

THE EFFECT OF INDIVIDUAL MOTIVATION AND COGNITIVE ABILITY ON STUDENT PERFORMANCE OUTCOMES IN A DISTANCE EDUCATION ENVIRONMENT

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ABSTRACT

The authors explored the effects of general mental ability and motivation (operationalized as conscientiousness) on performance in an online distance education course. The results supported the hypotheses that both higher levels of motivation and higher general mental ability are positively associated with academic performance in a distance learning environment, while low levels of either motivation or general mental ability were associated with lower levels of performance. The results also support the presence of a significant interaction effect between motivation and general mental ability in terms of their relation to performance. High levels of either motivation or general mental ability alone with low levels of the other factor did not produce high levels of performance, demonstrating the importance of simultaneously considering both factors. Theoretical and practical implications of the results are discussed.

Distance education refers to institution-based, formal education provided to geographically diverse students through interactive telecommunications systems. Institutions that have an educational mission as all or part of their purpose have been quick to utilize distance education technologies as these technologies offer an effective way to both expand the student population base and take advantage of technological capabilities to more efficiently address the needs of current student populations.

Academic institutions, especially, are increasingly using distance education to provide academic courses. By 2007, 3.9 million students were taking at least one online class (Doyle, 2009). A single massive open online course (MOOC), Norvig and Thrun's AI class, has been shown to enroll 160,000 students (Carr, 2012). Driving this increase is the convergence of several factors which make distance education an increasingly effective method to deal with several practical problems and opportunities.

First, in many areas of the world, there is both a growth of the university-age undergraduate population, and a growth in the need for education of older populations who must continue life-long learning in order to adapt to changing educational needs in the workplace. Governments and other organizations are reluctant to invest the capital expenditures required to build new conventional campuses and educational facilities, preferring to attempt to “do more with less” by encouraging distance education as a way to deal with increasing educational needs over a more geographically dispersed or divergent population (Oblinger, Barone, & Hawkins, 2001).

Second, education consumers are increasingly shopping for courses that best accommodate their learning styles and schedules when pursuing higher-education degrees or skill training (Johnstone, Ewell, & Paulson, 2002; Paulson, 2002; Carnevale, 2000). Today’s customers of education, raised on the instant availability of the digital communication and accustomed to accomplishing work on their schedule because of this availability, increasingly are demanding that at least some, if not all, of their educational sources be flexible and delivered in formats other than traditional classroom settings.

Third, these trends are facilitated by rapidly improving technology that provides for a continuously improved and more effective distributed learning environment (Oblinger et al., 2001). Major organizations are investing very heavily in differing distance education technologies and systems, lending validity to the fact that although the technology of distance education may not have reached the stage of standardization, the use of distance education is likely a permanent change in the educational landscape and not a fad whose implications can be ignored.

Fourth, distance education is attracting a new subpopulation of higher-education learners – those who are “generally older, have completed more college credit hours and more degree programs, and have a higher all-college GPA than their traditional counterparts” (Diaz, 2002, pp. 1-2).

Finally, in addition to its use in the higher-education sector, distance education also has strong implications for education and training in private, public, and military organizations (De Lorenzo, 2005; Schreiber & Berge, 1998). The combination of all of the above factors points to an increase in the range of applications of distance education in the future, and increasing organizational concern with the efficacy of distance education efforts.

Distance Education Effectiveness

Successful outcomes of distance educational experiences depend on a number of factors, including both institu-

tional (e.g., the user-friendliness of technology and quality of content) and individual (i.e., ability and motivation) characteristics. The growth of distance education as a major distribution channel for lifelong learning services targeted toward working adults offers an opportunity to identify both characteristics of successful distribution systems, and equally important, identification of methods of student classification to determine which potential students are more likely to be successful in the distance education environment. Identification of characteristics of successful student populations will help ensure that distance education learning techniques are used where most pedagogically appropriate, efficient, and effective.

There is a large amount of prior research, especially from scholars engaged in work in educational systems and new technology, on various aspects of distance education. A great majority of this research, as would be expected from a growing field with a lack of widely accepted standards, is more concerned with the technical aspects of delivering distance education, and less with determining what populations might best utilize distance education (De Lorenzo, 2005). Distance education literature also has historically suffered from a lack of standardization of term definition and usage. Distance education is a field in which many different disciplines come together to be used in combination to achieve a desired end that cannot be accomplished by any single discipline; therefore, this lack of standardization is not unexpected. Part of the purpose of this paper is to address this aforementioned situation with respect to student performance outcomes.

There is also a substantial and increasing need to better identify those students who “fit” into distance education courses, so that appropriate student populations are exposed to the most appropriate pedagogical methodologies for their characteristics. For example, at the institution of two of the authors, an urban research university, the College of Business Administration has a goal of offering 30% of class sections each semester in a distance education format. Anecdotal evidence suggests that students enroll in these classes for a wide variety of reasons, with a correspondingly wide variation in success rates, yet there is currently no system to classify students in any fashion to determine either their suitability for the method used in the class or how they might be better counseled to enhance their probability of successful outcomes using the distance education method. Our university is not unique in this aspect, as classification of students to help ensure success in certain learning environments is the exception rather than the norm at most institutions. Students self-select when taking MOOCs which can have dropout rates as high as 95% (Carr, 2012). An understanding of what students belong in what type of course is critical harnessing the potential of these environments.

There is arguably a strong need for research in the areas of student classification, measurement for classification, and performance outcomes in distance education settings. As would be expected, the distance education literature generally has discussed the concepts of ability and motivation to succeed as important to performance outcomes. However, the applicability of this research is less clear than it should be due to the previously mentioned lack of standardization in terminology and measurement (De Lorenzo, 2005).

The research described in this paper addresses these weaknesses by using accepted terms and standardized measures from the behavioral literature for both ability and motivation. We do this in order to define a coherent line of research that can be focused on individual student characteristics and the relationship of those characteristics to educational outcomes. To be of the most practical use, these characteristics should be easily measurable, commonly available in educational settings, and useful to meaningfully discriminate among student population members in order to ensure the most efficacious use of resources dedicated to distance learning.

Ability and Motivation as Antecedents of Performance

Both ability and motivation have been hypothesized to positively effect performance. In particular, Maier (1955) proposed that ability and motivation have both main effects and interaction effects. Most empirical research has focused on main effects, however, Perry et al. (2010) found evidence of interaction effects when studying predictors of customer service performance. This study considers both the main effects of ability and motivation as well as their interaction effects.

Ability

Scholars have typically associated task skills and task knowledge with general mental ability (GMA; Viswesvaran, 2002). Motowidlo et al. (1997) defined task knowledge – including both declarative and procedural facets – as “knowledge of facts and principles related to functions of the organization’s technical core... [and] knowledge of procedures, judgmental heuristics, and rules for processing information and making decisions about matters related to the technical core” (p. 80). Moreover, they argued that task knowledge primarily stems from GMA, as those higher in mental ability have greater capacity for insight as well as higher capacities for information processing, attending to important stimuli and excluding unimportant stimuli, and using knowledge compared to those lower in mental ability. They perform better because they learn

more efficiently and more effectively, both of which result in the acquisition of more task knowledge.

Researchers have employed a number of measures of GMA, but the measures generally fall into one of two categories: standardized academic entrance exam scores (e.g., CSAT; Sackett et al., 1998) and standardized intelligence tests (e.g., Wonderlic Personnel Test; Mount, Barrick, & Strauss, 1999). An extensive literature search indicates that GMA is the one of most important individual difference predictors of job performance across jobs (e.g., Schmidt & Hunter, 1998). Schmidt and Hunter’s meta-analytic examination of 19 common job performance predictors indicated a validity coefficient of .51 for GMA. Further, most of the other predictors (e.g., assessment centers, job experience) contributed little to no explanation of performance variance beyond that accounted for by GMA.

Consistent with prior research, we expect GMA to positively impact performance in a distance education course because those with a higher GMA remember more and apply their knowledge more effectively than those with a lower GMA.

Hypothesis 1: GMA scores are positively related to performance in a distance education course.

Motivation

Campbell (1976) suggested that motivation could be characterized as the choice to initiate effort on a certain task (direction), the choice to expend a determined amount of effort (intensity), and the choice to continue expending that amount of effort (duration). Researchers have used the personality construct of conscientiousness as a proxy for motivation because highly conscientious individuals are likely to display high levels of all three aspects of motivation due to their organized, achievement-oriented, and persistent nature (Mount et al., 1999).

Schmidt and Hunter (1992) labeled conscientiousness as the most important trait-based motivation variable in the field, and empirical research suggests that it is the strongest individual difference predictor of job performance, with the exception of GMA (e.g., Behling, 1998; Hogan, Rybicki, Motowidlo, & Borman, 1998). Additionally, Schmidt and Hunter’s (1998) results indicated that conscientiousness significantly contributes to the predictive validity of overall job performance beyond GMA. Schmidt and Hunter (1998) also reported similar results for integrity tests and structured interviews, both of which have large conscientiousness components. Although other

researchers have found positive effects of motivation on distance education outcomes, they relied on measures that were specific to the motivation for the particular learning activity rather than persistent characteristics of the learner (Wang et al., 2008). General learner characteristics can help understand learner behavior throughout their learning life across learning experiences. Wang et al. (2008) did not measure ability. Some researcher investigates the effect of distance education design on student motivation, but does not consider the students initial motivation and therefore gives little evidence to which student populations might be most successful and which may be at risk. For example, Liao (2006) shows a positive relationship between a flow educational experience and outcomes, the research does not show which students are likely to experience high levels of flow and ultimately learning success. Simpson (2008) argues the need for better theories of learner support which should be predicted on understanding of theories of learner motivation rather than just outcome experiences with one set of tools. Therefore, this study focusses on the learner motivation independent of tools use.

Goldberg (1993) suggested that conscientiousness is reflected by such characteristics as dependability and thoroughness versus carelessness and negligence. "Conscientiousness describes socially prescribed impulse control that facilitates task- and goal-directed behavior, such as thinking before acting, delaying gratification, following norms and rules, and planning, organizing and prioritizing tasks" (John & Srivastava, 1999, p. 121). Conscientiousness predicts task performance; because high-conscientiousness workers tend to be efficient, thorough, responsible, organized, and reliable (McCrae & John, 1992). They are likely to persevere and more effectively engage in self-discipline (Colquitt & Simmering, 1998), be more proactive and effective in goal-setting (Barrick, Mount, & Strauss, 1993; Gellatly, 1996), and exert more effort (Mount & Barrick, 1995) than low-conscientiousness workers. These task habits are likely to influence performance levels of effectiveness in fulfilling distance education course requirements. Accordingly, we propose:

Hypothesis 2: Conscientiousness is positively related to performance in a distance education course.

Ability x Motivation

Are the joint effects of ability and motivation on performance of an additive or interactive nature? If the former, then both motivation and ability are significantly related to performance in a distance education course, and their

effects are independent and complementary. If the latter, then increments in ability have different relationships with performance at different levels of motivation and increments of motivation have different relationships with performance at different levels of ability. Stated alternatively, the higher the ability, the greater the impact of motivation on performance and the higher the level of motivation, the greater the impact of ability on performance.

Motivation theorists (e.g., Campbell, 1976; Heider, 1958; Maier, 1955) have long hypothesized that performance-related work outcomes are an interactive function of motivation and ability, $P = f(M \times A)$. This perspective suggests that greater ability has greater effect at higher levels of motivation and that high levels of motivation have greater effects for more able individuals. In other words, capable individuals who make little effort because they are unmotivated will perform poorly and individuals who lack the ability to perform well will perform poorly even though they are motivated.

Kipnis (1962) demonstrated interactions between ability and persistence explaining supervisory ratings of the job performance of military personnel. O'Reilly and Chatman (1994) reported that the positive relationships between ability (i.e., business school entrance exam scores) and four important early career outcomes – job offers, salary, salary increases, promotion – among MBA graduates were stronger for those with higher levels of conscientiousness.

We suggest that the relationship of ability and motivation with performance is consistent with Maier's (1955) hypothesis when ability, motivation, and performance are measured. We expect that GMA results in greater performance in a distance education course among individuals who are dependable, hard-working, thorough, and efficient and that high levels of motivation enhance performance more among more able individuals. Thus, consistent with Maier (1955), we hypothesized that ability and conscientiousness interact to predict performance in a distance education course:

Hypothesis 3: The relationship between GMA and performance in a distance education course strengthens as conscientiousness increases and the relationship between conscientiousness and performance strengthens as GMA increases.

Method

Sample

The participants consisted of a total of 96 undergraduate business school students enrolled in a management course offered online by a public university in the United States.

Measures

GMA. We assessed GMA using the overall score of the American College Test (ACT), a college entrance exam. The ACT is a valid predictor of performance in college, as measured by grade-point average (Schmitt et al., 2007).

Conscientiousness. We used the 10-item version of the Conscientiousness scale of Goldberg's (1999) Big Five factor markers in the International Personality Item Pool (IPIP). Students rated the items using 5-point scale (1 = "Very Inaccurate" to 5 = "Very Accurate").

Course performance. Students completed four timed, multiple-choice exams, which were scored automatically by an online course system. Students were not permitted to take more than 60 minutes to complete each exam. Exam items were randomly generated, such that students would be asked to respond to different combinations and presentations of items. We summed the points earned on the four exam scores as our index of course performance.

RESULTS

Table 1 presents the means, standard deviations, reliability estimates, and correlations for the variables. As shown there, both ACT scores ($r = .29, p < .05$) and conscientiousness ($r = .22, p < .05$) were significantly and positively correlated with total test points. These results are consistent with meta-analyses investigating the relationship between ability and performance (Schmidt & Hunter, 1998) and the relationship between the Big Five model of personality and performance (Barrick & Mount, 1991). Further, consistent with prior research (Mount et al., 1999), the relationship between ability and conscientiousness was trivial ($r = .04, ns$).

We tested the two main effects hypotheses using multiple regression analyses. Table 2 presents the results of the regression analyses. The regression model including both ACT and Conscientiousness as predictor variables was significant ($F(2, 93) = 6.99, p < .001$). Further, the significant beta weights for each variable supported both Hypothesis 1, which proposed a positive relationship between ACT scores and exam scores, as well as Hypoth-

Variable (N = 96)	M (SD)	1	2	3
ACT	20.4 (3.62)	---		
Conscientiousness	3.97 (.43)	.04	---	
Test Scores	574.58 (35.23)	.29*	.22*	---

* $p < .05$

esis 2, which proposed a positive relationship between conscientiousness and exam scores.

We tested the interaction hypothesis using hierarchical regression. First, we centered the predictor variables. Second, we added the GMA x Conscientiousness cross-product term to the main effects model. Third, we tested the change in R2 between the model with only the main effects included and the model with both the main effects and the interaction term included. The test of R2 change indicated support for our third hypothesis, which proposed an interactive effect between GMA and Conscientiousness scores on exam scores ($F(1, 92) = 4.11, p < .05$).

In order to precisely identify the manner in which the ACT-performance relationship was affected by conscientiousness, we applied Bauer and Curran's (2005) extension of the Johnson-Neyman (J-N) technique to estimate regions of significance. Regions of significance indicate the levels of conscientiousness at which the group mean difference is significant. They provide an inferential test for any possible simple slope (Bauer & Curran, 2005). This

Dependent Variable:	B	β	R ²	F	ΔR^2
Step 1					
ACT	2.77**	.29			
Conscientiousness	17.46*	.21	.13	6.99***	
Step 2					
ACT	-17.45	-1.80			
Conscientiousness	-83.81	-1.01			
Interaction	5.14*	2.46	.17	6.18***	.04*

* $p < .05$, ** $p < .01$, *** $p < .001$

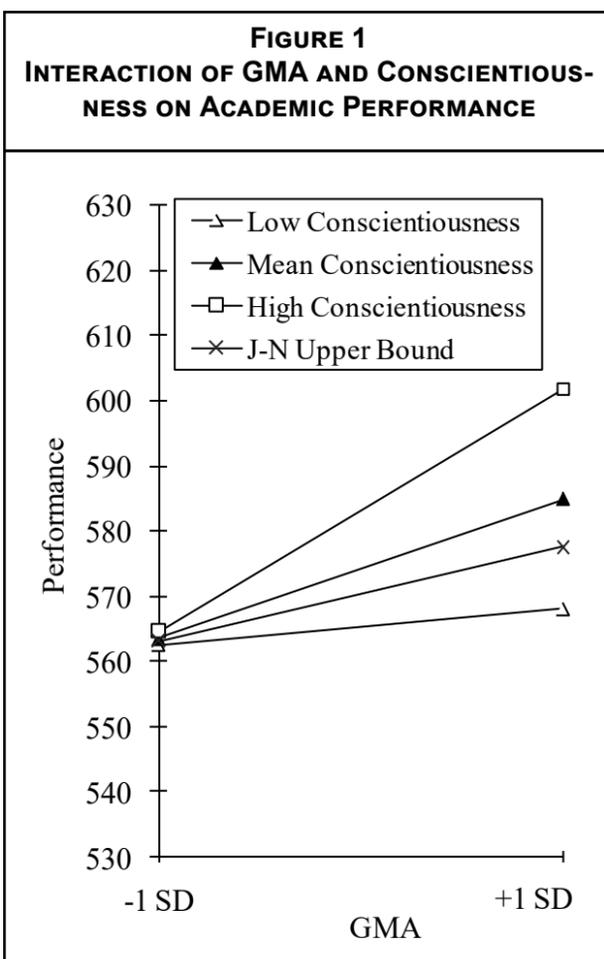
yielded 95% (non-simultaneous) regions of significance defined by a lower bound of -27.38 and an upper bound of -0.19 . The minimum and maximum values of (mean-centered) conscientiousness were $-.43$ and $.43$. The upper region fell within the observed range of conscientiousness scores. As the lower region did not, we did not represent or interpret it further.

Figure 1 is a graphic representation of the results of our application of Bauer and Curran's (2005) extension of the J-N technique to Cohen et al.'s (2003) suggested protocol for identifying the forms of interactions. It contains a plot of the equations at low, average, and high levels of conscientiousness scores (-1 , 0 , and 1 standard deviations from the mean). As shown in Figure 1, the ACT-performance relationship was non-existent among workers at low (simple slope: $t = .56$, ns) levels of conscientiousness. In contrast, the relationship was positive among workers at average (simple slope: $t = 3.16$, $p < .01$) and high levels of conscientiousness (simple slope: $t = 3.45$, $p < .01$). Congruent with the simple slopes analysis, the region of significance was between the average level of conscientiousness and one standard deviation below the mean of conscientiousness. Thus, ACT scores were unrelated to performance only among the individuals relatively low in conscientiousness. Conscientiousness was unrelated to performance among individuals with low ACT scores.

Discussion

We proposed that both GMA and conscientiousness are related to performance in a distance education course. The results were consistent with our predictions. We also proposed that the joint effects of GMA and conscientiousness (i.e., ability and conscientiousness) are interactive rather than additive. The results indicated that as conscientiousness increased, the effect of GMA on performance increased. Consistent with the interactive hypothesis, the GMA-performance relationship held for all but individuals relatively low in conscientiousness.

We offer four possible strengths of the current study. First, we used two well-known measures – the ACT measuring GMA and the IPIP measuring Conscientiousness – to test the interactive hypothesis. Second, our criterion measure was objectively scored. Although it was likely far from the ideal, scores did not reflect subjective interpretation that might affect variation in scoring across the participants. Third, the criterion measure reflected performance across four trials, which may provide a better assessment of performance than a single trial. Finally, our hypothesis was based on two constructs – GMA and Conscientiousness – that were theoretically relevant to the performance criterion.



Limitations and Future Research

First, replication is needed because we had only one sample. Second, our sample consisted of 96 undergraduate business students. Although anecdotal evidence indicated that many or most of these individuals had part-time or full-time jobs in the private, public, or military sectors, the generalizability of the results to other populations is not known. Similarly, the course content and our performance criterion may not be representative of distance education courses in settings outside of higher education. Third, we operationalized GMA in terms of the ACT score and motivation in terms of conscientiousness. Other GMA measures may have been more appropriate and/or would yield different relationships.

Equating motivation with conscientiousness permitted us to assess motivation in terms of individual characteristics, but motivation operationalized as a situational characteristic (e.g., supervisors monitoring course progress) is likely to provide an alternative approach to testing the interac-

tive hypothesis. The distance education research literature in the educational field tends to define motivation as a situational characteristic, not an individual characteristic. It would seem this would be a fertile area for research to determine the relatedness of the two methods of defining motivation with regard to performance in a distance education context.

Conclusion

Performance in a distance education course may represent a unique aspect of performance. Maximum performance reflects capabilities or what students "can do," whereas typical performance reflects what students "will do" (e.g., Kanfer & Ackerman, 2005). A student fulfilling distance education course requirements faces a highly independent set of tasks. Thus, the application of ability and motivation of the student may be more important in the distance education environment than other learning environments.

As we noted previously, the emergence of distance education as a distribution channel for lifelong learning services targeted toward large segments of the education-consuming population offers an opportunity to identify which students are likely to be successful. Not all individuals are predisposed to perform well in distance education courses. Unlike most education and training situations, the distance education context is one of considerable independence and few proximal situational influences.

Implications for educators or managers are two-fold. The first is the need to identify which students or employees would benefit most from distance education. The second is to identify which students or employees taking such courses would benefit from organizational assistance (i.e., formal study groups, mentors assigned, etc.). The present study is a preliminary step in addressing these issues. We found that high-ability, highly conscientious individuals performed at the highest levels. Individuals lower in ability and conscientiousness may be likely to benefit from various forms of assistance in order to enhance the effectiveness of their distance education performance and experience. Practically, this may mean that additional criteria other than student choice should be used to determine who should be taught with distance learning methodology, and that potential students should be counseled as to additional factors they should consider when deciding whether to enroll in a class taught with distance education methodology.

Since the use of distance education is increasing, more subject areas and more student populations will likely be touched by distance education technology making ever more important to understand the situations that will challenge distance education effectiveness and what

techniques can be used to improve effectiveness. In situations where either or both GMA and motivation are low, research should consider how distance education can be reinvented in ways that better support those weaknesses and what will be effective under the two situations. Further, can promising techniques such as tools that inspire flow be systematically adapted to students of differing ability and motivational characteristics.

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