Towards Accelerated Learning Pedagogical Templates in GIFT: Analogical Reasoning and Honesty-Humility Traits

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INTRODUCTION

Tactical Combat Casualty Care (TC3) is taught to members of the United States military at all levels to ensure Soldier safety. It is the process of responding to a casualty in the middle of a combat engagement. The United States Army utilizes medical training programs to educate and evaluate TC3 for all Soldiers. According to the Department of Defense, there are currently over one million US Army Soldiers which means that each of those Soldiers have experienced some basic level of TC3 during their Army service (DOD, 2018). Improvement in the education of TC3 is essential to help ensure Soldier safety and begin to lower the 90% of combat related deaths that occur before the injured Soldier reaches higher level medical care (Kotwal, 2011). The Army is also making the shift to more digital and online training to expedite learning and save on costs of hands on training for each Soldier (Army.Mil, 2013). The balance that must be struck in the future of army training is mitigating the expense while ensuring that adequate training is being distributed to all personnel.

Adaptive online educational tools are the way forward for the Army to expedite learning and is an explicit effort of the Army Research Lab’s Essential Research Area: “Accelerated Learning for a ready and Responsive Force” (DeFalco, 2018). In the effort of supporting expertise development, Jung (2016) and Hoffman et al., (2013) recommend fostering high-level reasoning skills. According to the Center for Advancement of Learning and Assessment (King, Goodson, & Rohani, N.D.), higher order thinking skills include critical, logical, reflective, metacognitive, and creative thinking, and are activated when individuals encounter unfamiliar problems, uncertainties, questions, or dilemmas.

Within this framework, then, supporting an accelerated learning pathway to develop the cognitive skills of an expert includes supporting the development of creative thinking--specifically creative reasoning-- a core element of cognitive readiness. Further, we conceptualize an accelerated learning pathway as a pedagogical design template that would be used to accelerate learning in an adaptive instruction system (AIS) that would sequence adaption of instruction according to salient learner traits, in this case personality traits. Pedagogical design templates contain specific, ready-to-be-used content and/or information to inform pedagogical decision-making and instruction that may or may not align to specific learning theories but can simply and streamline pedagogical planning and designs (Dobozy & Dalziel, 2016)—a useful tool for supporting transdisciplinary learning in adaptive instructional systems (AISs) such as the Generalized Intelligent Framework for Tutoring system (GIFT).

The first step in developing a pedagogical design template that would support accelerated medical expertise in an AIS includes understanding what learner traits are correlated with analogical and creative reasoning. Accordingly, our first experiment sought to determine whether there were significant positive correlations between personality traits as measured by the HEXACO with mental rotation tasks and analogical reasoning tasks—two approaches to measure an individual’s creative and analogical reasoning skills. This paper reports on our initial findings derived from our first correlational study conducted at the United States Military Academy in the fall of 2018.

ANALOGICAL REASONING AND DECISION-MAKING

Cognitive tasks

The importance of analogical reasoning on decision-making is well evidenced in prior related research. For example, Breuning (2003) looked at the impact that analogical reasoning had on foreign policy decision-making. Analogical reasoning in foreign policy is related to historical case-based explanations to determine how to interact with the current political climate (Breuning, 2003). His study analyzed a 1950s Senate Hearing transcript by breaking each paragraph into either case-based, explanation-based, or model-based reasoning. Breuning (2003) found that approximately 75% of the speakers at the hearing used more explanation-based reasoning than analogical (case-based). The results can be generalized to cognitive models in determining some of the ways that people think and make decisions. The cognitive processes involved in analogical reasoning may seem confusing for foreign policy, but it serves as a spring board for how people remember and react to evolving information.

Additionally, Visser’s (1996) identified the two different types of “spontaneous” use of analogy in design. The study analyzes the question of ill-defined problem solving from a cognitive psychology viewpoint by looking at action-execution and action-management analogies. Visser (1996) also explains that there is a gap in the literature on analogous sources and their carry over to tasks in the real world. Action execution is more related to developing and expelling the solution to a complex problem whereas action management looks to accomplish the next action that needs to be executed (Visser, 1996). The participants were recorded performing mechanical tasks, and the results showed that the greater the distance between the target task and the source task, the greater difficulty in creating the analogy. The integration of various types of analogical reasoning can be applied to intelligent tutoring software by helping the developer of the training tap into the ways that people think about learning and solving problems.

In addition to analogical reasoning, one’s skill in mental rotation tasks is another competency related to decision-making. Ganis and Kievit (2015) claimed that mental rotation tasks are one of the most influential paradigms in the history of cognitive psychology. Three-dimensional software was employed by Ganis and Kievit to generate 384 objects for rotation with both a baseline object and a target object. Importantly. Mental rotation can predict performance variables such as surgical and spatial skills. 54 participants (31 females) were tested individually at about 60cm from a computer screen and carried out two blocks of 48 trials. The results displayed a linear increase in response time and error rates with angular disparity (Ganis & Kievit, 2015). This means that the greater disparity, the larger the response time from the participants.

Further, Lufler, Zumwalt, Romney and Hoagland (2011) studied the correlational relationship between anatomy student’s performance in the course and their visual-spatial ability. 352 first year medical students completed the Mental Rotations Test before the gross anatomy course and 255 at the completion of the course in 2008 and 2009 (Lufler, Zumwalt, Romney & Hoagland, 2011). They determined that students who scored in the highest quartile of the MRT were 2.2 times more likely to sore over 90% on the practical examinations and on both practical and written exams (Lufler, et al., 2011). This is a significant connection to GIFT’s application for TC3 because if Soldiers can consistently do well with the mental rotation tasks then they arguably will have a greater likelihood of increased performance in real-world application. While mental rotation is important for creativity, it must be coupled with the ability to learn quickly and under pressure to have a positive impact on Soldier training.

Accelerated learning

Accelerated learning is a strong driving force behind the ideas of GIFT and other digital learning platforms in that they hope to educate the learner effectively and efficiently. Accelerated learning is defined by Hoffman, Feltovich, Fiore, Klein and Ziebell (2009) as not only the hastening of basic proficiency in a task but also encompasses the achievement of expertise. Cognitive flexibility and transformations can help to explain how people can react to accelerated learning. Flexibility is a person’s ability to understand their own mental barriers to learning and determine the way around that block (Hoffman, Feltovich, Fiore, Klein, & Ziebell, 2009). Transformation refers to the necessity of unlearning a task in order to eventually become an expert in that area. Hoffman explains that these factors, combined with a supportive mentor and corrective feedback, help to facilitate successful accelerated learning.

Hoffman (2010) provides a summarized framework for the elements within accelerated learning. He uses the military as an example of where this problem is constantly arising. There are two different forms for transferring knowledge with an accelerated learning framework: transfer across mission types and transfer across responsibility (Hoffman, 2010). In the military, this transfer happens constantly through the changing responsibilities from deployments to changing jobs throughout the military service time. Transfer across missions refers most directly to a Soldier’s doctrinal knowledge of the different types of missions they will conduct. Each individual Soldier knows the difference in mission between an ambush and movement to contact. Transfer across responsibilities is similar to the role of a squad leader who is promoted to platoon sergeant. That Soldier needs to know what a good squad leader does and how to coordinate an entire platoon as the highest ranking Non-Commissioned Officer.

Personality and Academic Performance

In a review of the literature, Batey and Furnham (2006) note that while creativity in terms of the production of ideas is related to intelligence, creativity as originality rests largely on personality factors. O’Connor and Paunonen (2007) studied the relationship between the Big Five personality traits and post-secondary academic achievement. This review of other studies uncovered that Openness to Experience was found to be positively correlated with scholastic achievement while Extraversion was negatively correlated (O’Connor & Paunonen, 2007). The current research on the Big Five lends itself to the importance of identifying the types of learners to potentially develop curriculums to improve levels of academic performance in the future (O’Connor & Paunonen, 2007).

Chamorro-Premuzic and Furnham (2008) conducted a study that analyzed the relationship between the personality traits of Openness, Conscientiousness, and cognitive ability and learning. Ability was measured by the Baddeley Reasoning test of fluid intelligence (*gf)* and the Wonderlic Personnel Test IQ (Chamorro-Premuzic & Furnham, 2008). The experimenters defined the learning levels as either surface, deep, or achieving and then had the students conduct four tests by then end of their first month at the university and again during their second year (Chamorro-Premuzic & Furnham, 2008). The results showed that exam marks were significantly correlated with the three personality traits tested. Specifically, Openness had a high positive correlation with IQ, and IQ was strongly correlated with academic performance (Chamorro-Premuzic & Furnham, 2008).

In an additional study, Chamorrow-Premuzic and Furnham (2009) hypothesized that Openness to Experience would have a positive relationship with deep learning. They tested 852 students on the Neuroticism- Extraversion- Openness- Five Factor Inventory (NEO-FFI), as well as a 42-item questionnaire that focused on the reasoning behind how students learn (Chamorro-Premuzic & Furnham, 2009). The results were binned into surface, deep, and achieving categories, showing that Openness to Experience and deep learning were positively correlated.

However, while there is a more robust body of evidence that employs the Big Five (or five factor model) as it relates to intelligence, we have made the choice to employ the HEXACO personality instrument (Ashton & Lee, 2007) as it includes a six trait—Honesty-Humility—that we hypothesize is implicated in positive learning outcomes. Importantly, the Honesty-Humility factor out predicted all factors of the Big Five for correlations with respect to an overt integrity test and business ethical dilemmas task (Ashton & Lee 2007). This is incredibly important to both college and military training tools in that a high Honesty-Humility score can be predictive of a decreased likelihood to cheat others. Also, Openness to Experience reflected in participants an increased opportunity for gains from the energy and time spend in the areas that the participant was interested in (Ashton & Lee, 2007).

CORRELATIONAL STUDY

Research questions and hypotheses

The overarching research question for this work seeks to determine the whether there are statistically significant correlations between analogical/creative reasoning tasks and spatial reasoning tasks with the personality traits measured by the HEXACO and the Short-Item Grit Scale (Duckworth & Quinn, 2009).

The first hypothesis maintained that there would be a statistically significant correlation between the HEXACO personality factor of Openness to Experience and a subject’s performance on the analogical reasoning and mental rotation tasks. The second hypothesis stated there would be a statistically significant relationship between the HEXACO personality factor of Honesty-Humility and a subject’s performance on the analogical reasoning tasks. The third hypothesis stated there would be a statistically significant positive correlation between the mental rotation and analogical reasoning tasks.

Participants

128 participants (*m=* 19.66 *SD* = 1.464) and then received 5 points of extra credit for their introductory psychology class for their participation in the study. In the study, 23 participants self-identified as a novice, 73 self-identified as a journeyman, and 1 self-identified as an expert in the field of combat casualty care treatment. The cadets make up a diverse population of 18-22 years old from across the United States and some allied nations.

Apparatus

The original plan for running this correlational study was to use GIFT to deliver the assessment instruments. However, at the time this study was ready to be launched, it was discovered that GIFT did not have the capability to design a timed question that would launch subsequent questions at the time expiration. For the mental rotation tasks, to obtain a more accurate measurement of a person’s spatial ability, the instrument is designed so that participants only have 7.2 seconds to respond whether the images are the same or different before loading the next image. At the time of writing this paper, timed questions have now been added as a functionality into GIFT, but this functionality was not integrated at the time of running this first correlational study. With that limitation in mind, this experiment utilized Qualtrics to distribute the survey and the SONA system at USMA to obtain participants and provide those participants with extra credit points. Qualtrics is an online survey software that allows the experimenter to digitally upload their survey for participants to complete. The survey consisted of the demographic questionnaire, the short item grit survey (Duckworth & Quinn, 2009), the HEXACO personality test (Ashton & Lee, 2007), the Analogical Finding Task Matrix (AFTM) (Weinberger, Iyer, & Green, 2016), and mental rotation tasks (Ganis & Kievit, 2015).

The Short-Item Grit survey determines how the attribute of Grit supports or impedes creative reasoning (DeFalco, 2018). The eight grit questions are scored on a five-point Likert scale ranging from “not like me at all” to “very much like me” in response to questions like “I am a hard worker” and “setbacks don’t discourage me” (Duckworth & Quinn, 2009). Participants were not limited in their time to answer these questions, but the average response time was five minutes to complete the survey.

The HEXACO personality survey took approximately twelve minutes to complete 60 questions, where participants respond on a five-point Likert scale.

The analogical task finding matrixes (there were two) asked participants to match 10 analogical pairs with one other pair with only one response per each analogical pair. This portion of the survey took approximately eight minutes. For example, participants could be given “Watermelon/Rind” and they could match it with “Orange/Peel.”

The mental rotation tasks took 7.2 seconds each and there was a total of 40 pairs delivered. In this task, the participant must identify if the three-dimensional shapes are the same or different before another pair of images are displayed for a response.

Research design

The research design was a correlational study to determine if there was a statistically significant positive relationship between the analogical reasoning and mental rotation tasks and any of the traits measured by the HEXACO, as well as to determine the relationship between the HEXACO traits and Grit, as well as the mental rotation tasks and analogical reasoning tasks.

Procedure

For the correlational study, participants were informed of potential extra credit survey opportunities through the SONA system and could access the survey either on a mobile device or on their laptops. The participants could choose from a list of approved surveys and 128 of them selected “Developing Accelerated Learning Models in GIFT.” The consent form was the first screen to appear to the participants. After consenting to the experiment, participants answered the twelve demographic questions for approximately five minutes.

Next, participants responded to the ATFM and matched two sets of 10 analogical pairs for roughly eight minutes. The participants then answered either “same” or “different” for the 40 mental rotation tasks, with a forced response time to occur within 7.2 seconds for each pair of shapes. Then the participants took the Short-Item Grit survey and then the 60 HEXACO questions for ten minutes. Participants had to complete all questions from the previous section before moving on to the next set of questions. At the completion of the Grit and HEXACO portion, participants had completed the entire survey and experimenters were able to assign extra credit points for their participation. The total time for this study was roughly 35 minutes.

Results

Descriptive data is displayed in Table 1 below. The discrepancy in sample sizes for the different portions of experiment one was likely caused by internet connection issues and the various time schedules that cadets at USMA operate under.

Table 1. Descriptive Statistics of Test Subjects

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable** | **Statistic 1** | **Statistic 2** | **Statistic 3** |
| Age (*N*=92) | Mean = 19.66 | *SD* = 1.464 | Range: 18-24 |
| Gender (*N*=92) | Female = 33 | Male = 64 |  |
| Military Service (*N*=92) | Yes = 15 | No = 82 |  |
| Critical Care Knowledge  (*N*=92) | Novice = 23 | Journeyman = 73 | Expert = 1 |
| Mental Rotation Score  *(N*=92) | Mean = 32.34 | *SD* = 6.288 | Total Score = 40 |

|  |  |  |  |
| --- | --- | --- | --- |
| Analogical Reasoning Semantic Distances:  Matrix 1 (*N*=97) | Mean = 774.38 | *SD* = 274.251 | Total Score = 1069 |
| Analogical Reasoning  Semantic Distances: Matrix 2 (*N*=97) | Mean = 603.91 | *SD* = 298.52 | Total Score = 1052 |
| Openness to Experience  (*N*=92) | Mean = 32.63 | *SD* = 6.326 |  |

After data collection from Qualtrics, data was cleaned and analyzed, correlational analyses were run in SPSS.

For the analogical reasoning tasks there were two matrices used to measure both creativity and analogical reasoning. The semantic distance score for the analogical reasoning tasks gives the measure of strength of an individual’s reasoning level (DeFalco, 2018). There was a statistically significant correlation between the Openness to Experience score on the HEXACO traits and the semantic distance score of the analogical reasoning task (r= 0.279, *N*= 92, *p*= 0.007). There was also a positive relationship between the analogical reasoning task and the mental rotation tasks (r=0.444, *N*=95, *p*=0.000).

Also, by splitting the groups into high (>33) and low (<32) of the Honesty-Humility factor, there was a statistically significant difference in the means sematic distance of analogical reasoning tasks in the first matrix, *F*(2,94) = 7.046, *p* = 0.001. There was also a positive correlation between GRIT and HONESTY-HUMILITY, r = .343, *N* = 92, *p*= 0.001. There was a positive correlation between the score of the semantic distance of analogical reasoning tasks in the second matrix and the HONEST- HUMILITY score, r= 0.332, *N* = 92, *p* = 0.001.

CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

The results of this correlational study confirmed that there was a statistically significant positive correlation between Honesty-Humility and an individual’s creativity levels. Also, there was a statistically significant positive correlation between Openness to Experience and a subject’s performance on the analogical reasoning tasks. This information is relevant for informing the design of a future experiment that will determine whether the sequencing of content with analogical/creative reasoning tasks contributes to an acceleration of medical decision-making expertise within the domain of critical care. With this data, we expect to make significant strides towards validating a transdisciplinary pedagogical design template that can become part of the suite of tools integrated into the dashboard of GIFT’s authoring tools.

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