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Explaining Student Cognition during Class Sessions in the Context Piaget's Theory of Cognitive Development

By John C. Ewing, Daniel D. Foster and M. Susie Whittington

Jack Everly Award

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NACTA Journal Awards Background

Selection Process

Each year NACTA recognizes outstanding contributions to the NACTA Journal. Members of the NACTA Journal Awards Committee read and evaluate each article published in the NACTA Journal during the year. Then, a ballot is submitted to the Chair in January with the top eight articles ranked. The Chair tabulates results. In early February, participating committee members rank a second ballot containing the few leading candidates. The final tabulation determines the award recipients.

E.B. Knight Journal Award

Award established by the NACTA Executive Committee after Knight's death in 1965, in recognition of his outstanding contributions to NACTA. E.B. Knight received his graduate degrees from the University of Missouri. He taught 1939-1949 at the University of Tennessee and 1949-1964 at the Tennessee Polytechnic Institute. E.B. Knight was a charter member of NACTA, served as first President 1955-56, was Editor of the Journal from 1958-1960, and author of numerous articles published in the NACTA Journal.

Jack Everly Journal Award

Award established by the NACTA Executive Committee in recognition of Jack's outstanding contributions to the NACTA Journal. Jack C. Everly taught at the University of Illinois. In 1971, he received the E.B. Knight Journal Award and received the NACTA Distinguished Educator Award in 1984. Jack served 25 years as Associate Editor (1971-74) and Editor (1974-96) of the NACTA Journal.

NACTA Journal Award Honorable Mentions: This award was started in the 1980s by former Chair Bob Sorenson to recognize outstanding paper(s) that contended for an award, but lacked the necessary votes. One, to rarely three awards are presented, at discretion of the Chair.

Explaining Student Cognition during Class Sessions in the Context Piaget's Theory of Cognitive Development

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Abstract

The purpose of this study was to explain student cognition during class sessions in the context of Piaget's Theory of Cognitive Development. The objective of the study was to describe comprehensively Piaget's active experience influence through six variables: four professor variables (cognitive level of professor discourse, cognitive level of professor questions, cognitive level of course objectives, and percent of lecture used during class sessions), and two student variables (student engagement and cognitive level of student questions) and, specifically, to describe their relationship to student cognition, which has not previously been operationally defined as it is defined in this study. Using a regression model, professor discourse and the percent of lecture used during class sessions explained more of the variance in student cognition. Recommendations included increasing professor and student awareness of the ability to teach and think using formal operations strategies for increased cognitive development, and to conduct further research to explain independent variables affecting student cognition.

Introduction

Critics of higher education believe that the university system is failing in the preparation of students (Tom, 1997). The Boyer Commission on Educating Undergraduates in the Research University (1998) advocated that students are not being prepared sufficiently to think beyond the lower levels of cognition. If a purpose for higher education is to meet the demand for high quality students to enter the workforce, universities and colleges must examine that which is occurring in their classrooms (Whittington, 2003), and be ready to produce evidence of that which has occurred (Brown and Lane, 2003) that contributed to critical thinking and problem solving for entry-level employment and beyond.

To meet this accountability challenge, Nordvall and Braxton (1996) recommended examining course-level academics to identify institutional quality, and advocated Bloom's Taxonomy (Bloom et al., 1956) for assessing level of understanding related to course content. Similarly, Sanders (1966) proposed using Bloom's Taxonomy as a way of observing and identifying levels of cognition for questions that were being asked by instructors. Bloom et al. (1956) stated that the taxonomy was designed for classifying student behaviors. The authors of the taxonomy believed that student and teacher behaviors could be observed and could be classified in a variety of content areas and educational levels (Bloom et al., 1956).

Woolfolk-Hoy (2004) suggested strategies for effective teaching appropriate for Piaget's stages of cognitive development. In the preoperational stage, the teacher uses actions and verbal instruction (lower level teaching strategies). Teaching in the concrete and formal operations stages requires higher-level teaching strategies. For example, concrete operations strategies involve hands-on learning, performing experiments and testing of objects while teaching in the formal operations stage involves giving students the opportunity to advance their skills in scientific reasoning and problem solving by offering open-ended projects, and exploring hypothetical possibilities (Woolfolk-Hoy, 2004). The level of cognitive development of a student may impact the level of difficulty in the transition to the undergraduate environment (Markwell and Courtney, 2006). At what Piagetian stage are our college students operating, and are our college of agriculture professors providing cognitive development opportunities appropriate for these stages of cognitive development? Transfer of learning is increased when students engage in materials are higher cognitive levels. If transfer of learning is not the primary objective of our institutions of higher education, the question begged is, "What is the relevance of formal schooling?" (Pugh and Bergin, 2006, p. 156). "One purpose of postsecondary education is preparing

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students for their future professional lives" (Thompson et al., 2003, p. 133). To meet this purpose, students' critical thinking abilities must be examined and explained in the context of teaching and learning in higher education.

Theoretical and Conceptual Frameworks

Piaget introduced his biologically-motivated Theory of Cognitive Development early in the last century, and from that time to today, educators and researchers have eagerly worked to exhibit a link between students' cognitive stage of development and their capacity for learning (Markwell and Courtney, 2006). Piaget (1964) believed that learning came prior to development.

In his theory of Cognitive Development, Jean Piaget posited that individuals did not advance one distinct step at a time through the stages, nor that progress was automatic. In fact, Piaget suggested viewing cognitive development as a continuum involving the interaction of four influences: maturation, active experience, social interaction, and a general progression of equilibrium (Piaget, 1961). Wadsworth (2004) stated, "Movement within and between stages of development is a function of these factors and their interaction" (p. 28).

A paucity of current research exists regarding the cognitive stage of development of college students. Cohen and Smith-Gold (1978) did find that the two cognitive stages at which most college students are operating are concrete operations and formal operations. The researchers cited several studies showing that the transition through the developmental stages occurs at much later ages, and that some individuals never obtain formal operations. Schwebel (1975) in a study of first-year college students found that formal operations, such as thinking in abstractions and logically, occurred much later in some people or not at all, and that many college students failed to attain full operational thinking. Cohen and Smith-Gold (1978) found, with a paper-pencil test, that a majority, 75%, of the students were not at the formal operations level when entering college. Pascarella and Terenzini (1991) stated that evidence suggests that close to half of entering college students are not operating at advanced stages of cognitive development and that postsecondary education plays a key role in exposing students to experiences that encourage development. Foster et al., (2009) reported results regarding Piagetian stage of cognitive development that aligned with previous findings with a majority of students not operating at the formal operations level. In addition, Bee (2000) stated that studies based on Piaget's model reveal that only half of adults function at the level of formal operations.

Piaget (1964) stated, regarding the stages of cognitive development, "although the order of succession is constant, the chronological ages of these stages varies a great deal" (p. 178). Woolfolk (2007) wrote, "Some students remain at the concrete operational stage throughout their school years, even throughout life. However, new experiences, usually those that take place in school, eventually present most students with problems they cannot solve using concrete operations" (p. 35).

Piaget further theorized that teachers had little impact on the maturation influence, but teachers, through the active experience influence, provided exploration, observation, testing, and information organization, all of which were likely to alter thinking processes. In addition, Piaget felt that teachers would impact the social transmission influence (i.e. learning from others) depending on the stage of cognitive development the student had already reached when entering a classroom relationship with the instructor.

Building upon Piaget's (1970) active experience influence, the cognitive level of classroom activity can be framed with assistance from Bloom's Taxonomy (Bloom, 1964) which is useful for documenting the cognitive levels at which teachers and learners process classroom content. Bloom's et al. (1956) six-step hierarchical system of thought processing (knowledge, comprehension, application, analysis, synthesis, evaluation) moves from the knowledge level, emphasizing subject matter recall, to the evaluation level, that entails making judgments.

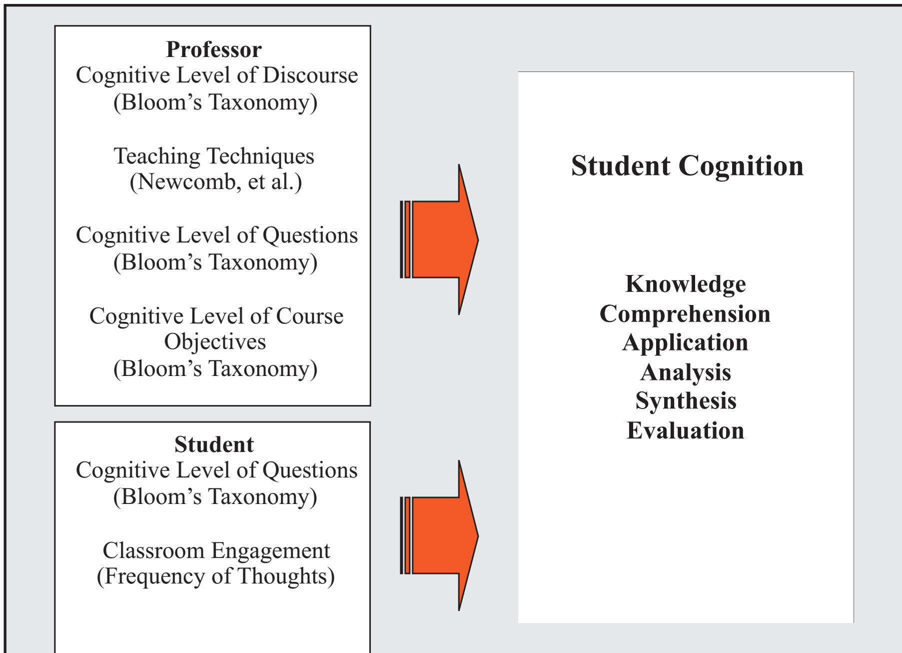

Figure 1. Conceptual Framework of Proposed Factors Influencing Student Cognition

Each level is reflected through cognitive classroom activity.

Given that learning is enhanced by increasing the percentage of student and instructor cognitive classroom activity occurring at the higher levels of cognition, Bloom's Taxonomy provides focus and direction to teachers who desire to enhance the quality of teaching and learning in their class sessions (Bowman and Whittington, 1994). Therefore, based upon Piaget's (1970) conclusion that activity influences student thinking, four professor variables and two student variables were examined in this study to explain student cognition during class sessions (see Figure 1). Student cognition, in this study, was operationally defined as a mathematical computation derived from measuring and assessing student thoughts during class sessions and applying a cognitive weight to students' brain processes during class (see Instrumentation).

Purpose and Objectives

The purpose of this research was to explain student cognition, those levels at which students were thinking based on classroom engagement, during class sessions in the context of Piaget's Theory of Cognitive Development. The objective of the study was to comprehensively describe Piaget's active experience influence through six variables; four professor variables (see Figure 1) and two student variables (see Figure 1). Specifically, the objective of the study was to describe the relationship of these six variables to the dependent variable, student cognition. Student cognition has not previously been operationally defined as defined in this study, nor has student cognition been explained, in a regression analysis.

Methods

The researcher met with all department chairs in the college of agriculture (N = 8), at a large land-grant university in the Midwest. The researchers explained the study and asked the department chairs to nominate three faculty members from their departments who received good student evaluations, positive student exit interview data, and favorable annual reviews of teaching. These teachers were identified as being good, and it should be noted that this may bias the results when compared with teachers with different skills and abilities. Individual appointments were scheduled, with those whom were nominated, to explain the study (a protocol was used such that all professors received identical information) and to seek their participation. Professors were informed of the importance of the study, the timeline, and the events that would take place in their classrooms as a result of their participation.

Twelve nominated faculty members, across all disciplines in the college, participated. The researchers scheduled observations and videotaping for each professor's class session two times during the quarter. However, scheduling conflicts prevented two observations for three of the professors. In-class observations were conducted by two researchers.

In addition, 21 students participated in the study; one student from each observed class session was randomly selected from the professor's class roster to participate in the student think-aloud protocols. As advocated by Kucan and Beck (1997), the think-aloud protocols had to be administered as immediately as possible to the time of the class session. Therefore, for students to be eligible for the study, they could not have academic commitments immediately following the scheduled class session observation. The think-aloud protocols were conducted by asking the students to watch a videotape of the class session they had just attended and record, using a hand-held cassette recorder, all that they were thinking during the class session. These thoughts were then transcribed and analyzed using Bloom's Taxonomy (1956).

Instrumentation

Six instruments were used to measure the professor and student variables. In each instrument in which Bloom's Taxonomy was used as the cognitive framework, content validity was based upon its direct development from Bloom's Taxonomy (1956) and the support, from theory and evidence (Ary et al., 2002), generally given to Bloom's hierarchy of cognitive behaviors. Based originally upon the cognitive levels identified by Bloom et al., Pickford and Newcomb (1989) developed a system to weight each of the cognitive levels. The cognitive factors' weight increases as the level of cognition increases; thus, awarding more overall weight to the higher levels of cognition.

Cognitive Level of Professor Discourse

The Florida Taxonomy of Cognitive Behavior (FTCB) was used in this study to determine the cognitive level of professor discourse during a class session observation (Webb, 1970). During each class session, the total number of cognitive behaviors that the professor displayed was recorded using the FTCB. The total number of observations per professor was summed to give an overall frequency at each cognitive level for each individual professor. A percentage of teaching behaviors was then determined for each cognitive level of professor discourse. The cognitive weighting factor (Pickford and Newcomb, 1989) for each level of cognition (see Table 1) was multiplied by the percentage for each level of cognition to yield a cognitive weighted score for professor discourse at each level of cognition. The cognitive weighted scores for professor discourse from each level of cognition were summed to yield a total cognitive weighted score for professor discourse during each class session.

Intra-rater reliability for the instrument was assessed using observations of two videotapes of teaching. The overall intra-rater reliability was $r_{(9\ weeks)} = .91$. Inter-rater reliability was established for this study by having an expert in cognition research complete an assessment of a sample videotape. The inter-rater reliability was r = .94.

Table 1. Cognitive Weighting Factors

Level of Cognition	Weighting Factor *(Professor discourse)*	Weighting Factor *(Questions, objectives, and student cognition)*
Knowledge	.10	.10
Translation	.20	.20 (Comprehension)
Interpretation	.25	.20 (Comprehension)
Application	.30	.30
Analysis	.40	.40
Synthesis	.50	.50
Evaluation	.50	.50

Note. Bloom et al. (1956), Newcomb and Trefz (2005) identified levels of cognition.
Note. Pickford and Newcomb (1989) development of weighting factors.

Professor Teaching Techniques

Frequencies for each group-and individualized-teaching technique, as described by Newcomb et al. (2004), were recorded while viewing each videotaped class session. Percentages for lecture versus non-lecture techniques used by individual professors during class sessions were calculated. Inter-rater ($r_{(3\ weeks)} = .84$) and intra-rater ($r_{(3\ weeks)} = .90$) reliabilities were established by watching a videotaped class session for a second time and recording each teaching technique observed. Two individuals, who have studied and experienced multiple teaching techniques, conducted validity tests and determined the instrument to be face and content valid.

Cognitive Level of Professor Questions

The cognitive level of each professor question that elicited student engagement with the class content was categorized using Bloom's Taxonomy (1956). The percentage of professor questions asked at each level of cognition during the class session was calculated. The cognitive weighting factor (see Table 1) for each level of cognition was then multiplied by the percentage of professor questions at each level of cognition to yield a cognitive weighted score for professor questions. The cognitive weighted scores for professor questions at each level of cognition were summed to yield a total cognitive weighted score for professor questions. Inter-rater ($r_{(3\ weeks)} = .93$) and intra-rater ($r_{(3\ weeks)} = .84$) reliabilities were established. The instrument was deemed to be face and content valid.

Cognitive Level of Course Objectives

Course objectives provided by the course syllabi were analyzed and categorized by cognitive level using Bloom's Taxonomy (1956). A percentage for course objectives written at each level of cognition was calculated by dividing the number of course objectives at each level of cognition by the total number of course objectives. The cognitive weighted score for course objectives was calculated at each level of cognition by multiplying the percentage of course objectives at each level of cognition by the appropriate weighting factor (see Table 1). The cognitive weighted scores for course objectives at each level of cognition were summed to yield a total cognitive weighted score for course objectives.

The intra-rater reliability for the cognitive level of course objectives was $r_{(3\ weeks)} = .92$. An expert in writing course objectives and cognition completed inter-rater reliability (r = .98). The cognitive framework was Bloom's Taxonomy (1956).

Cognitive Level of Student Questions

Questions asked by students during class sessions were analyzed and categorized by cognitive level using Bloom's Taxonomy (1956). A percentage for cognitive level of student questions was calculated for each level of cognition by dividing the number of questions at each cognitive level by the total number of questions asked by students during class sessions. The cognitive weighting factor (see Table 1) for each level of cognition was then multiplied by the percentage of student questions at each level of cognition to yield a cognitive weighted score for student questions at each level of cognition. The cognitive weighted scores for student questions at each level of cognition were summed to yield a total cognitive weighted score for student questions. Inter-rater ($r_{(3\ weeks)} = .90$) and intra-rater ($r_{(3\ weeks)} = .88$) reliabilities were established by watching a videotaped class session for a second time and recording the level of cognition for each question asked by students during the class session.

Classroom Engagement

Classroom engagement was recorded based on students' completion of think-aloud protocols. Student thoughts were transcribed and each thought was categorized into one of six thought-types. The six thought-types, based on previous research (Lopez and Whittington, 2000), were: (1) thoughts or observations about the professor, (2) nonsense or unrelated thoughts, (3) thoughts connected to previous learning, (4) thoughts about past experiences prompted by class subject matter, (5) deeper learning/questioning thoughts, (6) thoughts about behavior that got/maintained attention. Student thoughts that were categorized into thought-type 3, 4, 5, or 6 were deemed engaged thoughts. Engaged thoughts were directly related to, or were prompted by the course subject matter.

Reliability was established using a sample transcript and recording the level of student engagement during the class session. The intra-rater reliability for student engagement was $r_{(3\ weeks)} = .92$. Another individual, who was familiar with student engagement and teaching/learning, analyzed a sample transcript to establish inter-rater reliability (r = .89). Two students, who have studied and been trained in cognition research, analyzed face and content validity for this instrument. The raters indicated that the instrument was appropriate for categorizing student thoughts.

Student Cognition

All classroom engagements, acquired from the think-aloud protocol sessions, were classified into one of the six levels of Bloom's Taxonomy (1956), and a percentage was calculated for each cognitive level. The cognitive weighting factor (see Table 1) for each level of cognition was then multiplied by the percentage of classroom engaged thoughts at each level of cognition to yield a cognitive weighted score for student cognition at each level of cognition. The cognitive weighted scores for student cognition at each level were summed to yield a total cognitive weighted score named student cognition. Reliability was established using a sample transcript, and recording the level of cognition for each student thought during the class session. Intra-rater reliability for student cognition was $r_{(3\ weeks)} = .94$ and inter-rater reliability was (r = .91). The cognitive framework was Bloom's Taxonomy (1956).

Data Analysis

All professor and student data were entered into SPSS 14.0. Descriptive statistics were generated for each variable. A linear regression model, using the Enter method, was completed to explain the professor and student variables that influenced student cognition during class sessions. Four professor variables and two student variables (see Figure 1) were entered into the regression model at the ratio level of measurement.

Results

In Table 2, the descriptive statistics related to professor variables and student variables are displayed. The total cognitive weighted score for professor discourse mean was 18.95 *(SD = 4.26)*, indicating that the total cognitive weighted score average for professor discourse was between the knowledge and comprehension levels of cognition.

Professors used lecture as a teaching technique 56% of the time *(M = 55.76, SD = 26.28)*. Professor questions asked during class sessions carried a total cognitive weighted score for professor questions mean of 23.44 *(SD = 10.16)*, indicating that the total cognitive weighted score for professor questions was between the comprehension and application levels of cognition. Course objectives yielded a total weighted score for course objectives mean of 21.29 *(SD = 6.22)*. The objectives were primarily written at the comprehension level of cognition.

As can be seen in Table 2, for student variables, the mean total cognitive weighted score for student cognition (dependent variable) was 24.20 *(SD = 5.35)*. A total cognitive weighted score for student cognition of 24.20 was categorized between the comprehension and application levels of cognition. Student cognitive level of questions yielded a total cognitive weighted score for student questions mean of 17.93 *(SD = 13.57)*, indicating that the average cognitive level of student questions during class sessions was between the knowledge and comprehension levels of cognition. The percent of classroom engaged thoughts during class sessions was 42%.

Table 2. Descriptive Statistics Related to Professor and Student Variables

	Mean	SD	n
Total cognitive weighted score for student cognition	24.20	5.35	21
Total cognitive weighted score for professor discourse	18.95	4.26	21
Total cognitive weighted score for professor questions	23.44	10.16	21
Total cognitive weighted score for course objectives	21.29	6.22	21
Total cognitive weighted score for student questions	17.93	13.57	21
Percent of classroom engagement for students	41.72	17.6	21
Percent of lecture for professors	55.76	26.28	21

As can be seen in Table 3, correlations between professor variables and total cognitive weighted score for student cognition were .501 (substantial) for total cognitive weighted score for professor discourse and .511 (substantial) for course objectives (Davis, 1971). Therefore, as the total cognitive weighted score for professor discourse and the total cognitive weighted score for course objectives increased, the total cognitive weighted score for student cognition increased substantially. As professor use of lecture increased, the total cognitive weighted score for student cognition decreased moderately (-.489).

As can be seen in Table 4, given the small number of class sessions observed in this study (n = 21), the Adjusted R-square is the appropriate measure of interest for the model. Thus, 15.4% of the variance in

Table 3. Correlations for Total Cognitive Weighted Score for Student Cognition to Professor and Student Variables

	TCWSPD	Lecture (%)	TCWSPQ	TCWSCO	TCWSSQ	Engaged thought (%)
TCWSST	.501	-.283	.069	.511	.350	.024
TCWSPD		-.489	.002	.338	.467	-.172
Lecture (%)			-.244	-.258	-.041	.369
TCWSPQ				.338	-.132	-.307
TCWSCO					.239	-.050
TCWSSQ						-.034

Note. TCWSST = Total Cognitive Weighted Score for Student Cognition; TCWSPD = Total Cognitive Weighted Score for Professor Discourse; TCWSPQ = Total Cognitive Weighted Score for Professor Questions; TCWSCO = Total Cognitive Weighted Score for Course Objectives; TCWSSQ = Total Cognitive Weighted Score for Student Questions.

the dependent variable, student cognition, can be explained by the six independent variables (four professor variables and two student variables) entered into the model.

Table 4.Model Summary for Professor and Student Variables to Total Cognitive Weighted Score for Student Cognition

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.639	.408	.154	4.92

Conclusions/Implications/ Recommendations

Professors in this study are delivering content to students at the lowest cognitive levels during class sessions. Professor discourse, professor questions, and course objectives were found to be at the two lowest levels of Bloom's Taxonomy (knowledge and comprehension; 1956). Piagetian theory indicates that the professors in this study were using strategies best used with students operating at the preoperational cognitive stage of development, which is not the stage of development expected for college students.

Students, during the class sessions observed and recorded, were not being cognitively challenged to operate at higher levels for further cognitive development. Professors of these classes, therefore, should expect students to operate at higher cognitive levels after professors make conscious changes to write course objectives, plan classroom questioning, and deliver course content using strategies for formal operations of cognitive development. Porter and Brophy (1988) advocated that a professor's ability to address both low and high levels of cognition aid in promoting higher levels of student thinking.

Professors are often unaware of the cognitive levels of their current practices and behaviors (Newcomb and Trefz, 2005). However, most, upon learning of higher cognitive classroom techniques and strategies, adjust their practices to enrich their learning environments (Bowman and Whittington, 1994) including enhanced student cognition.

Students in the study are asking questions and engaging in content at the lowest cognitive levels during class sessions. Student questions and student cognition were found to be at the two lowest levels of Bloom's Taxonomy (knowledge and comprehension; 1956). Students must be able to think critically and to analyze information that has been presented to them (Education Commission of the States, 1995). If students are thinking primarily at lower levels of cognition during class sessions, critics of undergraduate education may be correct in stating that undergraduate students are not prepared to think at higher levels of cognition after leaving the university (Tom, 1997) and entering employment.

Students in the study are cognitively engaged in class content, during class sessions, less than half of the session. Students need to be engaged in the class session for meaningful learning to occur (Piaget, 1970; Woolfolk, 2001). Students not engaged with the class content are not able to retain and transfer the information for future use. Research (Barr and Tagg, 1995; Boggs, 1995) shows that students retain information better if they are active in their learning. Professors should use strategies, such as professor questions (Blosser, 2000) that guide students through the course content, and planned student activities (King, 1993), to encourage student thought and engagement during class sessions. When professors fail to assist students with developing a deeper understanding that will enable them to apply their knowledge in new and challenging situations, the full potential of education cannot be realized (Newcomb and Trefz, 2005).

The cognitive level of professor behaviors affects student cognition during class sessions. Lecture by itself does not often allow for active learning on the part of the student (Mangurian et al., 2001), but by employing other teaching techniques in the classroom, professors can help students learn (Bonwell and Eison, 1991).

Further research must explore other variables, among wider student populations, that explain student cognition during class sessions. Environment variables (Fraser, 1998; Fassinger, 2000) are known to influence learning, so discovering the extent to which additional professor, student, and environment variables are related will improve classroom practice. For example, Piaget's (1970) maturation (student variable), Fassinger's (2000) classroom climate (environment variable), and Weimer's (2002) student-centered techniques (professor variable), to name a few; need to be explored for potential relationships that explain student cognition, as it was defined in this study.

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Undergraduate Students' Use of Time in the College of Agriculture and Natural Resources at Michigan State University

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Abstract

College students' time use has been a concern of administrators, professors, academic advisors, and parents alike. Research in students' time use is especially limited in colleges of agriculture. This study assessed how undergraduate students in the College of Agriculture and Natural Resources (CANR) at Michigan State University use their time. Annually, from 2004 to 2008, students in the CANR received online surveys asking them to report their time use and demographic information. Over the course of five years, 2,803 students participated in the study. Data analysis revealed students' average use of time (hours/week) as: preparing for class (15.2), working for pay on-campus (13.5), working for pay off-campus (16.9), participating in co-curricular activities (6.1), relaxing and socializing (16.2), providing care for dependents (11.6), and commuting to class (5.0). The study showed significant differences in students' time use based on their academic year, gender, ethnicity, and home residence. These demographic differences in time use suggest that academic advising strategies should differ on the basis of student demographics. Study findings suggest that students need more counseling on time management strategies.

Introduction

College students' time use has been a concern of administrators, professors, academic advisors, parents and guardians alike. Time is an important resource for all, but it is a critical resource for students' successful performance. Meredeen (1988) indicated that the secret of survival and success at college can be largely defined in terms of how well students organize their time. Managing time is a challenge for many college students. Unlike high school students, college students have less in-class time and more outside-of-class work. Many college students find their academic life very stressful (Macan et al., 1990).

College students' time management is directly correlated with academic performance and stress. A universal assumption is that college grades are affected by the amount of time students spend on study; however, the relationship between college grades and quantity of time spent on study has not been fully established. Schuman et al. (1985) found a very small relationship between college grades and amount of study. Britton and Tesser (1991) found that two time management components -- short-range planning and time attitudes -- were significant predictors of cumulative grade point average and concluded that time management practices may have a positive effect on college grades. They also have shown that time management is a better predictor than Scholastic Aptitude Test (SAT) scores of college performance -- i.e., grade point average.

Time management is a skill, and it can be taught to students to make them more effective learners (Trueman and Hartley, 1996; Macan, 1994). Macan et al. (1990) found that students who perceived control of their time reported greater evaluations of their performance, greater work and life satisfaction, less role ambiguity, less role overload, and fewer job-induced and somatic tensions.

Because time management and college performance have a causal relationship, understanding undergraduate students' time use is essential for college administrators, academic advisors, and parents to make sure that students are making balanced use of time and progressing toward accomplishing their personal and professional goals. Research in students' time use is especially limited in colleges of agriculture, except for a study done by Gortner and Zulauf (2000), who studied undergraduate students' use of time in agricultural economics courses at Ohio State University. In an effort to better understand this underdeveloped field, this study was undertaken to focus on the time use of undergraduate students in the CANR at MSU. Findings of this study may be useful to college administrators, academic advisors, and parents seeking to help students become engaged learners and facilitate comprehensive development.

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Objectives

The general objective of this study was to seek information on how current undergraduate students in the CANR spend their time on various academic and extracurricular activities and to analyze differences in time use patterns by selected demographic characteristics. The specific objectives of this study were to:

1. Determine weekly time use profiles of CANR students in academic and non-academic activities.
2. Determine similarities and differences in time use patterns by selected demographic characteristics of respondents such as academic year, gender, ethnicity, and residence.

Methods

College students' time use has been studied by several researchers. Researchers have often recommended and used the time diary method to measure use of time (Gortner and Zulauf, 2000; Robinson and Godbey, 1997). Robinson and his colleagues consider the time diary to be the gold standard of time management, but Jacobs (1998) maintains that a self-reported measure of working time is a useful alternative to the time diary measure because it is simple and as accurate as time diary measure. He found no patterned discrepancies between the two methods, but unlike self-reported measures, time diary measures are an extremely data-intensive research strategy for measuring use of time. This study utilized the self-reported time use (hours per week) of undergraduate students in the CANR at MSU.

This survey adapted the time-use section of the survey instrument used in the National Survey of Student Engagement (NSSE), developed by Indiana University (NSSE, 2004). For this survey, the response item scales of the NSSE survey instrument were modified with self-reported approximate hours used per week instead of eight-point scales of time use. Respondents were asked to indicate the approximate number of hours they spend per week in seven major activities: preparing for class, working for pay on-campus, working for pay off-campus, participating in co-curricular activities, relaxing and socializing, providing care for dependents, and commuting to class.

Preparing for class included activities such as studying, reading, writing, doing homework or lab work, analyzing data, researching, and other academic activities. Co-curricular activities included student organizations, campus publications, social fraternities or sororities, and intercollegiate or intramural sports. Providing care for dependents was defined as taking care of parents, children, or a spouse. The modified survey instrument was circulated to the CANR Assessment Committee members to ascertain its content and face validity.

The population of this study consisted of all undergraduate college students in the CANR from 2004 to 2008. Data were collected using an online survey during March-April of each study year. An email list maintained by the Office of the Dean served as the sampling frame for this study. The online survey was sent to 2,565 students in 2004, 2,439 students in 2005, 1,997 students in 2006, 2,406 students in 2007, and 2,311 students in 2008. Two reminder emails were sent to the survey population to increase survey response rates.

A total of 2,803 usable responses were received. The average five-year survey response rate was 24.5 %. In 2004, ice cream coupons were provided as an incentive to complete the survey. No such incentive was provided in 2005. Response rates dropped significantly in 2005, so the ice cream incentive was again offered to survey respondents in 2006, 2007, and 2008.

Data were accessed from a web-based database and exported into Statistical Package for Social Science (SPSS) for analysis. Descriptive statistics were used to present findings. One-way analysis of variance (ANOVA) and independent sample t-tests were used to determine whether the weekly time use in various activities differed significantly by students' demographic characteristics. The level of alpha for significance was set at 0.05.

Results and Discussion

Description of the Respondents

Of the 2,803 respondents, about 14% were freshmen, 25% were sophomores, 40% were juniors and 21% were seniors. About 7% of the respondents indicated that they had second majors and fewer than 10% had second degrees. Sixty-four percent of the respondents were female. The ages of respondents ranged from 18 to 58 years. The mean age of respondents was 21 years. Nearly 90% of respondents were white; the rest were Hispanic followed by African-American, Asian-American, Native American, and others. More than half (54.6%) of the respondents indicated that they came to the CANR from suburban or urban communities. Nine out of ten respondents were in-state residents. About a quarter (24.4%) of the respondents had participated in 4-H and FFA. Over half of the respondents (55.3%) indicated that they were members of the National Honor Society in high school.

Time use profiles of respondents

i) Time spent preparing for class

Respondents spent an average of 15.2 hours/week preparing for class (Table 1). Time use patterns indicate that time spent preparing for class increased over the five-year period. The time used preparing for class in this study is similar to the result of a study of the full-time university and college students' time use (16 hours per week) for educational activities from 2003 to 2006 (U.S. Department of Labor, 2007). The finding of this survey on time use for academic activities is also close to that of a time management study of students of the Literature, Science and Arts College at the University of Michigan conducted by Schuman et al. (1985), who found that the median study time was 14.5 hours/week (2.9 hours per weekday). But time use in preparing for class in this study is far less than undergraduate students' time use (21.3 hours/week) in three agricultural economics courses at Ohio State University as reported by Gortner and Zulauf (2000).

notable finding of this study is that respondents spent more time relaxing and socializing (16.2 hours/week) than they spent on academic activities (15.2 hours/week).

The U.S. full-time university and college students' time use, on an average weekday, on leisure and sports was 19.5 hours/week (U.S. Department of Labor, 2007). Gortner and Zulauf (2000) reported 19 hours/week in planned leisure and recreation activities and 10.3 hours/week in watching TV for undergraduate students in agricultural economics at the Ohio State University. Although it seems that

Table 1. Respondents' Weekly Time use by Survey Year (hours/week)

Activities	Survey year										Total	
	2004		2005		2006		2007		2008			
	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)	n	Mean (SD)
Preparing for class	756	12.8 (8.6)	222	14.8 (10.0)	489	15.4 (11.0)	505	17.4 (13.5)	780	16.0 (11.8)	2752	15.2 (11.2)
Working for pay on-campus	338	13.9 (6.7)	86	13.5 (7.3)	207	13.8 (7.5)	216	13.5 (6.4)	326	13.0 (5.7)	1173	13.5 (6.6)
Working for pay off-campus	312	17.6 (9.6)	89	19.7 (11.3)	180	15.7 (8.9)	163	16.7 (8.6)	260	16.2 (8.9)	1004	16.9 (9.3)
Participating in co-curricular activities	552	6.7 (6.9)	156	6.8 (8.0)	352	5.5 (5.6)	376	5.7 (6.2)	551	6.0 (6.4)	1987	6.1 (6.5)
Relaxing and socializing	748	16.0 (11.5)	215	15.1 (11.6)	479	16.1 (15.8)	504	16.0 (12.2)	771	16.9 (12.5)	2717	16.2 (12.8)
Providing care for dependents	97	13.7 (18.9)	34	15.0 (18.7)	66	11.4 (12.9)	79	10.7 (13.8)	127	9.8 (15.3)	403	11.6 (16.0)
Commuting to class	756	4.4 (3.2)	213	5.2 (3.2)	482	5.6 (5.7)	500	5.0 (3.5)	760	5.0 (3.8)	2711	5.0 (4.0)

ii) Time spent working for pay

Respondents were asked to indicate the approximate number of hours per week they spent working for pay on- and off-campus. Four out of ten respondents indicated that they did work on-campus. A similar proportion of respondents indicated that they did work off-campus. Working students spent 13.5 hours/week working for pay on-campus and 16.9 hours/week working for pay off-campus (Table 1). Today's college students are working more than ever before and this rise in work follows a trend of increasing tuition costs. According to a recent national survey of American freshmen, nearly 50 % of respondents planned to work to meet their college expenses (Higher Education Research Institute, 2009).

iii) Time spent participating in co-curricular activities

Co-curricular activities included involvement in student organizations, campus publications, student government, social fraternities or sororities, and intercollegiate or intramural sports. Analysis of the data indicated that nearly three quarters (73.8 %) of respondents participated in co-curricular activities, spending about six hours per week on these activities.

iv) Time spent relaxing and socializing

Relaxing and socializing activities included watching TV, exercising, and other activities such as partying. On average, respondents spent 16.2 hours/week relaxing and socializing (Table 1). A respondents in this study spent more time relaxing and socializing than they did preparing for class, respondents of the CANR at MSU spent less time relaxing and socializing than other U.S. college students.

v) Time spent providing care for dependents

Respondents were asked to indicate the approximate number of hours/week they spent taking care of dependents living with them. About 15% of the respondents indicated that they spent time providing care for dependents living with them, with an average of 11.6 hours/per week (Table 1). Respondents' time use in providing care for dependents had the largest variation, as indicated by the highest standard deviation of 16.

vi) Time spent commuting to class

A high majority of respondents (98.5%) indicated that they commuted to class. The average commuting time for respondents is five hours/week. According to the college students and time use 2003-2006 report, full-time university and college students travelled for 7.5 hours/week on weekdays (U.S. Department of Labor, 2008). The finding of this study on average commuting time indicates that CANR students spent less time commuting than did average U.S. university and college students.

Time Use and Demographic Characteristics

Another objective of this study was to determine similarities and differences in the time use profile by selected demographic characteristics of respondents. The results of one-way analysis of variance (ANOVA) for time spent (hours/week) on various activities by academic year of respondents are presented in Table 2.

i) Time spent preparing for class

Table 2 shows that freshmen, sophomores, and juniors spent 15.7, 15.4, and 15.5 hours/week respectively, preparing for class. Although seniors spent 14.1 hours/week, an hour less than respondents of other academic years, no significant differences were observed for amount of time spent on academic activities by academic year of respondents. The NSSE 2008 survey results, on the other hand, showed that freshmen spent more time preparing for class than did seniors (NSSE, 2008).

ii) Time spent working for pay on-campus

Analysis revealed that respondents of various academic years spent significantly ($F=9.158$, $p<0.001$) different amounts of time working for pay on-campus. The Tukey's post hoc test was conducted for multiple comparisons to identify differences among respondents of various academic years. It indicated that seniors spent significantly ($F=9.158$, $p<0.05$) more time (15.0 hours/week) than did freshmen (12.7 hours/week) working for pay on-campus. This result is consistent with the NSSE 2008 results. Similarly, juniors spent more time (13.8 hours/week) working for pay on-campus than did sophomores (12.3 hours/week). The post hoc test also revealed that seniors spent more time (15 hours/week) than did sophomores (12.3 hours/week) on on-campus employment.

iii) Time spent working for pay off-campus

Respondents at various academic years were significantly ($F=6.464$, $p<0.001$) different in the amount of time spent working for pay off-campus. Seniors spent more time (18.1 hours/week) than did freshmen (13.9 hours/week) and sophomores (15.7 hours/week) working for pay off-campus. Juniors spent more time (17.4 hours/week) than freshmen (13.9 hours/week) in off-campus employment.

Table 2. Time Use (hours/week) by Academic Year of Respondents in the CANR

Activities	n	Hours/week Mean (SD)	F value	p value
Preparing for class			2.436	0.063
Freshman	379	15.7 (12.4)		
Sophomore	677	15.4 (11.0)		
Junior	1091	15.5 (11.3)		
Senior	600	14.1 (10.3)		
Working for pay on-campus			9.158	0.001***
Freshman	142	12.7 (6.8)		
Sophomore	300	12.3 (5.9)		
Junior	475	13.8 (6.0)		
Senior	256	15.0 (7.8)		
Working for pay off-campus			6.464	0.001***
Freshman	97	13.9 (8.2)		
Sophomore	184	15.7 (8.6)		
Junior	450	17.4 (9.2)		
Senior	270	18.1 (10.1)		
Participating in co-curricular activities			0.550	0.648
Freshman	247	5.8 (5.6)		
Sophomore	502	6.4 (6.9)		
Junior	796	6.2 (6.7)		
Senior	440	6.0 (6.4)		
Relaxing and socializing			3.153	0.024*
Freshman	374	17.6 (14.3)		
Sophomore	667	16.7 (14.1)		
Junior	1078	15.4 (11.9)		
Senior	593	16.2 (11.6)		
Providing care for dependents			3.614	0.013**
Freshman	45	9.8 (14.4)		
Sophomore	82	7.8 (9.2)		
Junior	171	11.7 (15.3)		
Senior	105	15.2 (20.6)		
Commuting to class			1.360	0.253
Freshman	372	5.3 (4.3)		
Sophomore	654	4.9 (4.5)		
Junior	1082	5.0 (3.7)		
Senior	598	4.7 (3.7)		

* Significant at 0.05 level ** Significant at 0.01 level *** Significant at 0.001 level

iv) Time spent co-curricular activities

An ANOVA result revealed no differences among respondents of various academic levels in time use on participating in co-curricular activities.

v) Time spent relaxing and socializing

An ANOVA result indicated a significant ($F=3.153$, $p< 0.05$) relationship between respondents' academic years and time spent relaxing and socializing. Freshmen spent more time (17.6 hours/week) than did juniors (15.4 hours/week) on entertainment.

vi) Time spent providing care for dependents

An ANOVA result showed a significant ($F=3.614$, $p<0.05$) difference between respondents at various academic years and time spent on providing care for dependents. Seniors spent more time (15.2 hours/week) than did sophomores (7.8 hours/week) taking care of dependents.

vii) Time spent commuting to class

An ANOVA result gave no difference in time spent commuting to class between respondents of various academic years.

One of the final objectives of this study was to determine if time use pattern varies by students' gender. There were significant differences between male and female respondents in time use for six out of seven activities (Table 3). Female respondents spent significantly ($t =7.361$, $p < 0.001$) more time (16.4 hours/week) on class preparation than did their male counterparts (13.1 hours/week). Similarly, females spent significantly ($t =2.800$, $p < 0.01$) more time (5.1 hours/week) on commuting to class than did males (4.7 hours/week).

Male respondents spent significantly ($t=2.683$, $p < 0.01$) more time (14.3 hours/week) working for pay on-campus than did female respondents (13.2 hours/week). Similarly, males spent significantly ($t=3.877$, $p < 0.001$) more time (18.3 hours/week) working off-campus than did females (16 hours/week). Males also spent significantly ($t=3.492$, $p < 0.001$) more time (6.8 hours/week) than did females (5.8 hours/week) taking part in co-curricular activities. Additionally, male respondents spent significantly ($t=5.620$, $p < 0.001$) more time (18.1 hours/week) relaxing and socializing than did female respondents (15.2 hours/week). These results are consistent with the findings of the NSSE 2008 survey for ANR respondents (NSSE, 2008).

Results of this study indicate that male students were significantly more involved in various activities than female students. These findings are consistent with findings about ANR respondents in the NSSE 2008 survey. It was interesting to note that male students reported spending more time (12.2 hours/week) providing care for dependents than did female students (11.3 hours/week). The male respondents' time use in relaxing and socializing is also consistent with the findings of Gortner and Zulauf (2000) and the NSSE (2008). The American Time Use Survey 2007 results showed that men spent 39.9 hours per week in leisure activities such as watching TV, socializing, or exercising compared with 35 hours per week for women (U.S. Department of Labor, 2008). The findings of Robinson and Godbey (1997) on time use by employed Americans, however, indicate that there was no difference in time use between men and women in watching TV for those between the ages of 18 and 24 years old.

Table 3. Time Use (hours/week) by Gender of Respondents

Activities	n	Hours/week Mean (SD)	t value	p value
Preparing for class				
Male	990	13.1 (10.7)	7.361	0.001***
Female	1755	16.4 (11.3)		
Working for pay on-campus				
Male	359	14.3 (6.9)	2.683	0.007**
Female	813	13.2 (6.4)		
Working for pay off-campus				
Male	398	18.3 (10.3)	3.877	0.001***
Female	603	16.0 (8.5)		
Participating in co-curricular activities				
Male	674	6.8 (7.6)	3.492	0.001***
Female	1307	5.8 (5.9)		
Relaxing and socializing				
Male	975	18.1(14.7)	5.620	0.001***
Female	1735	15.2 (11.5)		
Providing care for dependents				
Male	141	12.2 (16.4)	0.525	0.600
Female	261	11.3 (15.8)		
Commuting to class				
Male	981	4.7 (3.5)	2.800	0.005**
Female	1723	5.1 (4.3)		

Significant at 0.01 level * Significant at 0.001 level

Time use may differ by the sociocultural background of the student. To determine whether such a difference exists, respondents were grouped into two ethnic groups: white and students of color. In this study, "students of color" refers to all minorities, including African American, Hispanic, Asian American, and Native American respondents. Student's t-test was used to determine differences in weekly time use by ethnicity. Table 4 shows significant differences between these two ethnic groups in weekly time use for working for pay on-campus (t=2.848, p < 0.01), relaxing and socializing (t=4.579, p < 0.001), and commuting to class (t=1.979, p < 0.05). Students of color spent significantly more time (14.8 hours/week) working for pay on-campus and commuting to class (5.4 hours/week) than did their white counterparts (13.3 hours/week and 4.9 hours/week respectively). White respondents spent significantly more time (16.6 hours/week) relaxing and socializing than did students of color (13.3 hours/week).

This study also attempted to find out if time spent on various activities differed by home residence (rural vs. urban) of respondents. Student's t-test was used to determine the differences between these two groups. Findings indicated significant differences between the rural and urban respondents for time use in preparing for class, relaxing and socializing, and commuting to class (Table 5). Respondents from urban communities spent significantly (t=2.034, p < 0.05) more time (15.6 hours/week) preparing for class than did respondents from rural communities (14.7 hours/week). Similarly, respondents from urban backgrounds spent significantly (t= 4.022, p < 0.001) more time (17.1 hours/week) relaxing and socializing than did respondent from rural areas (15.2 hours/week). Respondents from rural communities spent significantly (t=2.722, p <0.01) more time (5.2 hours/week) commuting to class than did students from urban communities (4.8 hours/week).

Summary

This study reveals that CANR students tend to spend more time on relaxing and socializing than on academic matters. This suggests that CANR students need counseling about how much time they should devote to preparing for class, including reading, doing homework or lab work, researching, analyzing data, and writing reports and/or papers. The college and academic departments could counsel students on how best to manage their time during their studies. Seminars, workshops and counseling sessions could be organized during orientations or annual events, such as CANR Student Senate meetings, and through meetings with academic advisors.

Students' time use patterns on various activities also varied by demographic characteristics. Seniors spent significantly more amount of time working for pay on-campus and off-campus, and providing care for dependents than did respondents from other academic years. Gortner and Zulauf (2000) argue that the reason that seniors spend more hours at work is that there are fewer scholarship opportunities for upperclassmen. Disproportionately more fellowships are directed at freshmen and sophomores as recruitment incentives.

Significant differences were found between male and female respondents in time use. Male respondents were more involved in work, participation in co-curricular activities and socialization, whereas females were more involved in academic activities.

Table 4. Time Use (hours/week) by Ethnicity of Respondents

Activities	n	Hours/week Mean (SD)	t value	p value
Preparing for class				
White students	2388	15.1 (11.0)	1.105	0.269
Students of color	352	15.8 (12.3)		
Working for pay on-campus				
White students	990	13.3 (6.5)	2.848	0.004**
Students of color	175	14.8 (6.9)		
Working for pay off-campus				
White students	910	16.8 (9.3)	1.436	0.151
Students of color	92	18.3 (9.8)		
Participating in co-curricular activities				
White students	1723	6.2 (6.7)	1.336	0.182
Students of color	254	5.6 (5.0)		
Relaxing and socializing				
White students	2356	16.6 (13.1)	4.579	0.001***
Students of color	350	13.3 (10.6)		
Providing care for dependents				
White students	331	11.9 (16.6)	1.010	0.313
Students of color	70	9.8 (12.7)		
Commuting to class				
White students	2357	4.9 (3.8)	1.979	0.048*
Students of color	343	5.4 (5.1)		

* Significant at 0.05 level **Significant at 0.01 level *** Significant at 0.001 level

Table 5. Time Use (hours/week) by Residence Types of Respondents

Activities	n	Mean (SD)	t	p value
Preparing for class				
Rural	1242	14.7 (10.8)	2.034	0.042*
Urban	1501	15.6 (11.5)		
Working for pay on-campus				
Rural	578	13.7 (6.7)	0.674	0.501
Urban	591	13.4 (6.4)		
Working for pay off-campus				
Rural	524	16.6 (9.4)	1.330	0.184
Urban	478	17.3 (9.3)		
Participating in co-curricular activities				
Rural	916	6.0 (6.2)	0.645	0.519
Urban	1063	6.2 (6.8)		
Relaxing and socializing				
Rural	1232	15.2 (12.3)	4.022	0.001***
Urban	1477	17.1 (13.2)		
Providing care for dependents				
Rural	198	11.1 (15.6)	0.728	0.468
Urban	202	12.2 (16.4)		
Commuting to class				
Rural	1226	5.2 (4.1)	2.722	0.01**
Urban	1476	4.8 (3.9)		

* Significant at 0.05 alpha level ** Significant at 0.01 alpha level *** Significant at 0.001 alpha level

Findings also reveal significant differences in time use by the ethnicity of the respondents. White students spent significantly more time in relaxing and socializing than did students of color. Students of color were more engaged in academic activities and employment work than whites. Academic advising or counseling should focus more on male, white freshmen with urban backgrounds because they spent significantly more time on relaxing and socializing. Significant differences were observed between rural and urban respondents for time use. Respondents from urban communities were more engaged in academic activities, off-campus work, and co-curricular activities than the respondents from rural community backgrounds.

In this study, seniors and males were significantly different from others in time use. The differences in time use for selected demographic characteristics of respondents suggest that detailed time-management research studies be conducted to determine gender differences in time management and their impact on students' college performance (in terms of grade point average) and the relationship between time use profile and degree completion time and to compare self-reported online survey and weekly time diary methods of time use measurement.

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Quantifying the Critical Thinking Skills of Students Who Receive Instruction in Meat-Animal or Meat Product Evaluation

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Abstract

Meat-animal and meat product evaluation and participation on intercollegiate judging teams have long been reported to instill critical thinking and decision making skills in students, but no known work has quantified this objectively. Students within the Department of Animal Sciences at the University of Florida were given the EMI instrument to measure the Engagement, Cognitive Maturity, and Innovativeness of students at the start (Preintro; n = 110) and end (Postintro; n = 78) of the Introduction to Animal Sciences class, at the start (Preeval; n = 21) and end (Posteval; n = 21) of the meat-animal or meat product evaluation classes, and at the end (Postteam; n = 10) of participation on the intercollegiate meat or livestock evaluation team. Responses from Postteam students displayed greater ($P \le 0.03$) Engagement than students the other test groups and greater ($P \le 0.03$) Innovation than students from the Preintro, Postintro, and Preeval test groups. The results from this research objectively show participation on intercollegiate evaluation meat-animal or meat product teams improves students' critical thinking. The findings from this research further validate the efficacy of intercollegiate judging team participation to university administrators, program donors and sponsors, and prospective employers.

Introduction

The National Research Council (NRC) has stated that today's college graduates in the agricultural sciences are expected to have the ability to solve problems and critically evaluate complex situations (NRC, 2009). However, the NRC noted that many academic programs have not evolved to provide opportunities for students to develop these skills. They specifically suggested that students should be given opportunities to use a variety of data to make decisions and then be asked to defend their decisions. An existing activity that seems to meet all of these criteria is evaluating and assessing animals and animal products.

Animal science programs within land-grant universities and agricultural colleges have fielded animal or product evaluation teams for over a century, with a national contest for livestock and meat evaluation first held in 1900 and 1926, respectively (Davis et al., 1991; Mello et al., 1973). Most students involved in these activities take a background course at their home institution focused on proper terminology, understanding traits which influence the value of meat animals and the products they produce, and defending their decisions via written or oral communication (Heleski et al., 2003). Intercollegiate competitions serve as a method to gauge mastery of the skills acquired through coursework and add incentive for practicing evaluation and communication skills (Kauffman et al., 1984; McCann and McCann, 1992).

Employers in animal agriculture expect recent college graduates to have a strong knowledge base within their field of study and the ability for independent and critical thought (Berg, 2002; Field et al., 1998; Shann et al., 2006). Testimonies of former students, academicians, and meat-animal industry professionals document the value of participation on intercollegiate judging teams to instill critical thinking, communication skills and leadership in students (Field et al., 1998; Guthrie and Majeskie, 1996; Smith, 1989). Results from over 2,700 judging team alumni cited improved decision making skills as one of the primary skills gained from program participation (Davis et al., 1991; McCann and McCann, 1992). Other reports document judging team participants to have greater grade point averages (Berg, 2002) and post-graduation incomes (Morgan, 2003) than non-judging animal science alumni.

The only research known to objectively measure the critical thinking skills of students receiving instruction in livestock or meat evaluation reported students participating in a meat-animal evaluation course to have an increase in post-class Watson-Glaser objective critical thinking scores, compared to pre-class scores (Shann et al., 2006). The authors are not aware of any research which objectively quantifies the critical thinking of meat animal or meat product judging team participation.

Objective

The purpose of this study was to objectively assess the critical thinking skills of students within the Department of Animal Sciences at the University

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of Florida (UF) at the start and conclusion of the Introduction to Animal Sciences class and the meat-animal or meat product evaluation classes and at the conclusion of competing on the intercollegiate meat or livestock evaluation teams.

Materials and Methods

Evaluations were made during the 2009-2010 academic year. Students were given the EMI instrument at the start (Preintro; n = 110) and end (Postintro; n = 78) of the Introduction to Animal Sciences class, at the start (Preeval; n = 21) and end (Posteval; n = 21) of the meat-animal or meat product evaluation classes, and at the end (Postteam; n = 10) of participation on the intercollegiate meat or livestock evaluation team. The critical thinking disposition test known as the EMI is similar to the Watson-Glaser test and measures the Engagement, Cognitive Maturity, and Innovativeness of students (Ricketts and Rudd, 2005). This test has been reported as having Cronbach's alpha coefficients of 0.89, 0.75, and 0.79 for Engagement, Cognitive Maturity, and Innovativeness constructs, respectively, suggesting the value of the test to assess differences in critical thinking (Norris and Ennis, 1989).

The 26 question EMI test contains 11 questions which measure Engagement, eight questions measuring Cognitive Maturity, and seven measuring Innovativeness. Each question was answered on a one to five summated rating scale, with one representing a low level of critical thinking and five representing extensive critical thinking, thus the possible per student totals for Engagement, Cognitive Maturity, and Innovativeness were, 11 to 55, 8 to 40, and 7 to 35, respectively. The Engagement questions measure a students' predisposition to use confident reasoning. The Innovativeness questions measure a students' predisposition to be intellectually curious and seek the truth. The Cognitive Maturity questions measure a students' awareness of real problems and openness to other points of view, while being aware of their own biases (Ricketts and Rudd, 2005).

The three formal meat-animal or meat product evaluation classes assessed along with the Introduction to Animal Sciences class were Live Animal and Carcass Evaluation, Meat Selection and Grading, and Live Animal Evaluation. Students within these classes were given the EMI instrument on the first and last day of instruction, whereas students participating on the intercollegiate meat or livestock evaluation teams were only given the EMI instrument at the conclusion of program participation.

Introduction to Animal Sciences is a four credit hour lecture and supplemental laboratory course which emphasizes the role of beef cattle, dairy cattle, swine, sheep, poultry, and horses in serving humans. The course introduces the anatomy and physiology of digestion, growth, and reproduction and the application of genetics to livestock improvement. The course also introduces animal health and management systems, livestock marketing, and animal products.

Live Animal and Carcass Evaluation is a hands-on two credit hour lecture/laboratory course which provides instruction on the evaluation, grading, and economic value of fed-beef, market hogs, and slaughter cows and the carcasses they produce. Laboratory activities include estimating carcass merit of live animals, and subsequent evaluation of their carcasses.

Meat Selection and Grading is a hands-on two credit hour lecture/laboratory course which provides instruction on grading, determining value, and ranking carcasses, wholesale cuts, and assessing the fabrication acceptability of subprimal cuts of beef, pork, and lamb. Laboratory activities include grading and ranking carcasses and cuts, defending their rankings via written reasons, and evaluating the acceptability of subprimal cuts.

Live Animal Evaluation is a hands-on two credit hour lecture/laboratory course which provides instruction on the science and art of live animal evaluation addressing all aspects of improving the selection of meat animals and the efficiency of meat animal production. Laboratory activities include evaluating and ranking market animals and breeding animals of all meat animal species using phenotype and performance records, and defending their rankings via oral reasons.

Members of the intercollegiate meat or livestock evaluation teams at UF receive extensive hands-on experience as they meet approximately 45 times during a 15-week semester to practice their evaluation and communication skills. Students take one of the three background courses prior to participation on one of the intercollegiate evaluation teams for consecutive spring and fall semesters. Students are given up to 15 minutes to evaluate the animals, carcasses or cuts, and to note differences, and then are given time to prepare oral or written reasons defending their placing. Students travel outside the state and practice at various operations including: livestock breeders, feeding operations and commercial slaughter facilities, as they travel to compete in up to three intercollegiate contests in the fall and spring semesters.

Question responses from the EMI were analyzed using ordinary least squares (PROC GLM, SAS Inst., Inc., Cary, NC) using test group (Preintro, Postintro, Preeval, Posteval, and Postteam) as the only fixed effects for the dependent variables of Engagement, Cognitive Maturity, and Innovativeness. The arithmetic mean and SD were reported for descriptive statistics and least squares means were separated statistically using pair-wise t-tests (P-DIFF option of SAS) when a significant ($P < 0.05$) F-test was detected. Additionally, the SE for each main effect mean was reported.

Results and Discussion

Demographics of students within Introduction to Animal Sciences (Intro) are indicative of the Animal Sciences majors at UF with the majority being pre-professional or science option (Prepro) and female (Table 1). This complements Buchanan (2008) who reported an increase in the percentage of both female students and students who intend to apply to a college of veterinary medicine, from departments of animal science across the country. Also, Intro is a required class for admittance into the College of Veterinary Medicine at UF, thus many non-animal sciences majors (NAS) in Intro are pre-professional students as a Biology, Microbiology and Cell Science, Food Science, or Wildlife Ecology and Conservation major. The average age of undergraduate students has increased over the past 20 years (Buchanan, 2008; Tsapogas, 2004). Approximately 40% of students are admitted into the College of Agricultural and Life Sciences at UF as juniors, rather than freshman.

Demographics of students within the three meat-animal or meat product evaluation classes (Eval) and those who participated on the intercollegiate meat or livestock evaluation team (Team) were collectively similar (Table 1), but those percentage demographics were different than Intro. A majority of Eval and Team students were female, but both groups had a greater percentage of male students than Intro. The majority of Eval and Team students were animal sciences majors with a food animal or equine option (FAE). The percentage of NAS students is similar between classes (Table 1), but a different group of NAS students comprise the percentage in Eval and Team than in Intro. Most Eval and Team students which are NAS are either Agricultural Education and Communication majors who aspire to gain greater evaluation experience prior to becoming a secondary agricultural teacher or are students with an agricultural background who are either Food and Resource Economics majors or not a student within the College of Agricultural and Life Sciences at UF.

The responses for the EMI constructs of Innovation and Engagement in this study (Table 2) are similar to the findings by Ricketts and Rudd (2005) for a comparable sample size of secondary and post-secondary agricultural education students. The values for Cognitive Maturity were almost 10 units greater for students from the current study at 31.4, than those reported by Ricketts and Rudd (2005) at 21.7. Students from the current study were almost three years older (20.7 vs. 17.8) than those sampled by Ricketts and Rudd (2005), likely affecting measurements of maturity.

Student responses for Cognitive Maturity were similar ($P = 0.21$) across test groups (Table 3). The findings for Cognitive Maturity by this and other reports (Ricketts and Rudd, 2005) suggest this EMI construct is more easily affected by chronological age than educational enrichment. The questions used to develop the Cognitive Maturity construct by Ricketts

Table 1. Descriptive Statistics for the Sample of Students within the Department of Animal Sciences at the University of Florida Measured by the EMI Test

			Gender, %		Undergraduate option[a], %		
Classes[b]	No. of Students	Avg. Age ± SD	Male	Female	FAE	Prepro	NAS
Intro	118	20.4 ± 1.5	29.66	70.34	8.47	53.39	38.14
Eval	26	20.9 ± 1.2	42.31	57.69	42.31	30.77	26.92
Team	10	22.9 ± 2.1	40.0	60.0	50.0	20.0	30.0
Total	154	20.7 ± 1.6	32.5	67.5	16.88	46.10	37.02

[a]FAE; Animal Sciences major with a food animal or equine option. Prepro; Animal Sciences major with a pre-professional/science option. NAS; Non-Animal Sciences major.
[b]Intro; Introduction to Animal Sciences class. Eval; Meat-animal or meat product evaluation classes. Team; Participation on the intercollegiate meat or livestock evaluation team.

Table 2. Descriptive Statistics for the Cognitive Maturity, Engagement, and Innovativeness of Students as Measured by the EMI test[a]

EMI Construct[b]	No. of Observations	Mean	SD	Minimum	Maximum
Cognitive Maturity	240	31.40	3.53	21	40
Engagement	240	44.60	5.05	27	55
Innovation	240	28.39	3.68	12	35

[a]Greater values indicate more extensive critical thinking.
[b]Cognitive Maturity: a students' awareness of real problems and openness to other points of view, while being aware of their own biases; range- 8 to 40. Engagement: a students' predisposition to use confident reasoning; range- 11 to 55. Innovativeness: a students' predisposition to be intellectually curious and seek the truth; range- 7 to 35.

Table 3. Comparison of Students' Critical Thinking at the University of Florida at the Start and End of the Introduction to Animal Sciences and the Meat-Animal or Meat Product Evaluation Classes and at the End of Participation on the Intercollegiate Meat or Livestock Evaluation Teams, as Measured by the EMI test[a]

	Least squares means ± SE for test group[b]					
EMI Construct[c]	Preintro (n = 110)	Postintro (n = 78)	Preeval (n = 21)	Posteval (n = 21)	Posteam (n = 10)	*P*-value
Cognitive Maturity	31.03 ± 0.34	32.10 ± 0.40	30.57 ± 0.77	31.83 ± 0.77	31.00± 1.12	0.21
Engagement	43.82[e] ± 0.48	45.23[e] ± 0.56	44.14[e] ± 1.09	44.64[e] ± 1.09	49.00[d] ± 1.57	0.02
Innovation	27.87[e] ± 0.35	28.65[e] ± 0.41	27.91[e] ± 0.79	28.98[de] ± 0.79	31.40[d] ± 1.15	0.04

[a]Greater values indicate more extensive critical thinking.
[b]Preintro: start of the Introduction to Animal Sciences class. Postintro: end of the Introduction to Animal Sciences class. Preeval: start of the meat-animal or meat product evaluation classes. Posteval: end of the meat-animal or meat product evaluation classes. Postteam: end of participation on the intercollegiate meat or livestock evaluation team.
[c]Cognitive Maturity: a students' awareness of real problems and openness to other points of view, while being aware of their own biases; range- 8 to 40. Engagement: a students' predisposition to use confident reasoning; range- 11 to 55. Innovativeness: a students' predisposition to be intellectually curious and seek the truth; range- 7 to 35.
[d,e]Values within a row lacking a common superscript letter differ (*P* ? 0.03)

and Rudd (2005) were reported to explain less of the critical thinking skill scores than Engagement and Innovativeness and was also reported to have a slightly inverse relationship with measurements of critical analysis and inference.

Responses from Postteam students displayed greater ($P \leq 0.03$) Engagement than students the other test groups and greater ($P \leq 0.03$) Innovation than students from the Preintro, Postintro, and Preeval test groups (Table 3). Student responses for Engagement and Innovation were similar ($P \geq 0.20$) across the four classroom test groups (Table 3). The material and curriculum of the Eval classes are similar to those for Team students, suggesting the extensive hands-on experiential learning opportunities improved the critical thinking of Team students.

Intercollegiate judging team participation has long been promoted to instill confident reasoning (Engagement) and intellectual curiosity (Innovation) in animal science students (Field et al., 1998; Guthrie and Majeskie, 1996; Helieski et al., 2003; Mello et al., 1973). Engagement is developed in judging team members in preparation for and during intercollegiate contests. Students are required to make independent decisions under pressure, and then defend those decisions via either oral or written communication to an industry expert. Engagement is also instilled by teammates interacting as competitors. Innovation is instilled in judging team members by being exposed to experiential learning in a real-world setting, much different than a classroom, where students are prompted to question, explore, synthesize, make and defend judgments (Schillo, 1997; Smith, 1989). These skills have been identified repeatedly by employers as those needed for success in many different careers (Berg, 2002; Coorts, 1987; Guthrie and Majeskie, 1997; Smith, 1989; Taylor, 1990).

Summary

Meat-animal and meat product evaluation and participation on intercollegiate judging teams have long been reported to instill critical thinking and decision making skills in students. The results from this research objectively show participation on intercollegiate evaluation meat-animal or meat product teams improves students' critical thinking. The findings from this research further validate the efficacy of intercollegiate judging team participation to university administrators, program donors and sponsors, and prospective employers. These activities develop skills that employers seek and align with the NRC's (2009) vision for undergraduate education in the agricultural sciences.

The data presented in this study represent one point in time in one academic program at one university. This research should be replicated at other universities to determine these same results would hold true with animal and animal product evaluation classes and activities. This research should also be replicated in the future to determine if the results of the current study are stable over time. Finally, this research should be replicated by examining similar activities and courses in other agricultural disciplines.

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