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Measuring Correlations between Factors that Affect Student Motivation in Organic Chemistry

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Authors' contributions

This work was carried out in collaboration between all authors. Author KCC designed the study, wrote the protocol and supervised the work. Authors KAC and MPB carried out all laboratories work and performed the statistical analysis. Author MPB managed the analyses of the study. Author KCC wrote the first draft of the manuscript. Author KCC managed the literature searches and edited the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

In learning, motivation influences the direction, intensity, persistence and quality of learning behaviors in which students engage. To measure the motivation of students enrolled in undergraduate organic chemistry courses, a survey was developed to gauge student attitudes about the course value, self-efficacy, and class environment. The survey consisted of twelve statements to which respondents indicated agreement through a seven point Likert response scale. Since course value, self-efficacy, and a supportive class environment are all purported to be necessary factors to positively motivate students, pairwise correlations between the student responses were measured and assessed. Although correlation was generally found in responses to

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statements pertaining to a specific factor, the lack of correlation between these three factors indicates that individual students probably did not perceive all three factors to be present simultaneously. This may contribute to students' non-optimal performance despite generally positive responses to individual statements.

Keywords: Motivation; self-efficacy; course value; class environment; Likert survey; organic chemistry.

1. INTRODUCTION

Motivation is the personal investment that an individual has reaching a desired state or outcome [1]. In learning, motivation influences the direction, intensity, persistence, and quality of learning behaviors in which students engage [2]. If students are not properly motivated, the likelihood of academic success decreases substantially.

Although many theories have been offered to explain motivation, most accept that there are two core concepts [2].

1) The subjective value for achievement-related activities and goals: Students must associate value with course performance. Sources of value may include attainment value (satisfaction gained from mastery or accomplishment, e.g., a good grade), intrinsic value (satisfaction gained from doing the task rather than from the outcome of the task) and instrumental value (an activity that helps accomplish other important goals).
2) Outcome efficacies: Students must hold positive expectations that they are capable of performing specific actions that will achieve a desired outcome.

In addition to value and efficacies, motivation is also affected by students' perceptions of a supportive or unsupportive classroom environment; motivation is enhanced if students perceive the environment as supportive [3,4]. Motivated student behavior is only realized when value is perceived, student efficacy is high, and a supporting learning environment exists [2].

As is the case at most institutions, organic chemistry has a reputation among students as a challenging, "gate-keeper" prerequisite course for multiple programs including but not limited to pre-medical, pre-dental, pre-pharmacy, biology, biochemistry, and chemistry. Many find organic chemistry challenging because skill sets such as spatial visualization, pattern recognition and critical thinking must be applied by students who typically rely on memorization in other introductory science courses [5]. Also, organic chemistry content is cumulative, and failure to understand previously presented concepts will significantly impact subsequent learning negatively. Therefore, the presence of proper motivation is critical to increase a student's likelihood of academic success in this traditionally difficult course.

Specific factors associated with motivated student behavior have been highly correlated with academic performance in organic chemistry in previous investigations [5,6]. Using the Motivational Beliefs and Learning Strategies Questionnaire, Lynch and Trujillo reported that intrinsic goal orientation was positively associated with academic performance, while goal orientation based either on grades or upon satisfying others was negatively associated [5]. High task value (learning organic chemistry is meaningful and worthwhile) and self-efficacy were also positively associated with academic performance [5,6]. Students' perceptions of an instructor's autonomy support correlated positively with academic performance as well [6].

Although individual factors that affect student motivation have been associated with academic performance in organic chemistry, correlation of the three combined factors has not been addressed. The purpose of this study is to investigate the correlation of perceived value, student efficacy and learning environment associated with organic chemistry courses taught at Penn State Abington College by one of the authors. The correlation will be evaluated using student responses to statements pertaining to the factors in a Likert survey.

2. MATERIALS AND METHODS

2.1 Respondents

The respondents in this study were students enrolled in four organic chemistry courses conducted between Spring 2011 and Spring 2012. The survey was distributed to students at

the midpoint of the semester after receiving performance feedback from two examinations and multiple quizzes. The total number of students enrolled at the midpoint of these combined courses was 197; 120 students (60.9%) participated in the survey. Participation in the survey was both voluntary and anonymous. Of the 197 students enrolled at the time of the survey, 186 students (94.4%) completed the courses.

2.2 Instrument

The instrument was a survey consisting of twelve statements to which respondents indicated through a seven point Likert response scale how strongly they agreed or disagreed with the statement. A response of "7" indicated "I strongly agree", whereas a response of "1" indicated "I strongly disagree." The twelve statements were intended to reflect students' perceptions about value, efficacy, and environment:

Perceived value – Statements 1, 4, 6, and 8
Self efficacy – Statements 2, 10, and 12
Environment – Statements 3, 5, 7, 9, and 11

The statements are listed below in the numerical order in which they appeared on the survey:

S1. Mastering the material in organic chemistry will help me accomplish other important goals I have for myself.
S2. I expect to receive a grade of B- or better in organic chemistry.
S3. My classmates seem willing to help me if I have difficulty learning the subject.
S4. Mastering the material in organic chemistry is less important than receiving a good grade in the course.
S5. Previous courses in my college career have not sufficiently prepared me to learn organic chemistry.
S6. My primary goal in this course is to get a good grade.
S7. I have sufficient resources (books, office hours, etc.) to help me master the material in organic chemistry.
S8. The material in this course is not relevant toward my intended field of study.
S9. Attending class is helpful in mastering the material in organic chemistry.
S10: I do not believe I have the ability to do well in organic chemistry.
S11. When I have questions during lecture, I feel intimidated about asking them.
S12. I generally perform well in science courses.

2.3 Statistical Analysis

Pair-wise correlations between student responses were calculated. Correlation was deemed significant at the 0.05 level (2 tailed). Correlations were expected where the statements were measuring the same attribute of either course value, self-efficacy and class environment. Additionally, if students are to perform well, all three attributes must be present and that presence would lead to correlation between all statements. A significant correlation between statements measuring the same attribute indicates the quality of the instrument. Correlation between statements measuring different attributes assesses each student's combination of attributes.

3. RESULTS AND DISCUSSION

A summary of student responses to the survey statements is presented in Table 1. Responses to value perception statements suggest that multiple sources of value are operating in combination. Students overwhelmingly agreed in S2 (79.2%) that mastering organic chemistry will help accomplish other important goals, indicating that it has instrumental value. Perceived instrumental value is also supported by responses to S8; 76.7% of the respondents disagreed with the statement that the course material is not relevant to their intended field of study. Attainment value is indicated by responses to S6. Nearly 62% of the respondents agreed that a good grade is their primary goal; only 15.8 % disagreed with this contention. In light of the responses to S6, only 22.5% of the respondents agreed with the statement that mastering the material in organic chemistry is less important than receiving a good grade (S4). It is difficult to reconcile that 57.5% of the respondents to S4 disagreed that mastering the course material was less important than a good grade when 61.7% indicated agreement that a good grade was a primary goal unless mastery and grades are valued similarly.

Among efficacy perception statements, students overwhelmingly indicated self-efficacy in S2 and S12. Over 79% of the respondents agreed that they expected to receive a grade of B- or better, and over 76% agreed that they generally perform well in science courses. There was no attempt in this study to correlate performance outcomes with perceived motivational factors. However, despite nearly 80% of the respondents expecting

a grade of B- or better (S2), only 50% of the students completing the course realized such a grade. Less than 22% indicated in S10 that they lack the ability to do well in organic chemistry. In regard to environment, responses to statements S3, S7, S9, and S11 indicated a supportive environment exists: 82.5% agreed classmates are helpful, 93.3% agreed they possess sufficient resources, 97.5% agreed classroom attendance is helpful and only 21.7% indicated intimidation about asking questions in lecture, respectively. Interestingly, responses to S5 concerning the benefit of previously attended college courses may support the notion that organic chemistry is significantly different than other introductory science courses [5]. The distribution of responses to S5 is statistically significant (Chi squared = 14.92, p = 0.0209 (2 tailed)); nearly 35% of the respondents disagreed that previous courses sufficiently prepared them, while 41.5% agreed that they did.

Results of the statistical analysis of responses to the twelve statements performed to determine correlation among the statements is presented in Table 2. Among the statements related to value perceptions, S4, S6 and S8 correlate to each other; S1 only showed correlation with S8. The correlation between S4 and S6 is perplexing, since an inverse correlation between the two was expected when the instrument was constructed. The data for S4 and S6 suggests that it is not a matter or grades versus mastery, but that both are valued similarly. However, it is then difficult to reconcile the lack of correlation between S4 and S6 with S1 (0.603 and 0.963, respectively). Although the presence of instrumental and attainment value are clearly indicated in the responses, the lack of correlation suggests that in student minds grades and mastery are not necessarily related.

Among the efficacy perception statements, S2 significantly correlates with both S10 and S12, but S10 and S12 do not significantly correlate with each other (0.071). The lack of correlation between S10 and S12 may be due to the previously mentioned perception that organic chemistry is more challenging than other introductory science courses [5]. This perception may also contribute to the correlation among environmental perception statements. Of the five statements associated with environment, S3, S7, S9 and S11 all significantly correlate with each other. However, responses to S5 do not correlate to any of the above four statements (0.611 – 0.990). Students do not perceive previous college coursework as part of a supportive environment for organic chemistry. Both the use of different skill sets and the cumulative nature of the coursework certainly distinguish organic chemistry from the general chemistry courses that typically serve as its prerequisite.

Table 1. The percentage of respondents indicating a Likert scale value to statements S1 through S12

Statement	Likert scale (1: I strongly disagree, 7: I strongly agree)						
	1	2	3	4	5	6	7
S1	0.8	1.7	1.7	11.8	19.3	25.2	39.5
S2	4.2	4.2	5.0	7.5	16.7	16.7	45.8
S3	2.5	2.5	2.5	10.0	20.8	26.7	35.0
S4	21.7	18.3	17.5	20.0	14.2	7.5	0.8
S5	11.0	10.2	13.6	23.7	18.6	11.9	11.0
S6	2.5	3.3	10.0	22.5	20.0	21.7	20.0
S7	0.8	0.8	0.8	4.2	10.8	40.0	42.5
S8	38.3	26.7	11.7	5.0	7.5	5.0	5.8
S9	0.8	0.0	0.0	1.7	3.3	12.5	81.7
S10	37.0	21.0	11.8	8.4	13.4	5.9	2.5
S11	44.2	10.0	8.3	15.8	10.0	9.2	2.5
S12	0.0	0.8	5.8	16.7	27.5	30.0	19.2

Table 2. Correlations among student responses to statements S1 through S12. Correlations significant at the 0.05 level are indicated in bold text

		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
S1	Pearson	1	.639**	.279**	-0.048	-.261**	-0.004	.336**	-.409**	.340**	-.346**	-.377**	0.168
	Sig		0	0.002	0.603	0.005	0.963	0	0	0	0	0	0.068
	N	119	119	119	119	117	119	119	119	119	118	119	119
S2	Pearson	**.639****	1	0.12	-0.04	-0.113	0.091	.205*	-.268**	.207*	-.461**	-.366**	.285**
	Sig	**0**		0.193	0.665	0.222	0.323	0.025	0.003	0.023	0	0	0.002
	N	**119**	120	120	120	118	120	120	120	120	119	120	120
S3	Pearson	**.279****	0.12	1	-0.124	0.018	-0.039	.384**	-.213*	.362**	-0.1	-.198*	-0.092
	Sig	**0.002**	0.193		0.178	0.847	0.671	0	0.019	0	0.281	0.031	0.317
	N	**119**	120	120	120	118	120	120	120	120	119	120	120
S4	Pearson	-0.048	-0.04	-0.124	1	0.089	.230*	0.044	.186*	-0.109	.269**	0.065	-0.016
	Sig	0.603	0.665	0.178		0.34	0.012	0.631	0.042	0.238	0.003	0.483	0.864
	N	119	120	120	120	118	120	120	120	120	119	120	120
S5	Pearson	**-.261****	-0.113	0.018	0.089	1	0.106	-0.02	.223*	0.047	0.075	0.001	-0.059
	Sig	**0.005**	0.222	0.847	0.34		0.252	0.829	0.015	0.611	0.418	0.99	0.527
	N	**117**	118	118	118	118	118	118	118	118	118	118	118
S6	Pearson	-0.004	0.091	-0.039	**.230***	0.106	1	0.084	.196*	0.136	0.127	0.002	0.043
	Sig	0.963	0.323	0.671	**0.012**	0.252		0.363	0.032	0.139	0.17	0.981	0.64
	N	119	120	120	**120**	118	120	120	120	120	119	120	120
S7	Pearson	**.336****	**.205***	**.384****	0.044	-0.02	0.084	1	-0.099	.379**	-0.089	-.206*	-0.013
	Sig	**0**	**0.025**	**0**	0.631	0.829	0.363		0.281	0	0.338	0.024	0.884
	N	**119**	**120**	**120**	120	118	120	120	120	120	119	120	120
S8	Pearson	**-.409****	**-.268****	**-.213***	**.186***	**.223***	**.196***	-0.099	1	-0.039	.201*	0.052	0.001
	Sig	**0**	**0.003**	**0.019**	**0.042**	**0.015**	**0.032**	0.281		0.672	0.028	0.574	0.992
	N	**119**	**120**	**120**	**120**	**118**	**120**	120	120	120	119	120	120
S9	Pearson	**.340****	**.207***	**.362****	-0.109	0.047	0.136	**.379****	-0.039	1	-.275**	-.283**	.179*
	Sig	**0**	**0.023**	**0**	0.238	0.611	0.139	**0**	0.672		0.002	0.002	0.05
	N	**119**	**120**	**120**	120	118	120	**120**	120	120	119	120	120

		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
S10	Pearson	**-.346****	**-.461****	-0.1	**.269****	0.075	0.127	-0.089	**.201***	**-.275****	1	.345**	-0.166
	Sig	**0**	**0**	0.281	**0.003**	0.418	0.17	0.338	**0.028**	**0.002**		0	0.071
	N	**118**	**119**	119	**119**	118	119	119	**119**	**119**	119	119	119
S11	Pearson	**-.377****	**-.366****	**-.198***	0.065	0.001	0.002	**-.206***	0.052	**-.283****	**.345****	1	-0.122
	Sig	**0**	**0**	**0.031**	0.483	0.99	0.981	**0.024**	0.574	**0.002**	**0**		0.185
	N	**119**	**120**	**120**	120	118	120	**120**	120	**120**	**119**	120	120
S12	Pearson	0.168	**.285****	-0.092	-0.016	-0.059	0.043	-0.013	0.001	**.179***	-0.166	-0.122	1
	Sig	0.068	**0.002**	0.317	0.864	0.527	0.64	0.884	0.992	**0.05**	0.071	0.185	
	N	119	**120**	120	120	118	120	120	120	**120**	119	120	120

***Correlation is significant at the 0.01 level (2-tailed), *Correlation is significant at the 0.05 level (2-tailed)*

Correlation among value-, efficacy- and environment-related statements was mixed. The instrumental value of knowledge (S1) correlated with 7 of 8 statements outside the value category. In contrast, the attainment value of a good grade (S4 and S6) correlated with 1 and 0 statements respectively outside the value category. Efficacy statements S2 and S10 each correlated with 5 of 9 statements outside the efficacy category, both correlating with S1, S8, S9, and S11. Additionally, S2 correlated with S7, and S10 correlated with S4. The third efficacy statement correlated poorly: performance in science courses (S12) correlated only with class attendance (S9). Correlations of environment-related statements with value- and efficacy-related statements ranged from 4 of 7 (S9) to 2 of 7 (S3, S5, and S7); S11 correlated with 3 of 7. All 5 statements in this category correlated with the instrumental value of knowledge (S1), and S7, S9 and S11 each correlated with expectations of a good grade (S2). The remaining correlations were scattered.

4. CONCLUSION

Despite responses that indicate all three factors purportedly required for motivation are present in organic chemistry classes, no correlation between the three is evidenced upon statistical analysis. Although correlation was generally found among statements pertaining to the individual factors of value, efficacy and environment, the lack of correlation among these three factors indicates that individual students probably did not perceive all three factors to be present simultaneously. If all three factors must indeed be present to create truly motivated students, this may help to explain the challenging nature of organic chemistry despite generally positive responses to individual statements.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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