Self-Efficacy as a Predictor of Academic Performance among Students in an Entry-Level Crop Science Course[1]

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Abstract

While considerable research has examined the academic and cognitive value of assessments, little has been reported within the discipline of Crop Science and its impact of college students' performance. The purpose of this descriptive-correlational study was to assess the strength of self-efficacy of students taking an introductory crop science. Students in two academic settings (land-grant university and a community college, N=112) taking an entry-level agriculture course participated in an assessment and a diagnostic test, where self-efficacy was assessed in five agriculture subject areas (crops, soils, plant identification, technical applications/equipment, plant physiology) before and after the course. Results revealed a consistent predictor of academic performance was based on the diagnostic test. Although the mean scores were higher on the post-evaluation than on the pre-evaluation, self-efficacy was more consistently correlated with evaluation scores on the pre-assessment. This study presents a viable method for developing an evaluation tool to identify students that may require extra attention and course units, which may involve more class time or explanation.

Key Words: Self-efficacy and student perceptions, entry level agronomy, crop science, strength of self-efficacy

Introduction and Theoretical Framework

Self-efficacy is a construct that has been evaluated in numerous behavioral studies. Self-efficacy describes a person's perception of their ability to complete a given task (Bandura, 2003; Zimmerman, 2000). Self-efficacy is not to be confused with other similar constructs such as self-concepts studied by phenomenological theorist, McCombs (1989) where perceptions of more general constructs such as self-esteem are used as a measure of a person's perceived capacity to complete a task.

Perceived self-efficacy can be assessed based on level, generality and strength. Level, refers to the magnitude of difficulty of a given task (Zimmerman, 2000). Level of self-efficacy may be used to describe a subject's self-efficacy towards being able to run five miles compared to running one mile, for example. Generality refers to being able to transfer self-efficacy perceptions from one discipline or subject matter to another (Zimmerman, 2000). If for example, perceptions were generalizable between mathematics and statistics, then people with high self-efficacy regarding math would also have high self-efficacy beliefs with regards to statistics. Strength is the magnitude of how certain a subject is that they can perform a given task (Zimmerman, 2000).

The theoretical framework of this study relied on Bandura's (1977) self-efficacy theory. In the context of education and cognitive studies, measures of self-efficacy have been shown to accurately predict future academic

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performance (Bandura, 1993; Zimmerman, 2000). Not only does higher self-efficacy predict better academic performance in general, but also among individuals of similar skill levels, individuals with higher self-efficacy within groups of individuals with similar skill perform better (Collins, 1982). The utility of self-efficacy as a predictive tool has been shown to vary based on subject matter (e.g, english versus mathematics) (Zimmerman, 1995).

Similar subjective measures are also very common in agriculture education studies but differ significantly from other cognitive studies. Cano and Garton (1994) used the Group Embedded Figures Test (GEFT) in order to correlate agriculture education students' preferred learning style (field-dependent vs. field-independent) with both overall course scores and laboratory scores. Moss et al. (2002) used the Gregoric Style Delineator Profile to correlate agriculture economics students' learning style (Concrete Sequential, Concrete Random, Abstract Sequential, Abstract Random) with several components of course performance including; class discussion, exams, online coursework and overall course scores. These measures are subjective in that they are self-reported by study participants and cannot be confirmed by investigators.

Subjective measures in educational studies offer some customizability based on the nature of the course. For example, if a course has a laboratory component then investigators might collect subjective measures regarding student's preferred learning style such as: visual, hands on, field-based, etc. However many educational studies do not take specific areas of course material into account.

The Purpose of this Study

The purpose of this descriptive-correlational study was to assess the strength of self-efficacy of students taking an introductory crop science course at the beginning and end of the semester with regards to course material and competencies.

The research objectives of our study included:

1. To describe the general characteristics of the study population and determine if variations in evaluation scores were statistically significant among the groups.
2. To describe general trends of student perceptions both before and after the course and their performance on a diagnostic test.
3. To determine if the instrument used to assess student perceptions is reliable and evaluation scores are normally distributed.
4. To correlate student perceptions (self-efficacy measure) regarding their perceived notions of their knowledge relating to specific course subject matter with scores on a diagnostic test (academic performance measure) and determine if the correlations are statistically significant.

Materials and Methods

Study Participants

This study focused on all students enrolled in an introductory crop production course within 4-year and 2-year institutions during the academic years of 2011-2012. The lead researcher has been involved as the lead supervisor for the articulation of the course content that is shared between the two institutions, in the agreement that articulation of content is as seamless as possible. This study was deemed a time and place sample (Oliver and Hinkle, 1982), thus permitting the use of inferential statistics. This study was deemed exempt by Purdue University-West Lafayette (WL) Institutional Review Board representing both populations of this study.

Evaluations were administered to students at Purdue-WL (a 4-year program) as well as Ivy Tech Lafayette (a 2-year program). Ivy Tech Lafayette instructors are attempting to replicate course material and competencies of Purdue-WL's course. Most participants were male (N= 90, 79.6%), which is much higher than the proportion of male students enrolled at either Purdue-WL (57.4%)(Enrollment Analysis and Reporting, 2011) or Ivy Tech (40%) (Eric Burns and Tim Escue, 2011). However this is not unexpected as one might assume that there would be a greater proportion of males in agronomy courses. At the point of the initial assessment the majority of participants attended Purdue-WL (75%), grew up on a farm (63%) and were classified as freshmen (49%) (Table 1). Although at the beginning of the Fall 2011 semester at Purdue-WL the enrollment of Freshmen was only 27%, the high proportion of Freshmen in this course is not unexpected as it is an entry level course. The lower N-values for the post-assessment across all demographics were due to loss to follow-up at the end of the semester (Table 1).

Evaluation Protocol

Investigators administered evaluations during the first week of classes and after the completion of the course. Purdue-WL students were given a small extra credit bonus for filling out each evaluation accounting for less than 1% of their final course grade. Ivy Tech Lafayette students were not offered any incentive to participate. It is important to note that investigators administered performance evaluations immediately after self-efficacy assessments. Self-efficacy has been a significant tool in predicting future academic performance (Zimmerman, 2000; Bandura, 1993), however it has also been shown to be a viable predictor of academic performance even when the evaluation component immediately follows the perception assessment (Collins, 1982).

Self-Efficacy Assessment

Strength of self-efficacy was assessed using a 39-item assessment tool developed by the lead investigator. Participants responded using a five point Likert scale; strongly agree=5, agree=4, neutral=3, disagree=2, strongly disagree=1. Respondents also were given a no opinion option. Items regarding general perceptions of the students learning style, as well as the student's perceptions of where this course fit into their career goals were summed together to form the "overall" scale. Items of related specific course subject matter were summed to the scale categories crops, plant identification, soils, photosynthesis processes/plant physiology and technical applications/crop science equipment. See Table 2 for distribution of perception items on the perception assessments. Investigators based scales on course goals outlined in the course syllabus (Snyder, 2012, http://www.agry.purdue.edu/courses/agry105/).

Investigators distributed the same assessment tool to participants both before and after the completion of the course to assess student perceptions of self-efficacy. Most items were phrased, "My current level of ability, knowledge about subject X….." However any items that were phrased in the future perfect on the pre-assessment were changed to the past tense on the post-assessment. The full perception assessments are available at request by contacting the corresponding authors.

Table 1: Mean pre and post-evaluation scores for participants in the Fall 2011 and Spring 2012 semesters

Demographic	N[a]		Mean Evaluation Score Percentage (SD)		P-value	
	Pre	Post	Pre	Post	Pre	Post
Campus					<0.002*	0.574
Purdue University-WL	81	78	64.8 (10.3)	77.8 (8.9)		
Ivy Tech Community College-Lafayette	27	21	55.0 (13.8)	75.9 (18.5)		
Total	108	99				
Homestead					0.070	.0375
Farm	68	64	62.5 (11.7)	76.2 (11.4)		
Rural-non farm	27	23	64.9 (11.1)	79.7 (7.2)		
Town/city	13	9	55.7 (13.7)	74.4 (19.1)		
Total	108	96				
Classification					0.019*	0.163
Freshman	54	45	60.1 (11.8)	74.9 (9.3)		
Sophomore	34	32	63.0 (11.6)	77.8 (13.8)		
Junior	10	11	61.9 (10.6)	78.9 (9.7)		
Senior	10	11	72.9 (11.4)	83.2 (12.9)		
Total	108	99				

[a]The number of students in the Pre and Post sampling periods was 112

* Independent Student's t-test Significant at P ≤0.05 level (2-tail)

Table 2. Mean standardized pre and post-assessment perceptions results for students in the Fall 2011 and Spring 2012 semesters

	Mean		SD		N		Reliability[a]	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Overall[c]	4.40	4.24	0.40	0.42	107	96	0.647	0.583
Crops[d]	2.77	3.74	0.65	0.47	107	95	0.784	0.754
Identification[e]	2.97	3.84	0.67	0.51	108	97	0.853	0.831
Soils[f]	2.93	3.92	0.61	0.52	107	98	0.780	0.742
Photosynthesis/ plant physiology[g]	2.80	3.82	0.64	0.55	102	97	0.835	0.806
Technical[h]	3.31	4.00	0.64	0.55	102	96	0.721	0.145[b]

[a]Cronbach's alpha coefficient for reliability-Max value = 1

[b]If item 11 removed the Cronbach's alpha is .788

Note: strongly agree=5, agree=4, neutral=3, disagree=2, strongly disagree=1

[c] items 3, 4, 6, 8, 9

[d] items 12, 13, 15, 34, 35

[e] items 16, 17, 18, 19, 20, 21, 22

[f] items 10, 25, 26, 27, 28

[g] items 14, 23, 24, 29, 30, 31, 39

[h] items 11, 33, 36, 37, 38

Academic Performance

Investigators evaluated academic performance using a 75 item multiple-choice diagnostic evaluation developed by the lead investigator and reviewed by Purdue University and Ivy Tech faculty whose content area is Agronomy. All questions were multiple choice items related to the five subject matter scales mentioned above. The full academic performance evaluations are available at request by contacting the corresponding authors.

Statistical Analysis

Investigators used SPSS Version 19.01 for all statistical analysis. The first study goal was to determine if there was a statistically significant difference in mean evaluation scores across demographics. Thus a series of independent sample Student's t-tests were run to determine if there was a statistically significant difference in mean evaluation scores between participants by campus (Purdue-WL, Ivy Tech Lafayette), former homestead (farm, rural non-farm, town/city) and classification (freshman, sophomore, junior, senior).

Based on study goal 2) investigators standardized assessment perceptions by diving the summation of scaled items by the total number of items in each scale. Cronbach's alpha coefficients were generated to satisfy study goal 3) and to determined if scaled items were reliably measured. Shapiro-Wilk tests were also run to assess if pre and post evaluation scores were normally distributed. Lastly, Pearson Product-Moment Correlations were run to assess correlations between perception scales and academic performance.

Results and Discussion

Scores on the post-evaluation were higher across all demographics than the pre-evaluation as would be expected because the same evaluation was given during both pre and post sampling events (Table 1). Evaluation scores did not differ significantly between students of different homesteads on either the pre or post-evaluations (Table 1). The pre-evaluation scores differed significantly based on campus (P-value = <0.002), with Purdue-WL scores being higher than Ivy Tech Lafayette scores (Table 1). Pre-evaluation scores also differed significantly based on student classification (P-value =0.019) with seniors scoring highest (Table 1).

Note that not all scales are the summation of an equal number of assessment items. Within Table 2 are the displayed standardized mean perception values. Investigators standardized responses by summing together item responses for each scale and then dividing them by the number of items relating to that particular scale. If a participant responded either "no opinion" or did not respond to a particular item, then their responses were left out of analysis for that particular scale. The standardized mean perception value was higher for all scales on the post-assessment (Table 2). This is to be expected as it is reasonable to expect that students would feel they know more about course material after having taken the course.

Mean responses were highest for the overall perceptions scale on both the pre and post-assessments (Table 2). Among scales related to specific subject matter, technical perceptions were highest on both assessments and lowest was for crops perceptions on both assessments (Table 2). It is worth pointing out that mean values of overall perceptions is only 0.04 more on the post assessment, whereas the mean response for nearly all other scales increased by about 1. This may have been due to the fact that items scaled as overall were somewhat vague in nature and concerned perceptions of how useful this course would fit into their career goals. Items related to specific subject areas were less vague.

Cronbach's alpha (maximum value =1) coefficients were generated to determine reliability for scaled items. Alpha values were typically higher for pre-assessment scales (Table 2). Nearly all scales were above 0.7, indicating very good reliability among scales (Table 2). The second and third lowest alpha values were for overall perceptions on the pre-assessment (0.647), indicating decent reliability and the alpha value for overall perceptions on the post-assessment (0.583) indicating questionable reliability (Table 2). The alpha value for technical perceptions on the post-assessment (0.145) indicates very little reliability; however, if item 11 were removed from the technical scale then the alpha value would be 0.788 (Table 2).

Investigators evaluated academic performance in two ways; overall score on the evaluation and number of correct responses on items related to particular scales (Table 3). Shapiro-Wilk tests indicated that pre-evaluation scores were normally distributed and post-evaluation scores were not (Table 3). Notice in Table 3 that the numbers of specific items related to each scale are not equally distributed. Not only were overall scores higher on the post-evaluation than the pre-evaluation (Table 3), but scores for individual subject areas were also higher on the post-evaluation (Table 3). Again this is not expected as it is reasonable to expect that students would know more about course content after taking the course.

Correlations

All variables (perception scales, evaluation scores, number of correct responses per category) were treated as continuous variables. Pearson Correlation Coefficients were used to correlate self-efficacy measures (perceptions), with academic performance (evaluation

Table 3. Pre and post-evaluation results

Categories	M		SD		Median		Range	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Evaluation Score	62.89	76.86[b]	11.6	11.5	63.34	78.6	60	64
Crops (Max=14)[c]	9.78	11.4	2.1	2.2	10	12	9	9
Identification (Max=15)[d]	6.79	9.03	2.7	2.4	7	9	11	11
Soils (Max =17)[e]	9.17	12.31	2.8	2.4	9	13	13	13
Photosynthesis/ plant physiology (Max=8)[f]	4.81	6.18	1.5	1.4	5	7	7	8
Technical (Max=21)[g]	14.08	16.79	3.0	2.5	15	17	15	13

[a]Normally distributed based on Shapiro-Wiki test for normality (P >.05)
[b]Not normally distributed based on Shapiro-Wiki test for normality (P ≤ .05)
[c]items 1, 6, 19, 40, 41, 42, 51, 62, 63,67, 68, 69, 70, 71
[d]items 2, 4, 9, 10, 11, 14, 15, 16, 18, 34, 36, 61, 73, 74, 75
[e]items 3, 8, 31, 44, 45, 46, 47, 48, 49, 50, 52, 53, 54, 55, 56, 57, 58
[f]items 12, 13, 17, 19, 20, 30, 59, 65
[g]items 3, 7, 22, 23, 24, 25, 26, 27, 28, 29, 32, 33, 35, 37, 38, 39, 43, 60, 64, 66, 72

Table 4. Pearson Correlation Coefficients between self-efficacy measurements and evaluation performance

Perceptions-Pre Assessment		Pre-evaluation Score	Pre-evaluation Results by Subject Area: Crops	Soils	Identification	Technical and Equipment	Photosynthesis-Plant Physiology
Overall							
	Pearson Correlation	.005	.024	-.099	-.077	.033	.114
	N	107	106	106	103	105	106
Crops							
	Pearson Correlation	.246*	.304**				
	N	107	106				
Soils							
	Pearson Correlation	.338**		.256**			
	N	107		106			
Identification							
	Pearson Correlation	.292**			.287**		
	N	108			104		
Technical & equipment							
	Pearson Correlation	.229*				.278	
	N	102				100	
Photosynthesis & plant physiology							
	Pearson Correlation	.278**					-.031
	N	102					101

Note: The number of students in the Pre and Post sampling periods was 112.
* Pearson Correlation Coefficient is significant at the P ≤0.05 level (2-tail)
** Pearson Correlation Coefficient is significant at the P ≤0.01 level (2-tail)

Table 5. Pearson Correlation Coefficients between self-efficacy measurements and evaluation performance

Perceptions		Post-evaluation Score	Post-evaluation Results by Subject Area: Crops	Soils	Identification	Technical and Equipment	Photosynthesis
Post-Overall							
	Pearson Correlation	.08	.112	-.037	-.096	.103	.12
	N	98	98	98	99	97	99
Post-Crops							
	Pearson Correlation	.146	.264**				
	N	97	97				
Post-Soils							
	Pearson Correlation	.227*		.261**			
	N	98		98			
Post-Identification							
	Pearson Correlation	.192			.17		
	N	97			96		
Post-Technical & equipment							
	Pearson Correlation	.175				.222*	
	N	96				96	
Post-Photosynthesis & plant physiology							
	Pearson Correlation	.221*					.098
	N	97					98

Note: The number of students in the Pre and Post sampling periods was 99.
* Pearson Correlation Coefficient is significant at the P ≤0.05 level (2-tail)
** Pearson Correlation Coefficient is significant at the P ≤0.01 level (2-tail)

score, number correct on specific subject matter). Correlation Coefficients are shown for each relationship for the pre-evaluations (Table 4) and post-evaluations (Table 5). Effects of gender were not tested between variables as the number of female participants was too low for meaningful analysis. A Correlation Coefficient of 1.0 indicates perfect correlation, .70-.99 very high correlation, .50-.69 substantial correlation, .30-.49 moderate correlation, .10-.29 low correlation, and .01-.09 (Davis, 1971).

Pre-Evaluation

Correlations between all perceptions regarding specific subject matter and evaluation score were statistically significant (Table 4). The correlation between the more general overall perceptions and evaluation score was not statistically significant (Table 4). Correlations between specific subject matter perceptions and number of correct responses on specific subject matter were statistically significant for three of five subject areas (crops, identification, soils) (Table 4). Correlations between overall perceptions and results in specific subject areas were not statistically significant for any subject area (Table 4).

Post-Evaluation

Correlations between perceptions regarding specific subject matter and evaluation score were statistically significant in only two subject areas (soils, photosynthesis/physiology) and were not statistically significant between overall perceptions and evaluation score (Table 5). Correlations between specific subject matter perceptions and number of correct responses on specific subject matter were statistically significant for three of five subject areas (crops, soils, technical/equipment) (Table 5). Yet again correlations between overall perceptions and results in specific subject areas were not statistically significant for any subject area (Table 5).

This study shows a consistent relationship between strength of self-efficacy and academic performance. Self-efficacy measures not only correlated with overall evaluation scores but also with evaluation performance across specific subject areas (Table 4, Table 5). The relationship between self-efficacy and academic performance was much more consistent during the pre-evaluation (Table 4). General perceptions did not significantly correlate with any measures of performance as items scaled as overall were more general items related to self-perceptions and course utility. This study supports the notion that self-efficacy accurately predicts academic performance.

Past studies have shown that a stronger sense of self-efficacy results in better performance in academics. Self-efficacy has also been used in studies concerning career development, life-course trajectories and health behavior (Bandura, 1995). Possible explanations for the correlation between self-efficacy and academic performance in this study are that students with a stronger sense of self-efficacy may be more likely to perform better because they may be more motivated, expend more energy on academics and exhibit more persistence (Zimmerman, 1995). In a study regarding student effort in academics by Salomon (1984), it was found that students with higher self-efficacy are more likely to be high achievers in general and more likely to seek out extra-curricular activities as well as spend more time studying. Berry (1987) showed that students with high self-efficacy are more likely to be persistent and seek out opportunities outside of class such as extra help sessions in order to improve.

Self-efficacy has been used in few studies with agriculture students specifically. Johnson et al. (1999, 2000) performed two studies regarding agriculture students' self-efficacy with respect to computer proficiency. Both studies reported low scores in self-efficacy, but only one (Johnson et al., 1999) using participants in freshman level courses demonstrated that self-efficacy was a strong predictor of computer proficiency. The other study using participants in upper level agriculture courses (Johnson et al., 2000), found that there was only a weak association between self-efficacy and computer proficiency.

The relationship between self-efficacy and academic performance was far more consistent on the pre-evaluation than on the post-evaluation in this study. This pattern is not unexpected or outside the norm as self-efficacy has been shown to be a strong predictor of future academic performance (Zimmerman, 2000). In this study the academic performance evaluation was given immediately following the self-efficacy assessment. At the point of the pre-assessment students were asked to assess their knowledge/ability with regards to course subject areas, which they had not yet been exposed to in this particular course. On the post-evaluation the opposite was true, which may have influenced the relationship between self-efficacy and academic performance. Although measures of self-efficacy generally increased on the post-assessment and scores on the post-evaluation were higher, the relationship between self-efficacy and academic performance was not statistically significant across many subject areas on the post-evaluation. The less consistent pattern observed on the post-evaluation may be because evaluation scores were not distributed normally (Table 3).

Limitations, Conclusions and Recommendations

The study analysis was limited as correlations of pre-assessment perceptions and post-evaluation scores could have been used to express student learning gains over the semester to determine if pre-course perceptions could predict end of course knowledge. However correlations between pre-assessments and post-evaluations did not yield any useful data. This may have been due to the non-normal distribution of post-evaluation scores.

Not only were the scores on the post-evaluation generally higher among all students than their pre-evaluation scores, but their post-assessment perception scores were also generally higher. This trend is not unexpected and is actually desirable for course instructors as it shows that not only do students feel that they know course material better after having taken the course, but they actually know course subject matter better based on the results of their evaluation tests. However given this general increase in scores across most students, the results on the post evaluation were skewed towards a higher distribution and thus were not normally distributed. This limits the use of most tests of association on post-evaluating data which must assume normality.

This study demonstrates a feasible and effective method for instructors to assess their students perceptions of their own knowledge across course subject matter based on course goals and competencies. Using student perceptions as a measure of self-efficacy could allow instructors to identify not only students who may require extra attention but also to identify course units that may require more class time or explanation. By basing self-efficacy assessments on specific course units or competencies rather than on more general notions of learning style, which have been used in cognitive studies by Cano and Garton (1994) and Moss et al (2002), where instructors would be able to develop an assessment tool that is more applicable to their course specifically.

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