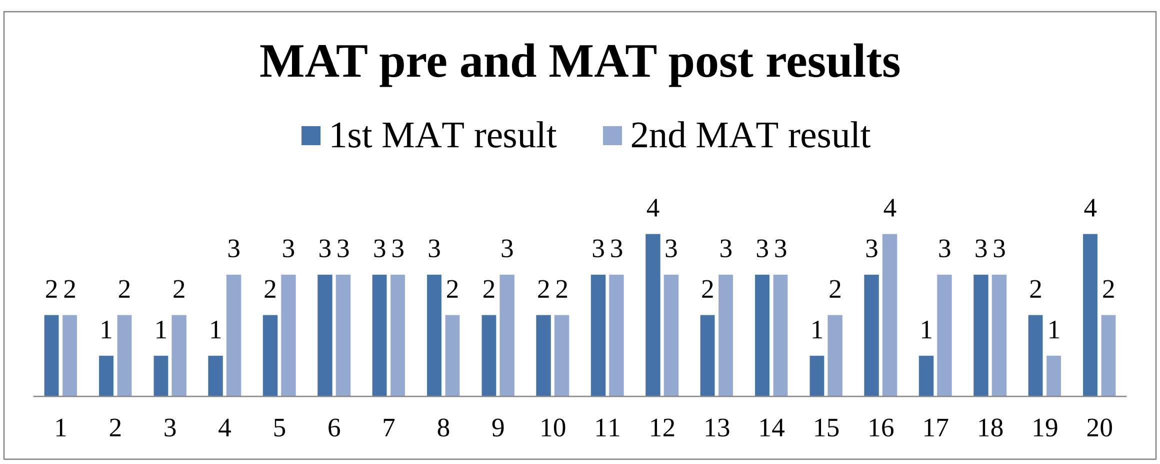

Figure 7: MAT pre and post results

4.8 Post-test of GLOCK mechanisms and video post-test

During the post-test phase, firearm confidence is confirmed again, as well as follow-up questions on the GLOCK mechanical mechanisms. MAT A or MAT B tests are then performed to determine whether or not the online intervention improved the participant's mechanical aptitude based on the use of a tactile activity. Figure 3-6 shows the results of the post-test, which produced an average correct score of 18.5 out of 23 questions. This produced a drop of almost 12% compared to the average score of the pre-intervention questions. This may be attributed to more difficult questions being presented for the video post-testing, as an indicator to determine evidence of student learning.

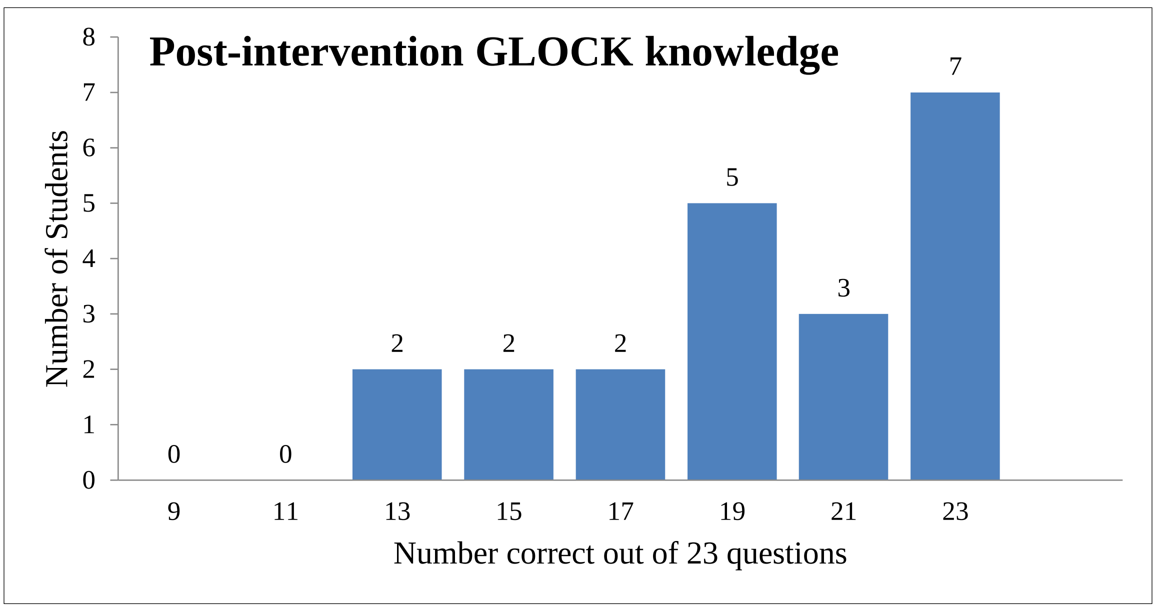

Figure 8: Post-test results of GLOCK mechanism knowledge

4.9 Normalization of MAT scores using the Z-score method

The intervention used two groups of standard mechanical aptitude test questions, MATa and MATb, with 4 questions each. The MAT tests were randomized, MATa first or

MATb first, to minimize the effect of one being more difficult than the other. The scores were normalized using the Z-score method, standardizing all MAT scores to a common scale with an average of zero and a standard deviation of one. This method of standardization allows for the calculation of the probability of a score (number MAT questions correct) occurring within a normal distribution and improves the ability to compare two scores from different statistical distributions. Z-scores for MATa were calculated using the following formula: $Z_a = \frac{x_a - \overline{x_a}}{s_a}$ [Equation 1]

Z-scores are calculated by taking the score, in our case the number of correct questions for a specific student, subtract the sample mean for all MATa scores, and divide the entire amount by the standard deviation of MATa. Likewise, Z-scores for MATb were calculated using the same formula, substituting scores from the b test for each variable. Figure 9 below shows a comparison chart between the standardized Zpre and Zpost scores. Actual values can be found in Table 1 on page 20. The normalized change in z-scores can be found in Figure 10 on the following page, showing improvement between pre and post intervention data.

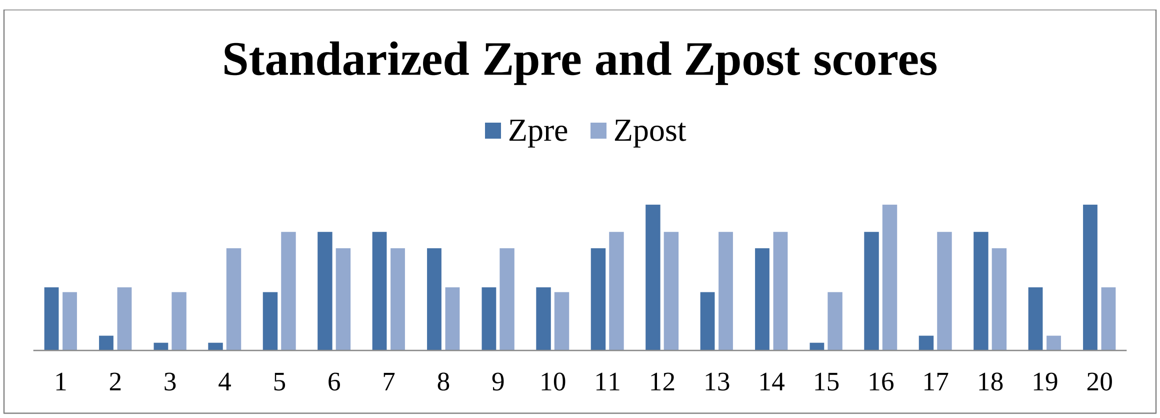

Figure 9: Comparison chart of Zpre and Zpost Scores

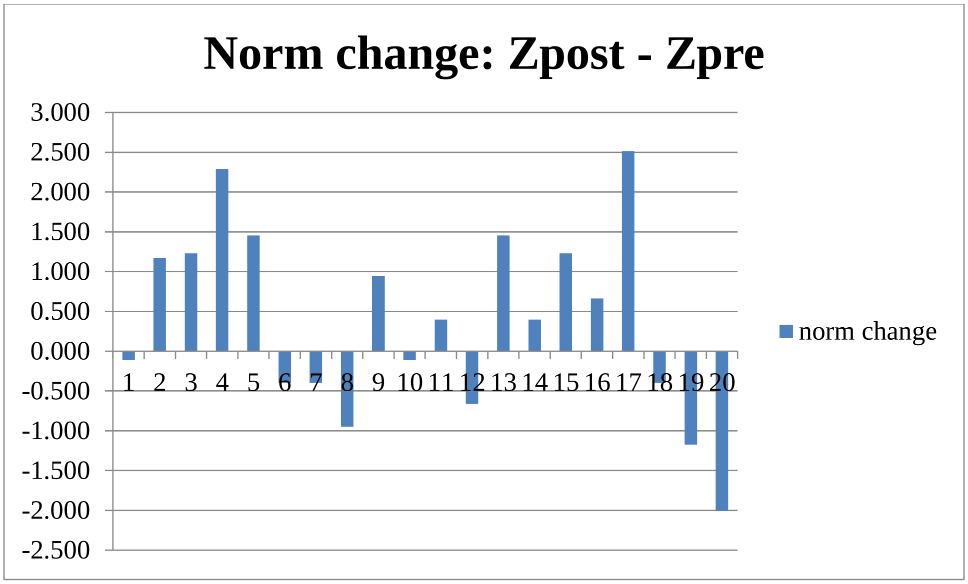

Figure 10: Normalized change Zpost-Zpre

The average norm change was 0.377, a positive number, yielding promising results for the intervention, a measured slight improvement in mechanical aptitude from the intervention. The nominal variable (the students) were given a 'before' and 'after' treatment. To check if the mean difference between the pairs is different than zero, a paired t-test was performed. The null-hypothesis in a paired sample t-test is that the average of the differences between the paired observations in the two samples is zero. The calculated result was a paired t-test value, p, of 0.054. This is very close to 0.05, or our 95% confidence interval. The result can be interpreted that statistically, the mean difference between the paired observations is significantly different from zero. Mechanical aptitude results from each student, along with calculated z-score values are shown in Table 1 on the following page.

Table 1: Normalization values (z-scores)

Randomize	MATa Correct	MATb Correct	MAT Change	Za	Zb	Zpre	Zpost	norm change
aFirst	2	2	0	-0.470	-0.582	-0.470	-0.582	-0.113
bFirst	2	1	1	-0.470	-1.641	-1.641	-0.470	1.171
aFirst	1	2	1	-1.812	-0.582	-1.812	-0.582	1.229
aFirst	1	3	2	-1.812	0.476	-1.812	0.476	2.288
bFirst	3	2	1	0.872	-0.582	-0.582	0.872	1.455
aFirst	3	3	0	0.872	0.476	0.872	0.476	-0.396
aFirst	3	3	0	0.872	0.476	0.872	0.476	-0.396
bFirst	2	3	-1	-0.470	0.476	0.476	-0.470	-0.946
aFirst	2	3	1	-0.470	0.476	-0.470	0.476	0.946
aFirst	2	2	0	-0.470	-0.582	-0.470	-0.582	-0.113
bFirst	3	3	0	0.872	0.476	0.476	0.872	0.396
bFirst	3	4	-1	0.872	1.535	1.535	0.872	-0.663
bFirst	3	2	1	0.872	-0.582	-0.582	0.872	1.455
bFirst	3	3	0	0.872	0.476	0.476	0.872	0.396
aFirst	1	2	1	-1.812	-0.582	-1.812	-0.582	1.229
aFirst	3	4	1	0.872	1.535	0.872	1.535	0.663
bFirst	3	1	2	0.872	-1.641	-1.641	0.872	2.513
aFirst	3	3	0	0.872	0.476	0.872	0.476	-0.396
aFirst	2	1	-1	-0.470	-1.641	-0.470	-1.641	-1.171
bFirst	2	4	-2	-0.470	1.535	1.535	-0.470	-2.005
11 MATa	2.35	2.55	0.3	-7E-17	1.8E-16	-0.189	0.189	0.377
9 MATb	0.74516	0.94451	**AVERAGE**					
	AVG	**AVG**			**PAIRED T TEST p VALUE**			0.054
	ST DEV	**ST DEV**						

5 Data correlation

Data was analyzed using comparative regression analysis to produce correlation factors r and p. R was used to identify positive correlation between variables, with values between -1 and 1. Values between -1 and 0 revealed negative correlation between data sets, while values between 0 and +1 revealed positive correlation between data sets. A target correlation R value of 0.50, shown in red in Table 2 below, was selected for moderate positive correction.

Table 2: Correlation R value between data sets

Correlation R value	***R1***	***R2***	***R3***	***R4***	***R5***	***R6***	***R7***	***R8***	***R9***	***R10***	***R11***
Gun Ownership	1	0.284	0.322	0.242	0.434	0.747	0.734	0.202	0.540	0.309	-0.110
Handgun Confidence	0.284	1	0.152	0.324	0.185	0.212	0.261	0.351	-0.004	0.175	-0.166
GLOCK Component Knowledge	0.322	0.152	1	-0.265	0.230	0.211	0.122	0.306	0.141	0.101	-0.233
Implicit Beliefs	0.242	0.324	-0.265	1	-0.016	0.098	-0.027	-0.270	0.122	-0.245	-0.099
Glock Use	0.434	0.185	0.230	-0.016	1	0.163	0.128	0.260	0.131	0.216	0.026
Gun Use	0.747	0.212	0.211	0.098	0.163	1	0.815	0.323	0.520	0.483	0.054
Disassembly Experience	0.734	0.261	0.122	-0.027	0.128	0.815	1	0.367	0.499	0.366	0.106
Video Pre Test - Number Correct (8)	0.202	0.351	0.306	-0.270	0.260	0.323	0.367	1	0.071	0.412	-0.351
Video Post Test - Number Correct (23)	0.540	-0.004	0.141	0.122	0.131	0.520	0.499	0.071	1	0.028	0.092
MAT Total	0.309	0.175	0.101	-0.245	0.216	0.483	0.366	0.412	0.028	1	-0.066
MAT change	-0.110	-0.166	-0.233	-0.099	0.026	0.054	0.106	-0.351	0.092	-0.066	1

R1: Gun Ownership
R2: Handgun Confidence
R3: GLOCK Component Knowledge
R4: Implicit Beliefs
R5: GLOCK Use
R6: Gun Use
R7: Disassembly Experience
R8: Video Pre-Test Number Correct
R9: Video Post-Test Number Correct
R10: MAT Total Correct
R11: MAT Change

The closer the correlation coefficient r is to 1, the more correlated two data sets are. Using a value of $r \geq 0.5$ as the positive correlation limit for moderate correlation, the following items are correlated, with some being very obvious:

- Gun ownership and gun use
- Gun ownership and disassembly experience

- Gun ownership and video post-test
- Gun use and gun ownership
- Gun use and disassembly experience
- Gun use and video post-test
- Disassembly experience and video post-test
- Gun use and total MAT correct

The gun use and MAT correct was an expected correlation, as gun users may have higher levels of mechanical intuition. We also expected to see positive correlation between users that have disassembly experience and the number of MAT questions correct as well as an improvement in MAT change. This correlation was positive, although only slightly positive, with r = 0.366 and 0.166, respectively. Now that we understand the how the data sets correlated with r values, and additional paired t-test was performed to evaluate the statistical significance of the correlation scores. Staying in a confidence level of 95% or greater, we looked for p values below 0.05. Table 3 on the next page shows the calculated p values. Not including the obvious correlated data sets, the paired t-test confirmed the following statistically relevant correlations:

- Gun ownership and video post-test
- Gun use and post-test
- Disassembly experience and video post-test
- MAT total and gun use test

We did not experience statistically significant correlation between the change or improvement in mechanical aptitude testing and other data sets in the study. We were expecting to see correlation with MAP change, however, further study is warranted and an increase in the number of participants may have the potential to increase correlation in this area.

Table 3: Paired t-test p value for statistically relevant correlation

Correlation p value	*p1*	*p2*	*p3*	*p4*	*p5*	*p6*	*p7*	*p8*	*p9*	*p10*	*p11*
Gun Ownership	1	0.225	0.166	0.304	0.056	1.54E-04	2.31E-04	0.392	0.014	0.185	0.644
Handgun Confidence	0.225	1	0.523	0.164	0.434	0.369	0.267	0.129	0.987	0.461	0.484
GLOCK Component Knowledge	0.166	0.523	1	0.259	0.329	0.372	0.609	0.190	0.554	0.673	0.323
Implicit Beliefs	0.304	0.164	0.259	1	0.946	0.680	0.909	0.250	0.610	0.299	0.678
Glock Use	0.056	0.434	0.329	0.946	1	0.493	0.592	0.268	0.583	0.360	0.914
Gun Use (non-GLOCK)	1.54E-04	0.369	0.372	0.680	0.493	1	1.22E-05	0.165	0.019	0.031	0.822
Disassembly Experience	2.31E-04	0.267	0.609	0.909	0.592	1.22E-05	1	0.112	0.025	0.113	0.656
Video Pre Test - Number Correct (8)	0.392	0.129	0.190	0.250	0.268	0.165	0.112	1	0.767	0.071	0.129
Video Post Test - Number Correct (23)	0.014	0.987	0.554	0.610	0.583	0.019	0.025	0.767	1	0.905	0.700
MAT Total	0.185	0.461	0.673	0.299	0.360	0.031	0.113	0.071	0.905	1	0.781
MAT change	0.644	0.484	0.323	0.678	0.914	0.822	0.656	0.129	0.700	0.781	1

p1: Gun Ownership
p2: Handgun Confidence
p3: GLOCK Component Knowledge
p4: Implicit Beliefs
p5: GLOCK Use
p6: Gun Use
p7: Disassembly Experience
p8: Video Pre-Test Number
p9: Video Post-Test Numbe
p10: MAT Total Correct
p11: MAT Change

6 Limitations and future work

6.1 Sample size

Although we remain confident that the project data is reliable, only 20 students participated in the online tutorial. A larger sample size has the potential to strengthen the statistical precision of the results. The small sample size was due to the limited number of students available and willing to participate, and consisted of students from two low-enrolled manufacturing related courses. For future studies, it is recommended that a larger group participate, with an ideal sample either set to an estimated 100 to 300 participants, or alternately calculating a sample size using statistical equations based on expected confidence and hypothesis probability.

6.2 Tutorial duration

On average, students in the study group spent about 60 minutes to complete the simulation. It is well-known that the typical engineering student has a 10 to 20 minute attention span when listening to lectures. With online tutorials being more 'immersive' employing various training methods, we can expect a higher level of student engagement. The right amount of time or duration may depend on the study group and the variance of the material being presented.

6.3 Hard skills vs soft skills

Hard skills such as technical skills and mechanical aptitude can be assessed through hands-on simulation. Hard skills are tangible and can be easily measured. As researchers, we are met with the challenge of understanding and measuring the effect, if any, of a participant's soft skills. Soft skills are attributes of individuals. They provide an indication of how individuals will tend to behave and interact with others. Soft skills would be one's attention to detail, safety orientation, and impulsivity [6]. For the project, it was important to include an understanding of student confidence and implicit beliefs regarding mechanical aptitude, however, for future work we may want to also identify learning styles, safety orientation, or other soft skill metrics.

6.4 Incentives

Extra-credit was offered as an incentive for taking part in the study group. When providing an extra-credit incentive, study bias could be introduced, as the students may just 'want to get through it', knowing that they will receive extra points. Adding the activity as part of a lab assignment across one course or multiple courses may help to remove potential bias. For this study, students were informed ahead of time and there was a level of expectation and excitement to participate.

6.5 Number of questions for the pre and post mechanical aptitude test

Four mechanical aptitude test questions were presented before, while four different mechanical aptitude questions were presented after the intervention. These tests were used to determine the change in mechanical intuition after the intervention. For future studies, it may be beneficial to increase the number of MAT questions. This would increase the range available for measured improvement.

6.6 Standardization of pre and post GLOCK questions

Pre-intervention questions measured participant's knowledge of GLOCK components and functions. Although the number of pre and post questions were the same, the post-intervention questions included more difficult video questions that were meant to be feasibility answered based on student learning provided by the tutorials. With the questions not being all the same, it was difficult to compare pre and post intervention performance. For future work, it is recommended that questions are standardized for pre and post-intervention so a meaningful before-and-after score can be produced and analyzed.

7 Conclusion

An online tutorial is a great way to engage students in a learning activity. Mechanical engineering students typically enjoy the challenge of MAP testing, and determining correlation between mechanical aptitude with shooting sports and other outdoor activities remains a topic for study. For this project, although the expected correlation was less than ideal, a slight increase in mechanical aptitude was realized. This leads the way for a larger study and could potentially produce increased levels of correlation. A learning intervention provided through a virtual experience has the potential to improve mechanical aptitude, while additional mechanical mechanisms could be used as training mediums in future tutorials. The stigma that handguns provide promotes excitement for some, and instills fear in others. Regardless, handguns represent a complex, high-level mechanical mechanism that is easily recognized, while keeping the attention of the participant. The challenge remains to keep student engaged, while producing evidence of student learning and preserving the robustness of data collection.

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Appendix A: List of guided track questions

A.1 Implicit beliefs

Students submitted a rating of 1 (not at all true of me) to 7 (very true of me)

- You have a certain amount of mechanical aptitude, and you can’t really do much to change it.
- Your mechanical aptitude is something about you that you can’t change very much.
- No matter who you are, you can significantly change your mechanical aptitude level.
- To be honest, you can’t really change how mechanically apt you are.
- You can always substantially change how mechanically apt you are.
- You can learn new things, but you can’t really change your basic mechanical aptitude.
- No matter how much mechanical aptitude you have, you can always change it quite a bit.
- You can change even your basic mechanical aptitude level considerably.

A.2 Confidence

- How easily do you feel that can you answer questions relating to the mechanical operation of a handgun? Please select a value on the following scale to indicate your ability to correctly answer such questions.

A.3 Experience

- Have you ever shot a firearm?
- Have you ever fired a handgun?
- Have you ever shot a firearm?
- Have you ever fired a handgun?
- Have you ever fired a GLOCK handgun?
- How often do you fire a GLOCK handgun?
    a. During Winter:
    b. During Spring:
    c. During Summer:
    d. During Fall:
- How often do you shoot a firearm other than a Glock handgun?
    a. During Winter:
    b. During Spring:
    c. During Summer:
    d. During Fall:
- Have you ever partially or fully disassembled a handgun or other firearm?
- Do you own any firearms?
- Check any that apply.
- When is the last time you fired a firearm?

A.4 Pre-Intervention Questions

- There are seven mechanical functions of a handgun. Select the order in which these functions occur.

- Which label points to the Primer?
- Which label points to the Bullet?
- Which label points to the Casing?
- Which label points to the Powder?
- Which label points to the Slide?
- Which label points to the Slide Release?
- Which label points to the Magazine?
- Which label points to the Barrel?
- Which label points to the Trigger?

A.5 Glock Video Pre-Test

- After the trigger is pulled, is there a round of ammunition in the chamber?
- After the trigger is pulled, is the firearm in the “cocked" condition?
- After the slide was cycled, is there a round of ammunition in the chamber?
- After the slide was cycled, is the firearm in the “cocked" condition?
- After the magazine was inserted into the firearm, is there a round of ammunition in the chamber?
- After the slide was cycled, is there a round of ammunition in the chamber?
- After the slide was cycled, is the firearm in the “cocked" condition?

A.6 MATa Test

- One revolution of the arm turns the disc how far?
- For air to flow from R through G, then through S to M, which of the following valves should be open?

- If the hand wheel is turned 20 revolutions clockwise, how far will the threaded block move?
- If nut "A" is removed entirely, in order to rebalance the arm, it will be necessary to turn nut ______

A.7 MATb Test

- The piston moves from midposition to the extreme right if the crank makes:
- As the shaft speeds up, the governor balls will move:
- For each cam revolution, the vertical valve rise equals distance
- If the pulley marked "X" is revolving at 100 RPM, the speed of pulley "Y" is:

A.8 GLOCK video post-test

- After the firearm was fired, is there a round of ammunition in the chamber?
- After the firearm was fired, is the firearm in the "cocked" condition?
- After the slide was cycled, is there a round of ammunition in the chamber?
- After the slide was cycled, is the firearm in the "cocked" condition?
- Hypothetically, after the slide was cycled, what would happen if the trigger was pulled?
- After the firearm was fired, is there a round of ammunition in the chamber?
- After the firearm was fired, is the firearm in the "cocked" condition?
- Hypothetically, after the firearm was fired, what would happen if the trigger was pulled again?
- After the magazine was released from the firearm, is there a round of ammunition in the chamber?

- After the magazine was released from the firearm, is the firearm in the "cocked" condition?
- Hypothetically, after the magazine was released from the firearm, what would happen if the trigger was pulled again?
- What happened when the trigger was pulled?
- After the trigger was pulled, where would the the slide be positioned?
- After the slide was locked back, is there a round of ammunition in the chamber?
- After the slide was locked back, is the firearm in the "cocked" condition?
- Hypothetically, after the slide was locked back what would happen if the trigger was pulled?
- After the round of ammunition was inserted into the chamber, is there a round of ammunition in the chamber?
- After the round of ammunition was inserted into the chamber, is the firearm in the "cocked" condition?
- Hypothetically, after the round of ammunition was inserted into the chamber what would happen if the trigger was pulled?
- After the slide was released, is there a round of ammunition in the chamber?
- After the slide was released, is the firearm in the "cocked" condition?
- What happened when the trigger was pulled?
- After the trigger was pulled, where was the slide positioned?

Appendix B: Guided Track Code

B.1 Gun-Main (main program that initiates all code)

*program: Gun-Introduction-NEW

*program: Gun-Intervention-NEW

*program: Gun-Conclusion-NEW

B.2 Gun-Introduction

-- Gun Intro

*maintain: Introduction to a web based learning assessment

*header: Introduction

*progress: 0%

Hello, and thank you for participating in our tutorial. This tutorial is designed to investigate your mechanical aptitude while providing a learning experience to stimulate your mechanical intuition. Our goal is to gauge your understanding of mechanical systems by asking you a set of questions prior to the learning intervention within this tutorial. Following the learning intervention, we will ask you a few more questions to assess what effect, if any, the intervention had on your mechanical understanding.

The tutorial will take 30-60 minutes to complete. If you need to take a break in the middle, keep your browser open so that you can pick up where you left off.

*button: Let's Go!

*question: What is your name (first and last)? Your name will only be used for extra credit purposes.

-- implicit theory

*maintain: Mechanical Aptitude

*header: Let's perform a self-assessment of mechanical aptitude

In the next series of questions, please indicate the extent to which you agree or disagree with each statement by selecting the slider number that corresponds to your opinion. These questions have been designed to investigate your ideas about mechanical aptitude.

*question: You have a certain amount of mechanical aptitude, and you can’t really do much to change it.

*confirm

*type: slider

1

2

3

4

5

6

7

*before: 1-Not at all true of me

*after: 7-Very true of me

*question: Your mechanical aptitude is something about you that you can't change very much.

*confirm

*type: slider

1

2

3

4

5

6

7

*before: 1-Not at all true of me

*after: 7-Very true of me

*question: No matter who you are, you can significantly change your mechanical aptitude level.

*confirm

*type: slider

1

2

3

4

5

6

7

*before: 1-Not at all true of me

*after: 7-Very true of me

*question: To be honest, you can’t really change how mechanically apt you are.

*confirm

*type: slider

1

2

3

4

5

6

7

*before: 1-Not at all true of me

*after: 7-Very true of me

*question: You can always substantially change how mechanically apt you are.

*confirm

*type: slider

1

2

3

4

5

6

7

*before: 1-Not at all true of me

*after: 7-Very true of me

*question: You can learn new things, but you can’t really change your basic mechanical aptitude.

*confirm

*type: slider

1

2

3

4

5

6

7

*before: 1-Not at all true of me

*after: 7-Very true of me

*question: No matter how much mechanical aptitude you have, you can always change it quite a bit.

*confirm

*type: slider

1

2

3

4

5

6

7

*before: 1-Not at all true of me

*after: 7-Very true of me

*question: You can change even your basic mechanical aptitude level considerably.

*confirm

*type: slider

1

2

3

4

5

6

7

*before: 1-Not at all true of me

*after: 7-Very true of me

--familiarity with firearms

*maintain: Firearm Familiarity

*header: A self-assessment of familiarity with firearms

*question: How easily do you feel that can you answer questions relating to the mechanical operation of a handgun? Please select a value on the following scale to indicate your ability to correctly answer such questions.

*confirm

*type: slider

1

2

3

4

5

6

7

*before: 1-Not at all confident

*after: 7-Very confident

*progress: 5%

*question: Have you ever shot a firearm?

*confirm

Yes

*program: Gun-Shooters-NEW

No

*maintain: Firearm Familiarity

*question: Have you ever partially or fully disassembled a handgun or other firearm?

*confirm

*type: checkbox

Yes - GLOCK Handgun

Yes - Other Handgun

Yes - Rifle

Yes - Shotgun

Yes - Other

No

*question: Do you own any firearms? Check any that apply.

*confirm

*type: checkbox

Yes - GLOCK Handgun

Yes - Other Handgun

Yes - Rifle

Yes - Shotgun

Yes - Other

No

*progress: 10%

*maintain: A handgun requires seven main mechanisms to operate

*question: There are seven mechanical functions of a handgun. Select the order in which these functions occur.

*confirm

Feed, Lock, Cock, Fire, Unlock, Extract, Eject

Lock, Cock, Feed, Unlock, Fire, Eject, Extract

Cock, Lock, Feed, Fire, Extract, Unlock, Eject

Cock, Fire, Lock, Unlock, Feed, Extract, Eject

*maintain: Firearm components

*header: Here are a few general questions regarding firearm components and assessories

*image: http://i.imgur.com/imkeEtb.jpg

This figure shows a round of ammunition and labels four components:

*list

Primer

Bullet

Casing

Powder

*question: Which label points to the *Primer*?

*confirm

1

2

3

4

*image: http://i.imgur.com/imkeEtb.jpg

*question: Which label points to the *Bullet*?

*confirm

1

2

3

4

*image: http://i.imgur.com/imkeEtb.jpg

*question: Which label points to the *Casing*?

*confirm

1

2

3

4

*image: http://i.imgur.com/imkeEtb.jpg

*question: Which label points to the *Powder*?

*confirm

1

2

3

4

*header: This figure labels 10 components of a GLOCK

*image: http://i.imgur.com/ziEpoDX.jpg

*question: Which label points to the *Slide*?

*confirm

1

2

3

4

5

6

7

8

9

10

*header: This figure labels 10 components of a GLOCK

*image: http://i.imgur.com/ziEpoDX.jpg

*question: Which label points to the *Slide Release*?

*confirm

1

2

3

4

5

6

7

8

9

10

*header: This figure labels 10 components of a GLOCK

*image: http://i.imgur.com/ziEpoDX.jpg

*question: Which label points to the *Magazine*?

*confirm

1

2

3

4

5

6

7

8

9

10

*header: This figure labels 10 components of a GLOCK

*image: http://i.imgur.com/ziEpoDX.jpg

*question: Which label points to the *Barrel*?

*confirm

1

2

3

4

5

6

7

8

9

10

*header: This figure labels 10 components of a GLOCK

*image: http://i.imgur.com/ziEpoDX.jpg

*question: Which label points to the *Trigger*?

*confirm

1

2

3

4

5

6

7

8

9

10

*header: This figure labels 10 components of a GLOCK

*image: http://i.imgur.com/ziEpoDX.jpg

*question: Which label points to the *Front Sight*?

*confirm

1

2

3

4

5

6

7

8

9

10

*header: This figure labels 10 components of a GLOCK

*image: http://i.imgur.com/ziEpoDX.jpg

*question: Which label points to the *Rear Sight*?

*confirm

1

2

3

4

5

6

7

8

9

10

*header: This figure labels 10 components of a GLOCK

*image: http://i.imgur.com/ziEpoDX.jpg

*question: Which label points to the *Slide Lock*?

*confirm

1

2

3

4

5

6

7

8

9

10

*header: This figure labels 10 components of a GLOCK

*image: http://i.imgur.com/ziEpoDX.jpg

*question: Which label points to the *Magazine Release*?

*confirm

1

2

3

4

5

6

7

8

9

10

*header: This figure labels 10 components of a GLOCK

*image: http://i.imgur.com/ziEpoDX.jpg

*question: Which label points to the *Frame/Receiver*?

*confirm

1

2

3

4

5

6

7

8

9

10

*progress: 15%

*wait: 3seconds

--short MAT pre

The following group of questions is designed to test your understanding of mechanical systems.

*randomize

*group

*name: aFirst

*program: Gun-NEW-MATa

*set: aDone

*group

*name: bFirst

*program: Gun-NEW-MATb

*set: bDone

--video pre-quiz

*progress: 20%

*program: Gun-VideoPreQuiz-NEW

B.3 Mechanical Aptitude Test A (MATa)

--NEW-MATa

*maintain: Mechanical Aptitude Questionnaire A

*header: Let's answer a few mechanical aptitude questions

The figure below shows a slotted disc turned by a pin on a rotating arm.

*image: http://i.imgur.com/QyGma7j.jpg

*question: One revolution of the arm turns the disc how far?

*confirm

1/4 turn

3/4 turn

1/2 turn

1 complete turn

*header: A system of valves

In the figure below, assume that all valves are closed.

*image: http://i.imgur.com/TSegeiM.jpg

*question: For air to flow from R through G, then through S to M, which of the following valves should be open?

*confirm

1, 2, 6, and 4

7, 3, and 4

7, 6, and 4

7, 3, and 5

*header: A threaded block and slide

In the figure below, the threaded block can slide in the slot but cannot revolve.

*image: http://i.imgur.com/vjBFVOL.jpg

*question: If the hand wheel is turned 20 revolutions clockwise, how far will the threaded block move?

*confirm

1 inch to the left

1/2 inch to the left

1 inch to the right

1/2 inch to the right

*header: A balancing arm

The arm in the figure below is shown as exactly balanced.

*image: http://i.imgur.com/VDmpGCm.jpg

*question: If nut "A" is removed entirely, in order to rebalance the arm, it will be necessary to turn nut ______

*confirm

"C" toward the right

"C" toward the left

"B" up

"B" down

B.4 Mechanical Aptitude Test B (MATb)

--NEW-MATb

*maintain: Mechanical Aptitude Questionaire B

*header: Let's answer a few mechanical aptitude questions

The figure below shows a crank and piston.

*image: http://i.imgur.com/uuoeHgw.jpg

*question: The piston moves from midposition to the extreme right if the crank makes:

*confirm

a 1/2 turn

a 3/4 turn

1 turn

2 1/2 turns

*header: A governor

The figure below shows a governor on a rotating shaft. Select the best answer.

*image: http://i.imgur.com/zrl4o4N.jpg

*question: As the shaft speeds up, the governor balls will move:

*confirm

down

upward and inward

upward and outward

inward

*header: A cam and a valve

The figure below shows a cam and a valve.

*image: http://i.imgur.com/tuZRQDK.jpg

*question: For each cam revolution, the vertical valve rise equals distance

*confirm

y

x plus y

x

twice x

*header: A double belt drive

A double-belt drive is shown in the figure below.

*image: http://i.imgur.com/tD78ref.png

*question: If the pulley marked "X" is revolving at 100 RPM, the speed of pulley "Y" is:

*confirm

800 RPM

400 RPM

200 RPM

25 RPM

B.5 Gun-Shooters

-- questions for those that have fired a firearm

*maintain: Let's talk about firearm firing frequency

*image:http://i.imgur.com/Bjzen5w.jpg

*question: When is the last time you fired a firearm?

*confirm

Within the last week

Within the last month

Within the last year

Within the last 5 years

More than 5 years ago

*image:https://i.imgur.com/bNA9YSh.jpg

*question: Have you ever fired a handgun?

*confirm

Yes

*set: handgunyes

*image:https://i.imgur.com/1aDRzkD.jpg

*question: Have you ever fired a GLOCK handgun?

*confirm

Yes

*set: glockyes

No

No

*if: glockyes

*question: How often do you fire a GLOCK handgun?

*confirm

At least once per week

At least once per month

At least once per year

Not at all

Are there certain times of the year that you shoot more often? Please indicate approximately how many times you shoot during each season.

*question: *During Winter:

*confirm

*type: slider

0 times

1 time

2 times

3 times

4 times

5 times

6 times

7 times

8 times

9 times

10 or more times

*before: zero times

*after: 10 or more times

*question: During Spring:

*confirm

*type: slider

0 times

1 time

2 times

3 times

4 times

5 times

6 times

7 times

8 times

9 times

10 or more times

*before: zero times

*after: 10 or more times

*question: During Summer:

*confirm

*type: slider

0 times

1 time

2 times

3 times

4 times

5 times

6 times

7 times

8 times

9 times

10 or more times

*before: zero times

*after: 10 or more times

*question: During Fall:

*confirm

*type: slider

0 times

1 time

2 times

3 times

4 times

5 times

6 times

7 times

8 times

9 times

10 or more times

*before: zero times

*after: 10 or more times

*question: How often do you shoot a firearm other than a Glock handgun?

*confirm

At least once per week

At least once per month

At least once per year

Not at all

Are there certain times of the year that you shoot a firearm other than a Glock handgun more often? Please indicate approximately how many times you shoot during each season.

*question: During Winter:

*confirm

*type: slider

0 times

1 time

2 times

3 times

4 times

5 times

6 times

7 times

8 times

9 times

10 or more times

*before: zero times

*after: 10 or more times

*question: During Spring:

*confirm

*type: slider

0 times

1 time

2 times

3 times

4 times

5 times

6 times

7 times

8 times

9 times

10 or more times

*before: zero times

*after: 10 or more times

*question: During Summer:

*confirm

*type: slider

0 times

1 time

2 times

3 times

4 times

5 times

6 times

7 times

8 times

9 times

10 or more times

*before: zero times

*after: 10 or more times

*question: During Fall:

*confirm

*type: slider

0 times

1 time

2 times

3 times

4 times

5 times

6 times

7 times

8 times

9 times

10 or more times

*before: zero times

*after: 10 or more times

B.6 Gun Video Pre-Quiz

--this is a video pre-quiz

*maintain: Firearm condition pre-quiz

*header: Firearm conditions are scenarios which involve different ways of component manipulation.

It's important to understand these 'what if' scenarios, as you watch the following series of videos and answer the questions which follow.

You will need to know a simple "formula": If there is a round of ammunition in the chamber AND the firearm is in the ”cocked condition,” THEN when the trigger is pulled a round of ammunition will be fired.

You can answer all of the questions from the information provided - no other information is required.

Assume that the videos are sequential, and that there are no hidden or missing steps. Assume that the firearm and magazines function correctly at all times.

After the video, you will be asked if the gun is in the ”cocked condition". The "cocked condition" means that the firing pin would be released if the trigger was pulled.

*button: Let's start with the first video

*maintain: Firearm condition pre-quiz: no magazine

*header: Condition = safety check, no magazine

Watch the video below to see a safety check being performed. At the end of the video, the trigger is pulled. Once you have watched the video, answer the questions below.

*video: https://www.youtube.com/embed/1wh7XEk94FQ

*question: After the trigger is pulled, is there a round of ammunition in the chamber?

*confirm

Yes

No

*question: After the trigger is pulled, is the firearm in the ”cocked" condition?

*confirm

Yes

No

*maintain: Firearm condition pre-quiz: manual slide cycling & no magazine

*header: Condition = manual slide cycling, no magazine

In the previous video, you watched a safety check being performed, and then the trigger was pulled. Now, watch the video below to see the slide being cycled manually. Note that there is no magazine inserted into the firearm. Once you have watched the video, answer the questions below.

*video: https://www.youtube.com/embed/eYrBdZpnoxM

*question: After the slide was cycled, is there a round of ammunition in the chamber?

*confirm

Yes

No

*question: After the slide was cycled, is the firearm in the ”cocked" condition?

*confirm

Yes

No

*maintain: Firearm condition pre-quiz: magazine added

*header: Condition = magazine added

In the previous video, you saw the slide being cycled manually. After the video ended, the trigger was pulled (not shown in the video).

Now, watch the video below to see a magazine being inserted into the firearm. The magazine contains at least one round of ammunition, but you do not know the exact number of rounds. Once you have watched the video, answer the questions below. Note that you do not need to know how many rounds of ammunition are in the magazine to correctly answer the questions.

*video: https://www.youtube.com/embed/pbBmMDbIOJg

*question: After the magazine was inserted into the firearm, is there a round of ammunition in the chamber?

*confirm

Yes

No

*question: After the magazine was inserted into the firearm, is the firearm in the ”cocked" condition?

*confirm

Yes

No

*maintain: Firearm condition pre-quiz: slide cycled with magazine

*header: Condition = slide cycled with magazine

In the previous video, you saw a magazine being inserted into the firearm. Now, watch the video below to see the slide being cycled. Once you have watched the video, answer the questions below.

*video: https://www.youtube.com/embed/7SjsKlwhJxA

*question: After the slide was cycled, is there a round of ammunition in the chamber?

*confirm

Yes

No

*question: After the slide was cycled, is the firearm in the ”cocked" condition?

*confirm

Yes

No

B.7 Gun-Intervention

-- intervention, 8 groups from LimeSurvey

*maintain: Let's learn about the GLOCK

*progress: 30%

*header: The GLOCK handgun is a great example of multiple mechanisms working together to perform a mechanical function.

The next series of slides will explain how the GLOCK semi-automatic pistol functions, how it employs a *3-part safety system*, and the inner workings of the *firing cycle*. We will also ask you a few questions regarding the functions as you review the tutorial.

*image: http://i.imgur.com/sMxZTas.jpg

*wait: 1seconds

*button: Let's talk about safety

*header: Safety is the most important factor about firearms

Four rules of gun safety are:

1) Treat all firearms as if they are loaded

2) Never point the muzzle at anything you are not willing to destroy

3) Keep your finger off the trigger until you are ready to fire at your intended target

4) Be sure of your target and what is beyond it

*image: http://i.imgur.com/Kvsxmzr.jpg

*wait: 1seconds

*button: What are the buttons for?

*header: External buttons of a GLOCK

The picture below shows three buttons on the GLOCK which are critical to the firing cycle. The *SLIDE LOCK* locks the slide to the receiver. The *SLIDE RELEASE* locks the slide open when there is no ammunition in the magazine and also releases the slide forward in the firing position. The *MAGAZINE RELEASE* will drop the magazine out of the gun so the gun can be loaded or unloaded.

*image: http://i.imgur.com/uFR6zDB.jpg

*wait: 1seconds

*button: Let's break this thing down

*header: A GLOCK pistol is made up of 34 parts

The GLOCK "SAFE ACTION" pistol is manufactured with 34 component parts. This low part count design helps to increase reliability and reduce maintenance.

Here is a short video showing an exploded view of all the components of a GLOCK 42, single stack. *Single stack* refers to the method of stacking the ammunition in the magazine. *Single stack* allows the ammunition to stack directly on top of each other, thus reducing the overall width of the grip design to reduce weight and increase concealability.

*video: https://www.youtu.be/BLHFwCWqHqw

*wait: 1seconds

*button: So many parts, but which are the top 5?

*header: A GLOCK has five main components

A GLOCK pistol has five main components: Slide, barrel, recoil assembly, receiver, and magazine.

*image: http://i.imgur.com/Wg9R6pB.jpg

*wait: 1seconds

*button: How do we clean this thing?

*header: A GLOCK can easily be disassembled for cleaning

This video shows how to disassemble and assemble the 5 main components of a GLOCK handgun. This is also referred to as *field stripping*, which is commonly performed to clean the main 5 components. If you have headphones, it would be good to plug them in and turn your volume on.

*video: https://www.youtube.com/watch?v=EJMdJ13nn84

*wait: 1seconds

*button: What does "safe-action" mean?

*header: The GLOCK "SAFE ACTION" system is a well designed mechanical mechanism

The *SAFE ACTION* system consists of three (3) automatic independently operating mechanical safeties which are sequentially disengaged (turned Off) when pulling the trigger and which are automatically re-engaged (Turned On) when releasing the trigger. This is a safety system which prevents a shot from being fired unless the trigger is pulled. It also prevents the pistol from firing if it is dropped.

This system consists of three safety mechanisms: Trigger Safety, Firing Pin Safety, and Drop Safety

*image: http://i.imgur.com/F71RuRO.png?1

*wait: 1seconds

*button: I might have to go out and buy a GLOCK

*header: The trigger safety is the first mechanism in GLOCK's 3-part safety system

GLOCK's *trigger safety mechanism* is incorporated into the trigger in the form of a lever. When in the forward/resting position, it blocks the trigger from moving rearward. To fire the pistol, the safety lever and trigger must be depressed at the same time. If both items are not depressed at the same time, the pistol will not fire. It also protects against firing if the pistol is dropped or is subjected to lateral (side-to-side) pressure.

*image: http://i.imgur.com/OvvvFBJ.jpg

*image: http://i.imgur.com/zRKcQJ7.jpg

*wait: 1seconds

*button: Let's take a quiz

*header: Trigger safety quiz

In the pictures below, you can see the small trigger safety extending out from the main trigger.

*image: http://i.imgur.com/GVWy5ns.png

*label: Trigger safety

*wait: 2seconds

*question: How does this safety work?

The trigger safety is connected to the firing pin; when the trigger safety is depressed, it allows the firing pin to travel forward and strike the primer.

No, please try again

*goto: Trigger safety

The trigger safety is in contact with the trigger gaurd; when the trigger safety is depressed, it allows the main trigger to be pulled back to fire the gun.

Yes, that's the right answer! Now let's check out the *firing pin safety*.

The trigger safety is connected to the extractor; when the trigger safety is depressed, it allows the extractor to extract the empty case from the chamber.

No, not this one, try again!

*goto: Trigger safety

The trigger safety is connected to the magazine; the trigger safety can only be depressed when there is a loaded magazine in the firearm.

No, sorry this isn't the right answer, please try again

*goto: Trigger safety

*wait: 3seconds

*header: The firing pin safety is the second mechanism in GLOCK's 3-part safety system

The spring-loaded *firing pin safety* projects into the firing pin channel and mechanically blocks the firing pin from moving forward. When the trigger is depressed rearward, a vertical extension of the trigger bar pushes the firing pin safety upwards, clearing the firing pin channel. The firing pin safety automatically re-engages during the slide cycling process.

*image:http://i.imgur.com/nswCMJu.jpg

*image:http://i.imgur.com/uD7WNEy.jpg

*wait: 1seconds

*button: Don't drop the ball

*header: The drop safety is the third mechanism in GLOCK's 3-part safety system

The rear part of the trigger bar has a *cruciform shape* and rests with both arms on the *drop safety* shelf, located in the trigger mechanism housing. When the trigger is pulled to the rear, the trigger bar begins separating from the firing pin lug. During the slide cycling process, the trigger bar is lifted and caught by the firing pin lug, which provides re-engagement.

*image:http://i.imgur.com/FU9wFGo.jpg

*image:http://i.imgur.com/aUlCugp.jpg

*wait: 1seconds

*button: How do these all work together?

*header: The GLOCK firing cycle is a result of all three safety systems working together

The video below shows how the GLOCK mechanisms work together during the *firing cycle*. You may want to plug in headphones to listen to the commentary in this video. Pay attention to how the barrel locks right before firing and unlocks right after firing.

*video: https://www.youtube.com/watch?v=uiV7m0VGKY8

*wait: 1seconds

*button: That was a long video but I understand more about the GLOCK than I did before

*header: The slide lock is an important feature

One of the components mentioned in the disassembly video was a *slide lock*. Here is a picture of the slide lock by itself. The red line simply indicates the top surface of the slide lock – it will be useful when you look at the next picture.

*image: http://i.imgur.com/mH5m0lV.png

Now, here is a picture of the *slide lock* in the frame. Note the red line. The light blue arrow is indicating the serrated edge of the slide lock.

*image: http://i.imgur.com/46XYglt.jpg

*progress: 40%

*wait: 1seconds

*button: Let's figure out how the barrel locks into place

*header: Barrel and locking block

Here is a picture of the *barrel*:

*image: http://i.imgur.com/gVyogUr.jpg

Here is a picture of the *locking block*:

*image: http://i.imgur.com/BRnJncQ.jpg

Here is a cutaway picture showing the detail of the chamber end of the barrel and the locking block. Note that part of the locking block has been cut away to show how the barrel sits in relation to the locking block when the slide is in the forward (i.e., ready to fire) position.

*image: http://i.imgur.com/igHP9vx.jpg

*wait: 1seconds

*button: Next

Here is a picture of the slide/barrel when the slide is in the forward position (i.e., ready to fire):

*image: http://i.imgur.com/M9euTk1.jpg

Here is the same picture, viewed from above. Note how the chamber end of the barrel mates with the slide. Pay particular attention to the area indicated by the arrow.

*image: http://i.imgur.com/oNz1AGf.jpg

Here is a picture of the slide/barrel in the few milliseconds after the gun has been fired. Notice how the barrel is now “unlocked” from the slide.

*image: http://i.imgur.com/JYTsre2.jpg

*wait: 1seconds

*button: Next

Here is a picture of the slide in the “full recoil” position. This occurs after the *last round in the magazine has been fired*, and after the round has been extracted from chamber and ejected from the gun. Look at the barrel – it is now angled upward slightly, rather than being in line with the slide.

*image: http://i.imgur.com/DOJzR1t.jpg

After the last round in the magazine has been fired and the magazine is empty, the slide will remain to the rear, as in the picture below. This facilitates reloading of the gun with a new, fully-loaded magazine.

*image: http://i.imgur.com/csNaEFV.jpg

*wait: 3seconds

*button: Let's take a closer look at the slide stop mechanism

*header: The slide stop

The *slide stop* holds the slide back by engaging with the small cut-out in the slide:

*image: http://i.imgur.com/peOjmnw.jpg

Here is a picture of the slide stop itself. Note that most of the slide stop fits inside the gun, and only the part circled in red is visible from the outside:

*image: http://i.imgur.com/ilh7ieq.jpg

*wait: 3seconds

*button: How do the magazine and slide stop work together?

*header: Magazine and slide stop function together

Here is a picture of a Glock with a loaded magazine (note that the slide has been removed). Observe when at least one round of ammunition is in the magazine, the slide stop is in the "down" position (i.e. flush with the frame).

*image: http://i.imgur.com/ixLKP4K.jpg

Here is another picture. Note that (a) there is NO round of ammunition in the magazine, and (b) the slide stop has now been pushed "up." This is what happens after the last round in the magazine has been fired.

*image: http://i.imgur.com/1IFLtQV.jpg

*wait: 3seconds

*button: How does this work?

*header: What moves the slide stop up?

Your task is to try and work out what forces the slide stop to go into the "up" position. To help you do this, here are some pictures of the magazine:

*image: http://i.imgur.com/R95pdSu.jpg

*image: http://i.imgur.com/vRhEsvx.jpg

Here is an empty magazine viewed from above; the round of ammunition next to the magazine shows you the orientation of the round compared to the magazine.

*label: Slide stop interface

*image: http://i.imgur.com/9P3eG0O.jpg

Here is a top view of the magazine interfacing with the slide stop (the slide stop is on the right hand side in this picture) *image: http://i.imgur.com/guYa395.jpg

When the magazine is empty it interacts with the slide stop, and pushes the slide stop upwards. By pushing the slide stop upwards, it catches the cut-out on the slide, and holds the slide back. This only happens when the magazine is empty.

*image: http://i.imgur.com/8v30DRD.jpg

*question: What parts of the slide stop and magazine follower interact to push the slide stop upwards?

A and 3

No, try again

*goto: Slide stop interface

A and 4

No, try again

*goto: Slide stop interface

B and 1

Almost, try again

*goto: Slide stop interface

B and 4

Yes, that's the right answer! The small corner of the magazine follower pushes against the slide stop tab. Now let's take a look at the trigger bar and connector mechanism.

C and 1

No, try again

*goto: Slide stop interface

C and 2

No, try again

*goto: Slide stop interface

*progress: 50%

*wait: 3seconds

*header: The trigger bar and connector

Here are some pictures showing how the end of the *trigger bar* contacts the *connector*:

*image: http://i.imgur.com/JXfhqLT.png

*image: http://i.imgur.com/ItlX1LS.jpg

Here’s a picture showing the relation between the end of the trigger bar and the connector before the trigger has been pulled:

*image: http://i.imgur.com/K6Gyhp1.png

Here’s a picture showing the relation between the end of the trigger bar and the connector after the trigger has been pulled:

*image: http://i.imgur.com/thHu1Iy.jpg

*wait: 1seconds

*button: Next

*progress: 60%

*header: Trigger bar, connector, and reset

The trigger connector controls the *trigger weight* or *trigger pull*, depending on it's *ramp angle*. Typical GLOCK trigger weights vary from 3.5 pound force to 8 pound force. Custom shops fabricate custom connectors which vary in trigger weight.

The following video demonstrates how the trigger assembly and *connector* works in the GLOCK handgun. This is a 12 minute video, but if offers a great explanation of the trigger assembly. It also explains how to improve the mechanism via polishing contacting surfaces.

*video: https://www.youtube.com/watch?v=1WaRLlyPHlo

*wait: 1seconds

*button: Next

It is possible to put different connectors in Glock handguns. As you can see from the picture below, the “lip” on each connector is set at slightly different angle (indicated by the red lines).

*image: http://i.imgur.com/4pBkhC2.jpg

*header: Trigger connector vs trigger pull

*label: Connector variation

*question: List the connectors in order of lightest trigger pull to heaviest trigger pull

Connectors B,C,A

No, please try again

*goto: Connector variation

Connectors A,B,C

Yes, that's the right answer! A, B,and C are 3.5lb, 5lb, and 8lb trigger pull, respectively. Now let's take another quiz.

Connectors B,C,A

No, please try again

*goto: Connector variation

Connectors C,A,B

Almost, please try again

*goto: Connector variation

*wait: 3seconds

*header: Connector lip quiz

*label: Connector lip

*image: http://i.imgur.com/4pBkhC2.jpg

*question: What is the purpose of the "lip" of the connector?

The lip of the connector provides a surface which guides the trigger bar up, enabling the trigger bar to release the striker/firing pin.

No, please try again

*goto: Connector Lip

The lip of the connector provides a surface which guides the trigger bar down, enabling the trigger bar to release the striker/firing pin.

Yes, that is the correct answer! The lip of the connector guides the trigger bar *down*. Now let's see if we remember the major parts of a GLOCK.

*goto: GLOCK parts

The lip of the connector prevents the gun from firing in fully automatic mode.

No, please try again

*goto: Connector Lip

The lip of the connector prevents the gun from cycling if the magazine is empty.

*No, not this time, please try again

*goto: Connector Lip

*progress: 75%

*wait: 3seconds

*label: GLOCK parts

*header: Now I know the major parts of a GLOCK

*image: http://i.imgur.com/tGRekFt.jpg?1

*question: List the 6 parts in the order shown in the image above

Receiver, magazine, barrel, retainer, bullet, slide

No, please try again

*goto: GLOCK parts

Slide, magazine, receiver, bullet, barrel, retainer

Yes, that's the right answer!

Upper, magazine, bullet, barrel, plunger, lower

Almost, please try again

*goto: GLOCK parts

Magazine, barrel, casing, receiver, retainer, slide

Didn't get it this time, please try again

*goto: GLOCK parts

*wait: 3seconds

*progress: 85%

Gun Video Post-Quiz

--this is a video post quiz

*maintain: Firearm condition post quiz

*header: Let's answer some additional questions about potential firearm conditions

Assume that the firearm you see in the video below is loaded with a magazine, and is ready to fire. Watch the video to see the firearm being fired, and then answer the questions below.

*video: https://www.youtube.com/embed/tiIzDNORb-Y

*question: After the firearm was fired, is there a round of ammunition in the chamber?

*confirm

Yes

No

*question: After the firearm was fired, is the firearm in the "cocked" condition?

*confirm

Yes

No

*maintain: Firearm condition post quiz: manual cycling

*header: Condition = manual cycling

In the previous video, you saw the firearm being fired. Now, watch the video below to see the slide being *cycled manually*. An unfired round will be ejected from the firearm when the slide is cycled. Once you have watched the video, answer the questions below.

*video: https://www.youtube.com/embed/bRPUZbXGoNo

*question: After the slide was cycled, is there a round of ammunition in the chamber?

*confirm

Yes

No

*question: After the slide was cycled, is the firearm in the "cocked" condition?

*confirm

Yes

No

*question: Hypothetically, after the slide was cycled, what would happen if the trigger was pulled?

*confirm

A round of ammunition would be fired.

A "click" would be heard, but no round of ammunition would be fired.

Nothing would happen, as the trigger cannot be pulled back any further than it already is.

*maintain: Firearm condition post quiz: firearm being fired

*header: Condition = firearm is fired

In the previous video, you saw the side being cycled. Watch the video to see the *firearm being fired*, and then answer the questions below.

*video: https://www.youtube.com/embed/CXma1I3O87E

*question: After the firearm was fired, is there a round of ammunition in the chamber?

*confirm

Yes

No

*question: After the firearm was fired, is the firearm in the "cocked" condition?

*confirm

Yes

No

*question: Hypothetically, after the firearm was fired, what would happen if the trigger was pulled again?

*confirm

A round of ammunition would be fired.

A "click" would be heard, but no round of ammunition would be fired.

Nothing would happen, as the trigger cannot be pulled back any further than it already is.

*maintain: Firearm condition post quiz: magazine released from firearm

*header: Condition = magazine released from firearm

In the previous video, you saw the firearm being fired. Now, watch the video to see the *magazine being released* from the firearm. You will see the magazine fall away from the firearm. Once you have watched the video, answer the questions below.

*video: https://www.youtube.com/embed/G8yXQcfB1mA

*question: After the magazine was released from the firearm, is there a round of ammunition in the chamber?

*confirm

Yes

No

*question: After the magazine was released from the firearm, is the firearm in the "cocked" condition?

*confirm

Yes

No

*question: Hypothetically, after the magazine was released from the firearm, what would happen if the trigger was pulled again?

*confirm

A round of ammunition would be fired.

A "click" would be heard, but no round of ammunition would be fired.

Nothing would happen, as the trigger cannot be pulled back any further than it already is.

*maintain: Firearm condition post quiz: magazine released and trigger pulled

*header: Condition = magazine released from firearm and trigger pulled

In the previous video, you saw the magazine being released from the firearm. After the magazine was released from the firearm, assume that the *trigger was pulled* (not shown in the video). Answer the questions below.

*question: What happened when the trigger was pulled?

*confirm

A round of ammunition was fired.

A "click" was heard, but no round of ammunition was fired.

Nothing would happen, as the trigger could not be pulled back any further than it already was.

*question: After the trigger was pulled, where would the the slide be positioned?

*confirm

The slide would be in the forward position.

The slide would be locked in the backwards position.

*maintain: Firearm condition post quiz: unloaded firearm

*header: Condition = unloaded firearm

Assume that the firearm you see in the video below is *completely unloaded*. The slide will be locked back using the slide stop lever. Watch the video to see the slide being locked back, and then answer the questions below.

*video: https://www.youtube.com/embed/u-Djt4NlvSE *question: After the slide was locked back, is there a round of ammunition in the chamber?

*confirm

Yes

No

*question: After the slide was locked back, is the firearm in the "cocked" condition?

*confirm

Yes

No

*question: Hypothetically, after the slide was locked back what would happen if the trigger was pulled?

*confirm

A round of ammunition would be fired.

A "click" would heard, but no round of ammunition would be fired.

Nothing would happen, as the the trigger cannot be pulled back any further than it already is.

*maintain: Firearm condition post quiz: live round in chamber

*header: Condition = live round manually inserted into the chamber

In the previous video, you saw the slide being locked back. Now, watch the video to see a live round of ammunition being *manually inserted into the chamber* of the firearm. Once you have watched the video, answer the questions below.

*video: https://www.youtube.com/embed/0DwFnfeJmlw

*question: After the round of ammunition was inserted into the chamber, is there a round of ammunition in the chamber?

*confirm

Yes

No

*question: After the round of ammunition was inserted into the chamber, is the firearm in the "cocked" condition?

*confirm

Yes

No

*question: Hypothetically, after the round of ammunition was inserted into the chamber what would happen if the trigger was pulled?

*confirm

A round of ammunition would be fired.

A "click" would heard, but no round of ammunition would be fired.

Nothing would happen, as the the trigger cannot be pulled back any further than it already is.

*maintain: Firearm condition post quiz: slide released

*header: Condition = slide released

In the previous video, you saw a live round of ammunition being manually inserted into the chamber of the firearm. Now, watch the video to see the *slide being released*. Once you have watched the video, answer the questions below.

*video: https://www.youtube.com/embed/nbvhU1YFCI0

*question: After the slide was released, is there a round of ammunition in the chamber?

*confirm

Yes

No

*question: After the slide was released, is the firearm in the "cocked" condition?

*confirm

Yes

No

*maintain: Firearm condition post quiz: trigger is pulled

*header: Condition = trigger is pulled

In the previous video, you saw the slide being released. After the slide was released, the *trigger was pulled*.

*question: What happened when the trigger was pulled?

*confirm

A round of ammunition was fired.

A "click" was heard, but no round of ammunition was fired.

Nothing happened, as the trigger could not be pulled back any further than it already was.

*question: After the trigger was pulled, where was the slide positioned?

*confirm

The slide was in the forward position

The slide was locked in the backwards position

B.8 Gun-Conclusion

--this program follows the intervention

--confidence

*maintain: Confidence Questionaire

*header: Let's answer some questions relating to the operation of a handgun

*image: http://i.imgur.com/zPCmSzY.jpg

*question: Now that you have completed the learning intervention component of this survey, how easily do you feel that you can answer additional questions relating to the mechanical operation of a handgun?

*confirm

*type: slider

1

2

3

4

5

6

7

*before: 1-Not at all confident

*after: 7-Very confident

--short MAT post

*if: aDone

*program: Gun-NEW-MATb

*if: bDone

*program: Gun-NEW-MATa

*progress: 90%

Now you will watch additional videos similar to those prior to the intervention. Please re-read the instructions below.

The videos manipulate the firearm in various ways. After each video, you will be asked to answer some questions.

There is a simple "formula" you will need to know: If there is a round of ammunition in the chamber AND the firearm is in the "cocked" condition, THEN when the trigger is pulled a round of ammunition will be fired.

You can answer all of the questions from the information provided - no other information is required.

Assume that the videos are sequential, and that there are no hidden or missing steps. Assume that the firearm and magazines function correctly at all times.

*button: Next

B.9 Gun Video Post-Test

--gun video post-quiz

*program: Gun-VideoPostQuiz-NEW

*maintain: Let's answer the mechanical function question again *question: There are seven mechanical functions of a handgun. Select the order in which these functions occur.

*confirm

Feed, Lock, Cock, Fire, Unlock, Extract, Eject

Lock, Cock, Feed, Unlock, Fire, Eject, Extract

Cock, Lock, Feed, Fire, Extract, Unlock, Eject

Cock, Fire, Lock, Unlock, Feed, Extract, Eject

*maintain: The End :)

Thank you for participating in this survey! Your cooperation is greatly appreciated.

*question: In the box below, please type YES or NO if you have learned something about the GLOCK mechanisms and feel more confident about handguns in general. You can also leave other comments here. Hit the *Submit* button to save your work.

*type: paragraph

*progress: 100%

Good Bye!

*image:https://i.imgur.com/8zFVrar.jpg

*quit