Why is Learning so Difficult to Measure when "Playing" Simulations

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ABSTRACT

The link between cognitive learning and success in business simulations has been elusive. Few research studies have successfully linked cognitive processes to business simulation outcomes with a significant amount of explained variance. This paper attempts to explain why this may be true and offers some suggestions to obtain better results.

INTRODUCTION

My grandpa, who only attained a 4th-grade education, once said to me, "You cannot learn how to ride a bicycle or how to swim, by reading a book," and he was correct. (Grandfathers are almost always correct.) The grade on an examination after taking a course in economics, statistics, marketing, etc. can reveal most of what has been learned after the class its final examination. This knowledge may have been obtained during the class and its multiple assignments or before (or simultaneously) in a different course or even by experience during some undefined activity when the person was younger. All that we can certify is the amount of knowledge the student, at that moment in time, knows about the content of that specific course. Instructors practice this phenomenon every day. Why does this method not work well with business simulations? Joseph Wolfe et al. (2017) wrote "After over 60 years of business game usage in higher education, there is still no objective evidence that they teach a course's subject matter. Many have attempted to answer this question, but few have succeeded" (Quote from the abstract).

Let's look at a typical business course. Each course designates a small body of specific knowledge. In microeconomics, it may be, "the price-demand curve slopes downward and to the right (in most cases), etc. In Statistics, it might be, a linear relationship between two variables is significant only if the "p" value is less than 0.05 and so on. (often a false assumption.) Most of what we teach are facts and methods; and it is assumed that given the facts and methods, the students should be able to apply them correctly. (There are numerous exceptions to this assumption.) Case courses require analysis and provide examples of alternative solutions, or try to point toward an acceptable solution with home-work providing practice. Simulations require analysis of situations, decisions necessary to be competitive, living with the consequences and planning for the next and future periods. The reasoning behind using a business simulation in a class is simply to have the participants get better and better at analysis, decision-making, and planning, round after round.

According to Kolb (1984). "Learning is the process whereby knowledge is created through the transformation of experience." He identified 4 steps of experiential learning, these being: "1) concrete experience (CE); 2) Reflective observation (RO); 3) Abstract conceptualization (AC); and 4) Active experimentation (AE). Active experimentation and concrete experience together constitute the tangible dimension of learning." These four steps describe how most business simulations work in a business school setting.

HOW HAS ABSEL APPROACHED THIS PROBLEM IN THE PAST

ABSEL authors have taken three approaches to the issue of learning from simulations. These have been:

1. Attempting to determine if any learning takes place as the result of participating in a business simulation.
2. Attempting to determine the relationship between simulation performance and various measures of cognitive learning.
3. Attempting to determine what learning may have occurred during the process of participating in a business simulation. This research included both cognitive as well as non-cognitive learning.

Does Any Learning Take Place?

At the very first ABSEL conference, Achilles Armenakis et al. (1974) reported a study of the performance of teams participating in the 1974 Emory University Intercollegiate Business Game. The authors devised a scoring system and evenly split the teams into two groups. They then attempted to determine the differences between the best performing teams and the poorer performing teams. That study had four primary hypotheses:

1. Do successful teams employ more quantitative methods than unsuccessful ones? No statically significant differences were found.

2. Does the experience in participating in the I.B.G. distinguish between teams that are successful and unsuccessful? No statically significant differences were found. Competing in a previous Emory University business simulation contest did not enhance the chances of winning a later Emery contest.
3. Does previous experience participating in business games differentiate successful and unsuccessful teams? A significant difference was found with ("p") < 0.05). This is an important finding, as it indicates that participants had learned from previous "plays" of a business simulation.
4. Do successful teams devote more time to making decisions than unsuccessful teams? No statically significant differences were found.

In the 3rd ABSEL conference, David J. Fritzsche (1976), Reported on learning styles, perceived learning, and simulation performance, using game grades as the dependent measure. His learning styles were non-cognitive measures defined by Kolb and Goldman (1973). These learning styles were identified as divergers, assimilators, convergers, and the accommodators. The meanings of these four styles are:

> **"The Diverger ...**is best at Concrete Experience (CE) and Reflective Observation (RO). His/her greatest strength lies in his Imaginative ability."
> **"The Assimilator's** dominant learning abilities are Abstract Conceptualization (AC) and Reflective Observation (RO). His/her greatest strength lies in his ability to create theoretical models."
> **"The Converger's** dominant learning abilities are Abstract Conceptualization (AC) and Active Experimentation (AE). His/her greatest strength lies in the practical application of ideas."
> **"The Accommodator** …has the opposite strengths of the Assimilator. He/she is best at Concrete Experience (CE) and Active Experimentation (AE). His/her greatest strength lies in doing things, in carrying out plans and experiments and involving himself in new experiences" (Quote from page 457, Fritzsche 1976).

The hypothesis that the grades assigned to the simulation differed depending on the learning styles was rejected with "p" = 0.25.

Miles, Biggs, and Schubert (1986) reviewed sixteen studies that used student self-judgment of skill acquisition through cases and simulation games as the dependent variable. They concluded that the mixed results uncovered were difficult to interpret and compare because of the wide variety of study environments used.

THE RELATIONSHIP BETWEEN SIMULATION PERFORMANCE AND COGNITIVE LEARNING

Whiteley and Faria (1989) conducted a study attempting to measure the learning from a business simulation by the final exam performance. Students were divided into two groups after the midterm exam., one playing a simulation and the other group did not. Both groups attended the post-midterm lectures in the class. The assumption was that those who "played" the simulation would perform better on the final after taking the effect of the midterm exam into consideration. The effect of the midterm on the final grade was significant ("p" <0.001) but the effect of the gameplay was not. They reported ("p") > 0.05). Their remark was "Despite the proliferation, and widespread use of business simulation games, a review of the literature reveals that the pedagogical value of such games remains unclear." (Quote from page 78)

Teach (1990), claimed profit was a false prophet of learning. He suggested that "Better measures of managerial ability would be gained by measuring and analyzing errors in forecasting over a wide variety of events. The ability to operate within budget constraints and to allocate limited resources among almost limitless needs is also an indicator of managerial ability." "Measuring profit performance requires the limitation that all firms must start as equals." (The quotes are from the abstract.)

Washbush and Gosenpud (1993), examined the relationship between learning and simulation performance, using a total enterprise simulation. They "found no direct, positive linear correlations between learning and simulation performance" (Quote from page 141). In the following year, Washbush and Gosenpud (1984) restudied that relationship. This time they divided the teams into three groups, a top performing set of teams, a middle-of-the-road set of teams and a set of the poorest performing teams. Voila! A strong relationship exists between the middle-of-the-road group. ("p" < 0.005) But no significant findings for the leaders or those with poor performing teams. The hypothesized was that teams that are leading have such a comfortable lead that they no longer have to work. Teams at the back-of-the-pack lost hope and gave up. Middle-of-the-roaders see chances of winning if they work hard. Long-term leaders have a substantial advantage over the rest of the teams may contribute to this "giving-up" phenomenon. (see Patz (1999, 2000, 2001, 2002. 2003 and 2004) and Teach and Patel (2007).

LEARNING BY PLAYING

Gee (2003) wrote **"…**the learning principles that good games incorporate are all strongly supported by contemporary research in cognitive sciences - the science that studies human thinking and learning through laboratory research, studies of the brain, and research at actual learning sites like classrooms and workplaces. Gee went on saying beyond using the learning principles that good games incorporate, I also argue that schools, workplaces, and families can use games and game technologies to enhance learning. Further, I believe that use of games and game technologies for learning content in schools and skills in workplaces will become pervasive."

Effect of Complexity

Examining the degree of learning by a simulation participant, this outcome is affected by the complexity of the simulation. Numerous authors have reported a variety of views. Complexity and realism may not be an advantage.

Springer et al. (1965) wrote that "The power of a model in solving a problem comes precisely from it's not corresponding to reality except in those details pertinent to the problem at hand." (Quote from page 178).

Frazer (1977) wrote, "...playing many different (simple) games in a course with students on different teams for each game is now a viable alternative to the traditional management simulation played over a prolonged period." (Quote from page 3).

Wolfe (1978) conducted a study to investigate the link between game complexity and the acquisition of business policy knowledge. Wolfe reported, "The simple game increased knowledge in two of the emphasis areas - the need for reappraisal and flexibility, and the effects of individual and group factors in policy and decision-making situation. The IG [intermediate complexity game] improved only one area, while the CG [complex game] improved a player's knowledge in all five areas." (Quote from page 149). Wolfe's selection of using only two simulations to represent complexity may have resulted from the difference between the two simulations rather the difference in complexity.

Patz (1990, 1992, 1995, 1999, 2000, 2001, 2002, 2003, 2004, 2005 and 2006) noted problems when evaluating participants in several total enterprise simulations. The participant biased evaluations were by a phenomenon he called "Dominance," which occurs when teams whose firms have the best performance early in the game seem to obtain a great deal of market power and go on to maintain or dominate the industry regarding performance. The results of Professor Patz's results were composite measures of firm performance which often have as many as ten identifiable measures.

Hall and Cox (1994) challenged the assumption that complexity was necessary to create educationally effective business simulations. These authors described two aspects of realism. The first assertion was that realism was "a key determinant of educational effectiveness and that realism was produced through complexity." And the second aspect was that "the amount of cognitive processing performed by participants relate to the simulation's complexity. In turn, the simulation's duration relative to cognitive processing produces cognitive pressure that may lead to role overload." This role overload was negatively related to the level of adult learning (Quotes from page 30).

The risk of role overload (French and Caplan 1972) is very great in large-scale simulations. TTeach (1990b) identified this problem as *analysis paralysis*. Teach and Murff (2008), reviewed complexity and its effects on simulation performance and learning. They suggested that the suggested preparation time and playing time as effective measures of simulation complexity.

TABLE 1
A SHORT LIST OF WHAT STUDENTS MIGHT LEARN
WHILE PARTICIPATING IN A BUSINESS SIMULATION

1. How forces outside of the firm's control may affect the firm's performance
2. How to understand marginal analysis
3. How to understand Opportunity costs
4. The importance of the many topics of forecasting and the costs of forecasting errors
5. What unintended consequences are
6. How product life cycles affect decisions
7. How variable costs turn into fixed costs as soon as commitments are made
8. The importance of product positioning
9. How to work in teams
10. How to differentiate important information from unimportant information
11. How to work under uncertainty
12. How to determine interactions among two or more decision variables
13. How to anticipate competitive responses
14. How to considering possible competitors' decisions when proposing strategies
15. How to analyze reports and financial results
16. How to assess risk
17. How to be innovative
18. How to be creative
19. How to create budgets
20. How to interpret useful statistics

ARE NON-COGNITIVE VARIABLES A DETERMENT OF SUCCESS: A SURPRISE FINDING?

No, not at all. We have all noticed highly successful entrepreneurs who have either never attended a college or university or have dropped out of college or university and started a successful business. In spite of business schools' claims to train future business executives, more CEOs and senior management personnel do not have MBAs than those who have these prestigious degrees. There is much more to learning than the cognitive sciences. How and why does this phenomenon occur?

One big problem found in studies that want to link the attributes of participating in business simulations to learning lies in degrees of freedom. Too many variables, too few observations, as well as a lot of unobservable, non-cognitive learning (skills) of the team members, confuses the outcomes and muddies the results.

What is the student expected to learn while participating in a business simulation? Some simple questions come to mind. "What price should I set, when I do not know what my competitors are going to do?" Or, "How do I forecast next period's industry level of demand." Or. "Once an estimate of industry demand is forecast, how do we then estimate our own firm's unit demand to set our production schedules that will reduce the out-of-stock costs?" These are only three of the important things a student needs to learn to be successful in a business simulation. There are many others. Then why can we not determine an individual's learning by using a multiple regression of the estimated causes of forecasting errors? (Teach, 2006) Does this measure learning?

Table 1 shows a brief and incomplete list of what simulation participants might need to learn while participating in a business simulation.

The table is only a small example. Almost any person who has worked with business simulations is capable of producing a list of 20 to 40 items that students might learn while participating in a competitive simulation.

Almost every item on the above list has been taught in Business school classes, and most students can explain how each term is defined, but most do not know how, when or where to apply the concepts. The how, when and where may be learned most efficiently through the adoption of experiential exercises such as business simulations in a business school curriculum.

Let's face it, most college-level business courses teach facts and methodology, and not how to implement methods nor how to determine which facts to use. Simulations rely on skills needed to interpret which facts are more important and what facts are less important. To successfully compete in a simulation, students need the skill of understanding the boundaries of uncertainty. (i.e., Is the student able to estimate what price a competitor might be charging in period t+2?

These are skills, not raw knowledge but competencies. Both leadership competencies and functional competencies are needed.

GRIT

A research study by Tim Kautz et al. (2008) provides some insight into measuring skill levels. The Kautz study reported "… non-cognitive skills such as perseverance skills ("grit"), conscientiousness, self-control, trust, attentiveness, self-esteem and self-efficacy, resilience to adversity, openness to experience, empathy, humility, tolerance of diverse opinions and the ability to engage productively in society, which are valued in the labor markets, in school, and in society at large." (Quote from page 9.) "Achievement test scores predict only a small fraction of the variance in later-life success." Heckman et al. (2014) found achievement tests explained only 17% of the variability of later-life earnings. Heckman and Kautz (2014) found IQ tests alone explained only 7 percent of the variability in later-life earnings. The author considers that classroom examinations could be included under the rubric of "achievement tests." Given this observation, why would success in university coursework predict success in running a simulated business? It requires much more than standard academics. It seems that the term "non-cognitive skills" when combined with achievement scores such as grades, may better define success than academic knowledge alone and could be predictive of success in business simulations. "Skills are not set in stone at birth and determined at birth and determined solely by genes. They can be fostered. Cognitive and non-cognitive skills change with age and instruction." … "non-cognitive skills are more malleable at later ages than cognitive skills (Quote from page 10). "Many psychologists do not recognize the differences between these measures and interchangeably use IQ, achievement tests, and grades to measure "cognitive ability" or "intelligence" and this practice is also wide-spread in economics" (Benjamin et al. 2013). The term "skills" indicates that these skills can be taught and learned. Skills have been widely studied, and there is a taxonomy of non-cognitive skills called the Big 5. (Borghans et al. (2008). These are Openness to Experience, Consciousness, Extraversion, Agreeableness, and Neuroticism/Emotional Stability.

Duckworth et al. (2007) defined an additional non-cognitive skill they called "Grit," which is a measure of persistence on task or in the pursuit of a goal. Previous research has provided evidence of the predictive validity of the Grit Scale on educational attainment among adults, and grade point average (GPA) among Ivy League undergraduates (*See Duckworth et al. 2007). Lora Reed introduced the concept of Grit to ABSEL 2016. She commented "*Grit may be more important for academic success than innate intelligence. Grit consists of traits including 'resilience, self-control, and persistence' (Pappano, 2013, p. 4). 'It doesn't depend just on what is inside of us but on being in the right circumstance with people we trust."

According to authors Goodwin and Miller (2013), grit consists of four components; 1) **Directedness**: A person must begin with a goal in mind, be intent on accomplishing that goal, and must dedicate time and talent to attain the objective or end state. 2) **Motivation**: (Fenton, 2015); both intrinsic and extrinsic. Motivation means that the person has the desire or passion for achieving the goal, and the goal is meaningful to that person. 3 **Self-control**: Self-control requires an individual to avoid distractions and remain focused on the task (Goodwin and Miller, 2013). 4) **A positive mindset**: A positive mindset consists of embracing challenges and accepting failure as part of learning.

Directedness or the pursuit of a goal may require long hours of tedious work, may take priority over other activities, and may necessitate the denial of pleasure (Shoda, Mischel, and Peake, 1990). Given the amount of focus and labor involved, the person must decide that the goal is worth pursuing. In other words, a person cannot wander aimlessly through life, lackadaisically derive a plan, and yet expect a lifelong dream to come to fruition. Grit requires commitment and performance; a desire to succeed without work is just desire. Furthermore, some research has shown there is an inverse association between grit and an orientation toward pleasure (Suzuki, Tamesue, Asahi, and Ishikawa, 2015).

While no one expects total deprivation, individuals with grit are willing to forego pleasure or gratification to continue working towards their goals. This mindset of goal-over-pleasure is a significant part of what puts gritty people into a league of their own.

The second component of grit is motivation. If a person has the desire to achieve his or her goal, and that goal is meaningful, then motivation exists. According to the American Psychological Association (APA), there are two types of motivation; the key difference is whether the motivation arises from the outside (extrinsic) or the inside (intrinsic).

Extrinsic motivation occurs when a person expects to be rewarded, receive praise, or evade punishment and chastisement (Cherry, 2013). A simple view of extrinsic motivation is that it has two subsets: (1) the person receives recognition or (2) he eludes adversity. In both situations, the individual behavior is rewarded.

"With intrinsic motivation, a person performs a task because he/she finds the activity personally rewarding" (Cherry, 2016). In this case, the person does seek a reward from others. "Intrinsic motivation has two subsets: (1) the individual enjoys the task on a personal level or (2) despite dislike or disinterest, the individual wants to solve the problem or overcome the challenge. In either case, the desire is innate." The achievement of a goal is an intrinsic and extrinsic motivation. "However, in dealing with grit, extrinsic motivation is not enough; the goal is personal and the achievement of that goal requires intrinsic motivation," Fenton (2015). "Students tend to enjoy learning and to do better when they are more intrinsically rather than extrinsically motivated to achieve" (Lucariello et al. 2016 Principle 9).

Self-control results in better adjustment, higher self-esteem, better interpersonal skills and more optimal emotional responses (Tangney 2004). "Self-control refers to the capacity for altering one's responses, especially to bring them into line with standards such as ideals, values, morals, and social expectations, and to support the pursuit of long-term goals." (Baumeister et al. 2007 Quote from the abstract)

"The fourth component is a positive mind-set. A positive mind-set consists of embracing challenges and accepting failure as part of learning" (Goodwin and Miller, 2013). Challenges and failure are only one part of life. "While obstacles are ubiquitous, it is a person's response to problems and failure that separates her from the fold. Stress-response is as individual as a person's immune system; analogously, some people will succumb to infection whereas others will remain healthy. Likewise, some people will face challenges with bravado; others will shy away. Avoidance is not necessarily a bad thing; avoidance is a part of evolution in which humans recognize they need to avoid conflict, ambiguity, or hardship because the circumstances threaten their survival," (Nicholson, 1998). Some situations merit avoidance, but gritty people are more willing to accept challenges and take the appropriate risk to achieve their goals. Reed and Jeremiah (2017) put it succinctly "Grit-in-short, although grit is not the only predictor of student success in both personal and professional contexts, it is certainly one predictor that should not be overlooked." (Quote from page 225)

There is a scale for measuring "Grit," developed by Duckworth et al. (2007). That scale has two dimensions; Consistency of Interests and Perseverance of Effort each with six variables, discovered with Common Factor Analysis using Promax Rotation.

The Big 5 Non-Cognitive Skills

Psychologists primarily measure non-cognitive skills by using self-reported surveys or observer reports. They have arrived at a relatively well-accepted taxonomy of non-cognitive skills called the Big Five, with the acronym OCEAN, which stands for Openness to Experience, Conscientiousness, Extraversion, Agreeableness, and Emotional Stability. (Goldberg 1981)

Openness to Experience is a general appreciation for art, emotion, adventure, unusual ideas, imagination, curiosity, and variety of experience (*Goldberg 1993) &* (McCrae & Costa, 1987).
Conscientiousness is a tendency to display self-discipline, act dutifully, and strive for achievement against measures or outside expectations (Costa & McCrae (1992).
Extraversion, or happiness Extraversion, focuses primarily on the quantity and intensity of relationships. (DeNeve and Cooper 1998)

Agreeableness (or Pleasantness): A tendency to be compassionate and cooperative rather than suspicious and antagonistic towards others (Toegel and Barsoux *2012).*
Emotional Stability: The tendency to experience negative emotions, such as anger, anxiety, or depression. (*Norris, Larsen, and Cacioppo 2007) and (Goldberg 1992)*

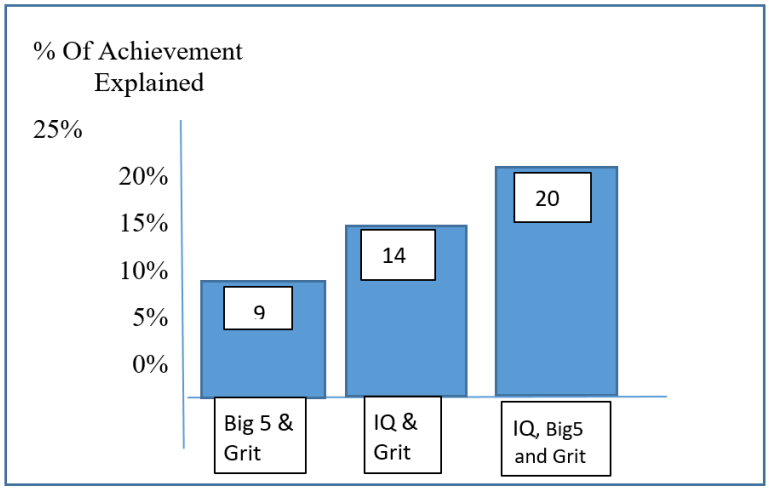
Originally, the Big Five was determined by having subjects self-report on 100 characteristics using Likert scale responses (Disagree strongly; Disagree a little; Neither agree or disagree; Agree a little; and Agree strongly) to questions such as: "I see myself as someone who: followed by 100 short statements like "is talkative", and "tend to find fault with others." Then in 2007, Beatrice Rammstedt and Oliver John produced a more manageable scale using only ten items.

"It is believed that the Big Five traits are predictors of future performance outcomes. Job outcome measures include job and training proficiency and personal data." (*Mount & Barrick 1998).* If these five traits are indicators of future performance outcomes, they may be predictors of business simulation outcomes AND these traits may be measurable both before and after "playing" simulations to see if any or all of them may be enhanced by participating in business simulations.

Predictive Power of Grit and The Big Five

Table 2. shows the decomposition of the variance for achievement and grades using IQ scores to represent cognitive ability, the combined set of the Big 5 non-cognitive skills and measures of Grit as independent variables. (Heckman et al. 2014)

TABLE 2
THE PERCENT OF EXPLAINED VARIANCE OF ACHIEVEMENT SCORES WHEN USING IQ, THE BIG 5 NON-COGNITIVE SKILLS AND GRIT AS INDEPENDENT VARIABLES



If all three variables were completely independent of one another, the maximum explained variance would equal 23%. Thus, these variables are almost orthogonal with each supplying important information. The dependent variable for this study was the score on an achievement test. The author believes that one may find even stronger relationships if a "success in simulations score" would be the dependent variable.

How could non-cognitive skills be taught? Just like riding a bicycle, swimming and getting to Carnegie Hall, performance is enhanced by "practice, practice, practice." The parallel being; simulations played in rounds are practice. "Skills" suggests that these attributes can be learned. In reality, the extent to which these personal attributes can change lies on a spectrum. Both cognitive and character skills can be changed over one's life cycle, but through different mechanisms and with different ease at different ages. (Heckman and Kautz 2013).

WHERE DO WE GO FROM HERE?

The next step is to have researchers to use the scales for Grit and the Big Five to create profiles of those participating in business simulations and discover if this concept is, in fact, valid. The author suggests that Grit and the Big Five may be more predictive than the cognitive measures we have used in the past. If one uses before and after measures when business simulations in the classrooms, it might discover that the repetitive nature business simulations enhance both Grit and the Big Five scores.

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