Science Motivation Questionnaire: Construct Validation With Nonscience Majors

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Abstract: This study examined how 770 nonscience majors, enrolled in a core-curriculum science course, conceptualized their motivation to learn science. The students responded to the Science Motivation Questionnaire, a 30-item Likert-type instrument designed to provide science education researchers and science instructors with information about students' motivation to learn science. The students' scores on the Science Motivation Questionnaire were reliable and related to students' high school preparation in science, GPA in college science courses, and belief in the relevance of science to their careers. An exploratory factor analysis provided evidence of construct validity, revealing that the students conceptualized their motivation to learn science in terms of five dimensions: *intrinsic motivation and personal relevance*, *self-efficacy and assessment anxiety*, *self-determination*, *career motivation*, and *grade motivation*. Women and men had different profiles on these dimensions, but equivalent overall motivation to learn science. Essays by all of the students explaining their motivation to learn science and interviews with a sample of the students were used to interpret Science Motivation Questionnaire scores. The findings were viewed in terms of a social-cognitive theory of learning, and directions for future research were discussed. © 2008 Wiley Periodicals, Inc. J Res Sci Teach 46: 127–146, 2009
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Orbach (2005), Director of the Office of Science of the U.S. Department of Energy, highlighted the importance of scientific literacy in a speech to the American Association for the Advancement of Science. In his speech, titled "The case for science: Economic growth, scientific literacy, and intellectual excitement," Orbach presented compelling data and argued persuasively for a scientifically literate society:

> In National Science Foundation (NSF) surveys...about 90 percent of U.S. adults report being very or moderately interested in new scientific discoveries and the use of new inventions and technologies. However, only half of NSF survey respondents knew that the earliest humans did not live at the same time as dinosaurs, that it takes the Earth one year to go around the Sun, and that electrons are smaller than atoms. Only one-third could adequately explain what it means to study something scientifically. Scientific literacy is an essential task to which we must all contribute. The future of our society depends upon an understanding of the scientific method. Otherwise, we shall be bedeviled by quackery, and our ability to adapt to our rapidly changing technological environment will be at risk.

In response to such calls for scientific literacy, the American Association of Colleges and Universities (2006) adopted a goal "to advance broad-based systemic innovation to connect science education, especially in general education, to large public questions where scientific inquiry and knowledge are essential." The goal applies not only to science majors, but to nonscience majors as well. It is essential that the latter become

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scientifically literate citizens who are able to understand the scientific issues (e.g., cloning, genetic engineering, stem-cell research, and global warming) that confront them.

As instructors of college science courses respond to the need for fostering students' scientific literacy, the important role of students' motivation has received increased attention (Dalgety, Coll, & Jones, 2003; Siebert, 2001; Zusho, Pintrich, & Coppola, 2003). At many colleges, the required (core curriculum) science courses for nonscience majors often have hundreds of students enrolled in each section, making it difficult to address the specific needs of individuals. Anecdotal evidence suggests that many of these students are poorly motivated, do not see the relevance of science to their careers, and find science frustratingly difficult (Arwood, 2004; Druger, 1998; Duchovic, Maloney, Majumdar, & Manalis, 1998).

Poor motivation in nonscience majors often leads to low achievement (Cavallo, Rozman, Blinkenstaff, & Walker, 2003; Glynn, Taasoobshirazi, & Brickman, 2007). But who are the students who are poorly motivated, and why are they poorly motivated? These are important questions for instructors of science who wish to improve their students' motivation. Answering these questions is difficult, particularly at institutions with large-enrollment classes, where it is difficult to know students personally.

To help answer these questions, the Science Motivation Questionnaire was developed (Glynn & Koballa, 2006). It has been found to be reliable and related to criterion-validity measures such as students' grades in their science courses and their belief in the relevance of science to their careers (Glynn et al., 2007). The Science Motivation Questionnaire is not intended to substitute for advisement sessions with struggling students, but to provide instructors with a reliable, valid, and convenient tool for gathering information that could increase the effectiveness of those sessions. It can also be used as a tool to evaluate the effectiveness of instructional strategies and materials designed to increase students' motivation.

The purpose of the present study is to further examine the psychometric properties of the Science Motivation Questionnaire and provide evidence of its construct validity with nonscience majors learning science in a course that satisfies a core-curriculum requirement. Construct validation is an important step in the process of providing science instructors and science education researchers with a tool for assessing, understanding, and improving college students' motivation to learn science.

Theoretical Framework

In general, *motivation* is the internal state that arouses, directs, and sustains goal-oriented behavior. In particular, *motivation to learn* refers to the disposition of students to find academic activities relevant and worthwhile and to try to derive the intended benefits from them (Brophy, 2004). In studying the *motivation to learn science*, researchers examine why students strive to learn science, how intensively they strive, and what beliefs, feelings, and emotions characterize them in this process.

In the social-cognitive theory of human learning (Bandura, 2001, 2005a,b, 2006), students' characteristics, behaviors, and learning environments are viewed interactively. Within this theoretical framework, learning is most effective when it is self-regulated, which occurs when students understand, monitor, and control their cognition, motivation, and behavior (Schunk, 2001; Schunk & Pajares, 2001). Motivated students achieve academically by strategically engaging in behaviors such as class attendance, class participation, question asking, advice seeking, studying, and participating in study groups (Pajares, 2001, 2002; Pajares & Schunk, 2001).

The motivational components that influence self-regulatory learning were reviewed recently by Glynn and Koballa (2006), Eccles and Wigfield (2002), Pintrich (2004), and Schunk, Pintrich, and Meece (2008). Among the motivational components that have been linked to learning science, six have been studied extensively, generally independently of each other, although they may be related. First, there is *intrinsic motivation*, which involves learning science for its own sake (e.g., Eccles, Simpkins, & Davis-Kean, 2006). Second, there is *extrinsic motivation*, which involves learning science as a means to an end (e.g., Mazlo et al., 2002). Third, there is *personal relevance*, which is the relevance of learning science to students' goals (e.g., Cavallo et al., 2003). Fourth, there is *self-determination*, which refers to the control students believe they have over their learning of science (e.g., Black & Deci, 2000). Fifth, there is s*elf-efficacy*, which refers to students' confidence that they can achieve well in science (e.g., Lawson, Banks, & Logvin, 2007). And sixth, there is *assessment anxiety*, which is the debilitating tension some students experience in association with grading in science (e.g., Parker & Rennie, 1998).

The research literature on the motivational components that influence self-regulatory learning—in conjunction with student interviews and focus groups—provided a basis for operationalizing the construct of *motivation to learn science* and developing the Science Motivation Questionnaire (Glynn & Koballa, 2006). A construct is a theoretical concept about the nature of human behavior, and construct validity is the extent to which an instrument can be shown to assess the construct that it purports to measure (Gall, Gall, & Borg, 2006). A construct, such as motivation to learn science, is not a directly observable variable. For this reason, a construct is often called a *latent* variable. Although a construct cannot be directly observed, it can be measured by means of items that serve as empirical indicators of how the construct is conceptualized by students. A construct could be conceptualized by students either as a unitary entity or one with dimensions (sub-constructs). Students' conceptualizations of a construct may differ somewhat from how experts conceptualize it and describe it in the literature (Donald, 1993). Students' conceptualizations are important in their own right, however, particularly within a social-constructivist view of learning science, because students' conceptualizations influence their actions (McGinnis et al., 2002; Scott, Asoko, & Leach, 2007).

The Present Study

One of our goals was to obtain further information about the psychometric properties of the Science Motivation Questionnaire and establish evidence for its construct validity with nonscience majors learning science in a core-curriculum course. The potential value of the Science Motivation Questionnaire is that it can provide information about how motivated a student is and why a student is motivated or not motivated to learn science. This information can be useful to science instructors and science education researchers in fostering motivation, and thereby, achievement. Another of our goals was to gain additional insight into students' motivation to learn science by asking them to explain their motivation in essays and interviews. Related to our goals, we had four major research questions:

- Do students conceptualize their motivation to learn science as a unitary entity or in terms of dimensions?
- If students conceptualize their motivation to learn science in terms of dimensions, then what are these dimensions?
- What are the relationships among these dimensions, student characteristics such as gender, and criterion variables such as high school science preparation, GPA in college science courses, and the career-relevance of science?
- How are these dimensions related to the motivational components discussed in the self-regulatory learning literature?

We used the method of *exploratory factor analysis* (Fabrigar, Wegener, MacCallum, & Strahan, 1999; Gorsuch, 2003; MacCallum, Widaman, Zhang, & Hong, 1999; Wood, Tataryn, & Gorsuch, 1996) to address our research questions and identify any underlying dimensions conceptualized by students. The underlying dimensions were identified by statistical *factors* that consisted of clusters of items on the Science Motivation Questionnaire. Our use of exploratory factor analysis was consistent with that described by Byrne (2001):

> Exploratory factor analysis (EFA) is designed for the situation where links between the observed and latent variables are unknown or uncertain. The analysis thus proceeds in an exploratory mode to determine how and to what extent the observed variables [i.e., items] are linked to their underlying factors. (p. 5)

We had no prior knowledge that the items of the Science Motivation Questionnaire did, indeed, measure the motivational components discussed in the self-regulatory learning literature that were used to develop the items. For this reason, we used exploratory factor analysis to examine relationships among the items and identify a set of factors that describes in a concise and understandable manner how students view those relationships (Anderson, Fisher, & Norman, 2002; Owen et al., 2007; Pett, Lakey, & Sullivan, 2003). Our purpose was to examine the constructs measured by those items and obtain information that would be useful in the refinement of those items:

> Factor analysis can be used to determine what theoretical constructs underlie a given data set and the extent to which these constructs represent the original variables...Theory often drives item development, and these items are often subsequently assessed with EFA to help refine the assessment. (Henson & Roberts, 2006, pp. 396; 407)

We used exploratory factor analysis rather than *confirmatory factor analysis* (Kline, 2005; Schumacker & Lomax, 2004) because a confirmatory factor analysis is most appropriately applied to questionnaires that have been fully developed and their factor structures validated (Byrne, 2001). When researchers have knowledge of these structures, confirmatory factor analysis is used to "test the utility of the underlying dimensions of a construct identified through EFA, to compare factor structures across studies, and to test hypotheses concerning the linear structural relationships among a set of factors" (Pett et al., 2003, p. 4).

In summary, then, we examined students' conceptualizations of their motivation to learn science because these conceptualizations influence students' behavior. We conducted this study to explore these conceptualizations and acquire information about their structural relationships, which would be useful in the construct validation of the Science Motivation Questionnaire.

Method

Participants

At a public university with 24,711 undergraduate students in the southern United States, we studied 770 undergraduate students enrolled in three sections of *Concepts in Biology*, a core-curriculum 15-week semester course for nonscience majors, with three 1-hour lectures and a 2-hour lab each week. The students participated in the study between the 12th and 14th weeks of the 15-week semester. The same professor, a woman with a Ph.D. in genetics and 12 years teaching experience, taught all sections using the same syllabus and textbook in each section.

Voluntary participation, rather than compulsory, was specified by the university's guidelines for research with human participants. Informed consent forms were signed by the students, who volunteered "to help us better understand the goals of nonscience majors" and to earn a small amount of extra credit. Those who did not participate explained later that they "didn't have time," "lost the announcement," or "forgot." There were a total of 984 students in the three sections, and 779 (79%) volunteered to participate. The data of 770 were analyzed—the data of nine students were not analyzed because their responses were incomplete.

The 984 students in the three sections included 681 (69%) women and 303 (31%) men. There were more women than men for two reasons. First, this university, like many others, has more women (58%) than men (42%) undergraduates: In the U.S., women earned 59% of all undergraduate degrees last year (Toppo & DeBarros, 2007). Second, the students were nonscience majors: At this university, like many others, women represent more than 70% of the students in many large-enrollment nonscience majors in education, family and consumer sciences, the arts, and the humanities (Marsden, 2006).

Women often outnumber men in studies of this kind: For example, Lawson et al. (2007) studied 459 students—300 women (65%) and 159 men (35%)—in an introductory biology course for nonscience majors. They noted: "The relatively high ratio of females to males can perhaps be attributed to the fact that the course enrolls a high percentage of the elementary education majors, who are predominantly female" (p. 710).

The 770 volunteers we studied included 585 (76%) women and 185 (24%) men. Compared to the percentages of all women (69%) and men (31%) in our sections, about 7% more women (and fewer men) volunteered. This 7% difference is consistent with findings that women volunteer more often than men do for academic research studies (Porter & Whitcomb, 2005).

Some of the participating students were from underrepresented groups, including Asian/Pacific Islander (6%), African American (6%), Multiracial (3%), Hispanic or Latino (2%), and Native American (0.3%). These percentages were similar to those of the university population. Minority status was not treated as a statistical variable because there were relatively small numbers in each underrepresented group and statistical inferences might be misleading.

Science Motivation Questionnaire

In an earlier study (Glynn & Koballa, 2006), following guidelines by DeVellis (2003) and Bradburn, Sudman, and Wansink (2004), the 30-item Science Motivation Questionnaire (see Appendix) was developed based on (1) the literature on six motivational components that influence self-regulatory learning, (2) interviews and focus groups, with both science and nonscience majors, and (3) four science educators, two men and two women, who selected—from a pool of 87 potential items—the five items most representative of each of the six motivational components. These 30 items were tested with science and nonscience majors and found to be reliable and valid.

The motivational components and their associated items included *intrinsically motivated science learning* (items 1, 16, 22, 27, and 30), *extrinsically motivated science learning* (items 3, 7, 10, 15, and 17), *personal relevance of learning science* (items 2, 11, 19, 23, and 25), *self-determination (responsibility) for learning science* (items 5, 8, 9, 20, and 26), *self-efficacy (confidence) in learning science* (items 12, 21, 24, 28, and 29), and *anxiety about science assessment* (items 4, 6, 13, 14, and 18). A follow-up study (Glynn et al., 2007) with nonscience majors provided additional evidence of the reliability of the Science Motivation Questionnaire items: The Cronbach coefficient alpha was 0.93. In addition, the 30-item total score was found to be related to science GPA ($r = 0.56$, $p < 0.01$) and the belief that science was relevant to one's career ($r = 0.51$, $p < 0.01$), providing evidence of criterion-related validity.

As DeVellis (2003) recommends, the items are strongly worded, unambiguous declarative statements in the form of short, simple sentences without jargon. The statements are easy to read: The Flesch-Kincaid formula indicates readability at the sixth-grade level. Students respond to each of the 30 randomly ordered items on a five-point Likert-type scale of temporal frequency ranging from 1 (*never*) to 5 (*always*). The *anxiety about science assessment* items are reverse scored when added to the total, so a higher score on this component means less anxiety. The Science Motivation Questionnaire maximum total score is 150 and the minimum is 30. Students who score from 30 to 59 are "never to rarely" motivated, 60–89 are "rarely to sometimes" motivated, 90–119 are "sometimes to often" motivated, and 120–150 are "often to always" motivated.

Procedures and Criterion Variables

We used a confidential, two-part (A and B) on-line procedure to gather information from the students. In *Part A*, we gathered background information, after first explaining "Your responses will help science-education researchers to better understand and improve science instruction." To promote candid responses, we assured the students their identities would remain confidential as specified in the institutional review board documentation they received. Under such conditions, self-reported GPA and other criterion variables have been found to be reliable (Cassady, 2001; Kuh, 2005).

There were three criterion variables: high school preparation in science, GPA in college science courses, and belief in the relevance of science to one's career. First, we asked students "How well did your high school science courses prepare you for college science courses?," to which they responded on a Likert-type scale where 5 = very well, 4 = well, 3 = satisfactory, 2 = unsatisfactory, 1 = very unsatisfactory. The mean high school preparation was 3.33 ($SD = 1.10$). Second, we asked students their science GPA: "What is the average of the grades you have received in the college science courses you have already taken?" In courses such as ecology, geography, geology, chemistry, astronomy, and physics, the science GPA was 2.86 ($SD = 0.92$) on a scale where 4.0 = A, 3.0 = B, 2.0 = C, 1.0 = D, and 0 = F, and the mean number of courses already taken was 4.26 ($SD = 1.40$). Third, we asked students "What is the relevancy of science to your probable career?," to which they responded on a Likert-type scale where 5 = very high relevancy, 4 = high, 3 = medium, 2 = low, and 1 = very low relevancy. The mean career relevancy was 2.44 ($SD = 1.17$).

In *Part B* of the on-line procedure, we asked the students to respond to the 30 items of the Science Motivation Questionnaire. The items were presented without the questionnaire title and with the instructions: "In order to better understand what you think and how you feel about your college science courses, please respond to each of the following statements from the perspective of: When I am in a college science course. . ."

After responding to the Science Motivation Questionnaire items, the students wrote essays. We asked the students to "describe your motivation to learn science and explain it in as much detail as possible because this information will help us to develop more effective science courses." No restriction was placed on the length of the essays.

Semi-structured individual interviews were conducted (Corbetta, 2003; Patton, 2002; Silverman, 2000). A sample of 48 students, who had completed the on-line procedure, was randomly selected, and 45 of these agreed to be interviewed before or after class—3 of the 48 declined to be interviewed because they did not have time before or after class. Of the 45 interviewees, there were 32 women (71%) and 13 men (29%), percentages similar to those of all the students in the three sections and to those of the 770 students who voluntarily completed the on-line procedure.

Following the procedures described in detail by Patton (2002), the interviews were conducted by the first author using an *interview guide* of core questions that were asked during 20-minute interviews that occurred in the classroom (or at a nearby sitting area) where the *Concepts in Biology* course was taught. The guide included the following orientation and four questions:

> In order to better understand what you think and how you feel about the college science courses you've taken, I'd like to ask you some questions. The information you provide will help instructors to develop more effective science courses. Question 1: Could you describe your motivation to learn science in college courses: In other words, how motivated are you and why? Question 2: What aspects of college science courses motivate you to learn? Question 3: What aspects of college science courses discourage you from learning? Question 4: What isn't being done enough in college science courses, which could be done more, to increase students' motivation to learn?

The interview guide ensured that the same basic line of inquiry was pursued with each interviewee, yet the guide also allowed for follow-up questions to flexibly explore or probe a response in greater depth. In essence, the guide provided a framework within which the interviewer asked relevant questions and encouraged each interviewee to respond and elaborate. The interviews were recorded, transcribed, and categorized according to the students' scores on the Science Motivation Questionnaire.

Results

Preliminary analyses indicated that the students in the three course sections did not differ significantly in student characteristics and criterion variables, so these sections were combined ($n = 770$) for subsequent analyses. Our sample size met Comrey and Lee's (1992) exploratory factor analysis criterion: A sample of more than 500 cases is "very good." An alpha level of 0.05 was established for statistical tests where applicable.

We used Statistical Program for the Social Sciences (SPSS), version 15.0 (SPSS Inc, 2006), to analyze the data, address our major research questions, and examine any underlying dimensions perceived by students responding to the Science Motivation Questionnaire. We carried out the steps recommended by Thompson (2004) to determine the reliability and criterion-related validity of students' scores, assess the adequacy of the matrix of correlations among the items, extract the factors, rotate them, examine the factor loadings, and interpret the factors. When means were compared using t tests, we also computed the Hedges' g effect size (Cohen, 1992; Hedges & Olkin, 1985), interpreting meaningful effects as small (0.20–0.49), medium (0.50–0.79), or large (0.80 and above).

Reliability and Criterion-Related Validity of Total Scores

We computed the reliability (internal consistency) of the 30 items: Cronbach coefficient alpha was 0.91, which is considered "excellent" (George & Mallery, 2000), indicating that 91% of the variance of the total scores on this questionnaire can be attributed to systematic variance. The students' total scores on the 30 items correlated significantly with their reported high school preparation in science ($r = 0.58$, $p < 0.001$), college science GPA ($r = 0.61$, $p < 0.001$), and the relevance of science to their careers ($r = 0.50$, $p < 0.001$), providing evidence of criterion-related validity. The mean total score on the 30 items was 96.40 ($SD = 14.78$), indicating that the students were motivated to learn science in the "sometimes to often" (90–119) range, a moderate level of motivation. The findings for the reliability, criterion-related validity, mean, and standard deviation of total scores on the Science Motivation Questionnaire were similar to those in previous studies with nonscience majors (Glynn & Koballa, 2006; Glynn et al., 2007).

As was the case in the previous studies with nonscience majors, no significant differences were found between women and men in total scores on the Science Motivation Questionnaire, high school preparation in science, or college science GPA. The belief that science was relevant to one's career was slightly stronger in the women ($M = 2.51$, $SD = 1.22$) than the men ($M = 2.22$, $SD = 1.00$), $t(768) = 2.98$, $p < 0.01$, Hedges' $g = 0.25$; however, as the means indicate, neither the women nor the men believed that science had much relevance to their careers—both groups had mean ratings in the low to medium range.

Adequacy of Correlation Matrix of Items

We computed correlations for all pair-wise combinations of the 30 items and determined that the resulting matrix of correlations was appropriate for factor analysis by means of a Bartlett's test of sphericity, $\chi^2 = 12{,}064.16$, $df = 435$, $p < 0.001$, and a Kaiser–Meyer–Olkin measure of sampling adequacy, $KMO = 0.93$. These tests of multivariate normality and sampling adequacy indicated that the matrix was of good quality. If too many items are highly correlated there could be a problem with multicollinearity, and if too many are insufficiently correlated, there could be a problem with insufficient common variance, leading to as many factors as items.

Factor Extraction

To extract factors, we performed a principal component analysis on the 30 items. Our goal in using this method was to identify a succinct set of factors that extract variance in descending order and effectively summarize the relationships that students perceived in the items (Pett et al., 2003). Principal component analysis uses eigenvalues, which represent the proportion of variance accounted for by each statistical component (factor). Eigenvalues are used to derive *factor loadings*, which indicate how strongly particular items are related to particular factors. Loadings less than 0.30 are usually considered weak.

Using the Kaiser–Guttman rule, we identified five factors that had eigenvalues greater than 1, indicating that they accounted for more than their share of the total variance in the items. Together, these five factors accounted for 60.23% of that variance, which is considered good. We also used a *scree* plot: We examined potential factors by plotting them against their eigenvalues in descending order of magnitude to identify breaks in the slope of this plot. The scree plot supported the five-factor solution obtained using the Kaiser–Guttman rule.

Factor Rotation

The five factors were rotated, turning their reference axes about their origin. Rotation is needed routinely because the original factor structure, while mathematically accurate, is difficult to interpret. We used a Varimax rotation to produce what is called a *simple structure* that facilitates interpretation; we also used a Direct Oblimin rotation with similar results.

Factor Loadings and Factor Interpretation

Principal components analysis was most suited to our goal and produced clear results, but it, like the other six factor extraction methods available in SPSS, has its unique advantages and disadvantages (reviewed by Fabrigar et al., 1999; Velicer & Jackson, 1990), so we also performed a principal axis factoring and compared the results with those of the principal components analysis. We again found five factors, with similar patterns of items loading on the factors, attesting to the stability of the five-factor solution.

The factor loadings from the principal components analysis with the Varimax solution are in Table 1. All of the items met the criterion of loading at least 0.35 on their respective factor (Tabachnick & Fidell, 2000). The eigenvalue associated with each factor, the percent of variance explained by each factor, the cumulative percent of variance explained, and the Cronbach coefficient alpha for each factor are in Table 2. The Cronbach coefficient alphas for Factors 1, 2, 3, and 4 range from acceptable to excellent, but the one associated with Factor 5 is less than acceptable, so at least some items in Factor 5 need revision. Figure 1 visually depicts the relative importance of each factor in terms of the percent of variance each explains in the data.

The students' essays and interviews helped us to interpret the factors and understand the students' motivation to learn science. Example quotes that broadly represent students' views are in Table 3: For each factor, an explanation by a student with high motivation on the factor and an explanation by a student with low motivation on the factor are provided. A student with high motivation on the factor had a factor-based score in

Table 1
Factor loadings on the Science Motivation Questionnaire

Item #	Factor Loading	Item
Factor 1: intrinsic motivation and personal relevance		
22	0.81	I find learning the science interesting
1	0.76	I enjoy learning the science
25	0.75	The science I learn has practical value for me
23	0.70	The science I learn is relevant to my life
16	0.63	The science I learn is more important to me than the grade I receive
2	0.63	The science I learn relates to my personal goals
27	0.62	I like science that challenges me
30	0.61	Understanding the science gives me a sense of accomplishment
19	0.60	I think about how I will use the science I learn
11	0.60	I think about how the science I learn will be helpful to me
Factor 2: self-efficacy and assessment anxiety		
4	0.81	I am nervous about how I will do on the science tests (r)
13	0.78	I worry about failing the science tests (r)
6	0.76	I become anxious when it is time to take a science test (r)
28	0.73	I am confident I will do well on the science tests
14	0.69	I am concerned that the other students are better in science (r)
29	0.65	I believe I can earn a grade of ‘‘A’’ in the science course
18	0.63	I hate taking the science tests (r)
24	0.54	I believe I can master the knowledge and skills in the science course
21	0.49	I am confident I will do well on the science labs and projects
		Note. The ‘‘r’’ items were reverse scored.
Factor 3: self-determination		
8	0.82	I put enough effort into learning the science
26	0.76	I prepare well for the science tests and labs
9	0.73	I use strategies that ensure I learn the science well
5	0.39	If I am having trouble learning the science, I try to figure out why
Factor 4: career motivation		
17	0.79	I think about how learning the science can help my career
10	0.77	I think about how learning the science can help me get a good job
Factor 5: grade motivation		
3	0.65	I like to do better than the other students on the science tests
7	0.58	Earning a good science grade is important to me
12	0.53	I expect to do as well as or better than other students in the science course
15	0.50	I think about how my science grade will affect my overall grade point average
20	0.46	It is my fault, if I do not understand the science

the ‘‘often to always’’ range, and a student with low motivation had a factor-based score in the ‘‘never to rarely’’ range.

An examination of the five factors indicated that they were related to the six motivational components that influence self-regulated learning. Factor 1 contained 10 items: the five intrinsic-motivation items and the five personal-relevance items. For simplicity, therefore, we labeled this factor *intrinsic motivation and personal relevance*. This 10-item factor was the most important of the five factors because it explained 30.09% of the total amount of variation in students' responses to the 30 questionnaire items. We interpret this

Table 2
Eigenvalue, percent of variance explained, and Cronbach's coefficient alpha for each factor

Factor	Eigenvalue	% of variance	Cumulative %	Cronbach's alpha
Factor 1	9.03	30.09	30.09	0.91
Factor 2	4.02	13.41	43.50	0.88
Factor 3	2.58	8.59	52.09	0.74
Factor 4	1.40	4.65	56.74	0.88
Factor 5	1.05	3.49	60.23	0.55

Factor 1 is intrinsic motivation and personal relevance, Factor 2 is self-efficacy and assessment anxiety, Factor 3 is self-determination, Factor 4 is career motivation, and Factor 5 is grade motivation.

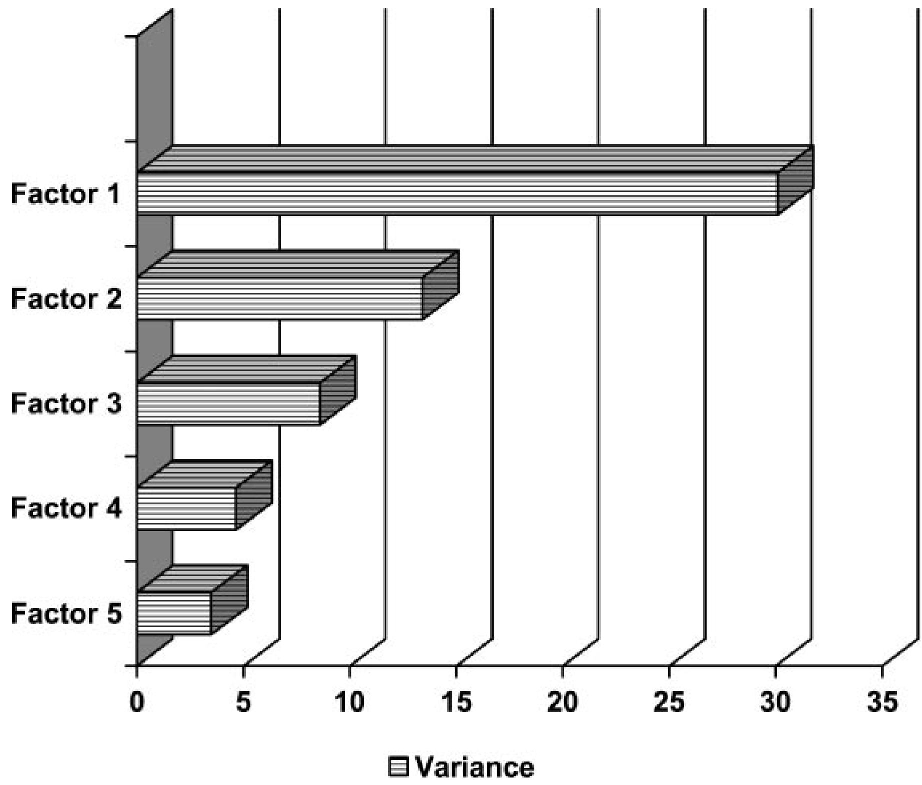

Figure 1. Percent of variance in the Science Motivation Questionnaire scores explained by each factor. Factors are (1) intrinsic motivation and personal relevance, (2) self efficacy and assessment anxiety, (3) self determination, (4) career motivation, and (5) grade motivation.

finding to mean that the students considered the intrinsic-motivation and personal-relevance items to be so closely related that the students grouped them as a set: This set represented one dimension by which the students conceptualized their motivation to learn science. Examples of the students' explanations of their motivation to learn science that illustrate this dimension are in Table 3.

Factor 2 contained nine items: four self-efficacy items and the five assessment-anxiety items. We labeled this factor *self-efficacy and assessment anxiety.* This factor was the second most important of the five, explaining 13.41% of the total variation in the students' responses to the 30 questionnaire items. As was the case with Factor 1, we interpreted this finding to mean that the students considered the self-efficacy and assessment-anxiety items to be so interdependent that they grouped them as a set: It represented a second dimension by which students conceptualized their motivation to learn science. Examples of students' explanations of their motivation to learn science that illustrate this second dimension are in Table 3.

Factor 3 contained four items: These were four of the five self-determination items. Accordingly, we labeled this factor *self-determination*. It accounted for 8.59% of the total variation in students' responses to the 30 questionnaire items. The students viewed these self-determination items as a set that represented a third dimension by which they conceptualized their motivation to learn science. This dimension is illustrated in Table 3.

Factor 4 contained only two items, but the loadings were strong, accounting for 4.65% of the total variation in students' responses to the 30 questionnaire items. The items were two of the extrinsic-motivation items, and both of them had to do with students' future careers, so we labeled this factor *career motivation*. Although these two items had strong loadings, it is desirable psychometrically to have more than two items in a scale, and for this reason the Cronbach coefficient alpha in Table 2 should be interpreted cautiously. More

Table 3

Example quotes from students' explanations of their motivation to learn science: for each factor, an explanation by a student with high motivation and an explanation by a student with low motivation are provided

Factor 1: intrinsic motivation and personal relevance

High motivation: ''I am not a science major, but I really enjoy it and am interested in it. Science is everywhere, and gaining knowledge in it will help me in the future. I desire to not only know the 'what' but also the 'how' and 'why' behind things. I feel that acquiring knowledge about our environment is necessary to make decisions about future policies around the world.''

Low motivation: ''In general, I find science dry and lacking any sort of interesting material. As an English major, science is not something I look forward to at all. For me it's not very practical and life-applicable. I mean, it's not that I hate science, it's just that I have no interest in learning about it. I would rather leave it to the scientists and people who care about it.''

Factor 2: self-efficacy and assessment anxiety

High motivation: ''I don't think science courses are easy. I just do my best in them, and I usually do good. Like, you've got to put the time into the courses and apply yourself. I do the readings and am usually ready for class. I prepare for labs. I've got friends who get low grades and complain about how hard the science tests are, but I don't think they're really trying. If you put your mind to it, you can do good in all your courses.''

Low motivation: ''I'm not a science person at all. I don't understand it really. Not too interested in it, and combining that with my not understanding it, I have very low motivation. I'm always nervous about the test material because I do not do so well on the tests. I have never been talented in the science/math field. It does not come easily to me, or it does not come at all. I've therefore avoided it as much as possible. I'd much rather be in a class that lets me express opinions and my creativity.''

Factor 3: self-determination

High motivation: ''I am not majoring in anything science related, nor am I particularly good at science, but I am not the type of person who can slack off, so I am motivated to learn because it is just a part of my personality. I want to do well, and I put the effort into it. I work hard, shoot for As, and usually get them. I have an overall strong work ethic, so I work hard in all of my classes.''

Low motivation: ''Science has always been a hard subject for me. I just don't get it and don't think there is much I can do about it at this point. I put most of my time into my humanities courses and hope for the best in the required science courses. I respect science though. My girlfriend is a biology major who wants to go to medical school.''

Factor 4: career motivation

High motivation: ''Since I'm majoring in marketing, my success in the field of business will depend partly on my knowing science. I might be working for a high-tech company like Microsoft or Dell. Actually, it would be helpful to know science at most companies. If I got a job marketing products at a company like Exxon, or Dow, or Alcoa, knowing science would be a big help. I like science anyway. I think knowing science gives a person a well-rounded education. I think knowing it gives me an edge in the business world.''

Low motivation: ''I'm not very motivated at all to learn about science because I'm a business major, and the last time I checked you didn't have to know about atoms or cells to be an accountant. Honestly, it's hard for me to get involved in classes that are unrelated to what I want to do in life. I'm taking science courses to meet my prerequisites and I don't really see why science applies to business or at least why I need to know a lot of science. Because I'm not in a major that generally requires knowledge of scientific ideas, I think science classes are the most boring ones I have to take in college.''

Factor 5: grade motivation

High motivation: ''I want to get good grades in my science courses, just like my other ones. It's hard sometimes. I usually work really hard just to understand the content and, when I don't, it's usually the teacher's fault or a bad textbook. Like, I've had some awful teachers. But my parents don't want to hear any excuses about my grades, and they're the ones paying for me to be here.''

Low motivation: ''I'm taking science courses because they are required for me to graduate. I don't expect to get high grades in them. I never have. As long as I get C's, that's ok. I happen to be a person who does much better with arts and literature than math and sciences. This is my junior year and I've been putting off taking some of my required science courses. My motivation is to pass the courses and get them out of the way. I channel my energy into my other classes, like history and English.''

Students in this table with high motivation had a factor-based score in the ''often to always'' range and those with low motivation had a factor-based score in the ''never to rarely'' range.

items need to be developed to tap this dimension. As can be seen in Table 3, the relevance (or irrelevance) of science to one's career was a dominant theme in the students' explanations of their motivation to learn science.

Factor 5, the last factor, also contained the remaining three of the five extrinsic-motivation items and accounted for 3.49% of the total variation in students' responses to the 30 questionnaire items: We labeled this factor *grade motivation*. This factor also contained item #12, *I expect to do as well or better than other students on the science tests*, which was derived from the self-efficacy motivational component. Item #12 was perceived by many students as grade motivation—and the competition that students often associate with grades. Finally, this factor contained item #20, *It is my fault, if I do not understand the science*, which was derived from the self-determination motivational component. Item #20 was perceived by some students as grade motivation and avoiding blame. In Table 3, under Factor 5, the first student's explanation illustrates concern about grades and avoiding blame. Items #12 and #20 should be revised to make them fit better with the other items in this factor.

Correlations Among the Factors and the Criterion Variables

Having identified five factors, each of which accounted for a meaningful amount of variance in students' responses to the Science Motivation Questionnaire, our next step was to generate composite scores to represent values for the factors and to examine their relationship to each other and to the criterion variables of high school science preparation, science GPA, and relevance of science to one's career. There are two approaches to generating such composite scores: factor-based scales and estimated factor scores. We choose the former for reasons explained by Pett et al. (2003):

> An advantage to using a factor-based scale approach to generating factor scores is that these scores are more easily interpreted than estimated factor scores and can also be compared from one study to another. The correlations between estimated factor scores and factor-based scales are also high. (p. 223)

The correlations among the factor-based scales and the criterion variables are in Table 4. All of the factor-based scales correlated significantly with the criterion variables of high school preparation in science, college science GPA, and relevance of science to one's career. Factor 1 (*intrinsic motivation and personal relevance*) and Factor 2 (*self-efficacy and assessment anxiety*) tended to have larger correlations with the criterion variables than the other factors did. The largest correlation in the set, however, was the 0.70 between Factor 4 (*career motivation*) and the relevance of science to one's career: This large correlation was due to the career focus of the scale items and that particular criterion.

The factor-based scales correlated significantly with each other, as would be expected given the large sample size: The size of a correlation was what was important. Most of the correlations were low to moderate, but one was relatively large: The 0.68 between Factor 1 (*intrinsic motivation and personal relevance*) and Factor 4 (*career motivation*). This correlation is interpreted in the Discussion Section, but cautiously, because Factor 4 is based only on two items.

Gender Differences on the Factor-Based Scales and Criterion Variables

There were no significant differences in total scores on the Science Motivation Questionnaire due to gender; however, there were small, meaningful score differences on the factor-based scales, which

Table 4
Correlations among the factor-based scales and the criterion variables

	FS1	FS2	FS3	FS4	FS5	HS	SGPA
FS1							
FS2	0.38						
FS3	0.40	0.20					
FS4	0.68	0.13	0.28				
FS5	0.32	0.29	0.41	0.17			
HS	0.41	0.52	0.34	0.23	0.39		
SGPA	0.45	0.56	0.31	0.24	0.33	0.47	
Career	0.56	0.19	0.17	0.70	0.15	0.18	0.22

FS is factor-based scale, HS is high-school science preparation, SGPA is college science GPA, and career is the relevance of science to one's career. All correlations are significant, $p < 0.01$, $n = 770$.

indicated that different profiles of motivation to learn science were associated with gender. The scores on the *self-efficacy and assessment anxiety* scale were higher among the men ($M = 27.95$, $SD = 7.07$) than the women ($M = 25.69$, $SD = 6.48$), $t(768) = 4.04$, $p < 0.001$, Hedges' $g = 0.34$, suggesting that the men had more confidence and less anxiety than the women. The scores on the *self-determination* scale, however, were higher among the women ($M = 15.00$, $SD = 2.41$) than the men ($M = 14.14$, $SD = 2.57$), $t(768) = 4.18$, $p < .001$, Hedges' $g = 0.35$, suggesting that the women believed they had more control over their learning than the men. The scores on the *career motivation scale* were slightly higher among the women ($M = 5.09$, $SD = 2.14$) than the men ($M = 4.71$, $SD = 1.92$), $t(768) = 2.12$, $p < 0.05$, Hedges' $g = 0.18$, but the effect size was below the criterion of 0.20. There were no significant differences due to gender on scores on the *intrinsic motivation and personal relevance* scale or the *grade motivation* scale.

Discussion

We conducted this study to obtain further information about the psychometric properties of the Science Motivation Questionnaire and establish evidence for its construct validity with nonscience majors learning science in a core-curriculum course. This questionnaire, designed to provide knowledge of how motivated a student is, and why a student is motivated, can be useful to science instructors and science education researchers in fostering a student's motivation, and thereby, achievement.

Consistent with previous findings (Glynn & Koballa, 2006; Glynn et al., 2007), we found the students' total scores on the Science Motivation Questionnaire to be reliable and related to the criteria of high school preparation in science, GPA in college science courses, and belief in the relevance of science to one's career. The present findings provide further evidence that the questionnaire, in its entirety, is a good measure of motivation to learn science. Women and men were found to be similar in their total scores on the Science Motivation Questionnaire. This, too, is consistent with previous findings with nonscience majors.

Most importantly, this study provided new insight into how nonscience majors conceptualize their motivation to learn science. An exploratory factor analysis of students' responses to the Science Motivation Questionnaire revealed that the students did not think about their motivation as a unitary entity, but rather in terms of five dimensions, which were related to motivational components discussed in the self-regulatory learning literature.

Dimensions of Motivation to Learn Science

The students' *intrinsic motivation and personal relevance* dimension included all of the items in the intrinsic-motivation and personal-relevance motivational components that influence self-regulated learning. The students viewed the items in these two components as highly related and, therefore, integrated them as a set. The students found science intrinsically motivating (interesting, enjoyable, etc.) when it was personally relevant (valuable, important, etc.) and *vice versa*. The students' explanations of their motivation to learn science documented this. For example, one of the students explained:

> Science is one of my favorite subjects. It intrigues me. I've always had a keen interest in science, especially chemistry and biology, and I find the knowledge really useful. I feel that it is important to understand the world you inhabit and body you reside in, and in order to do that, you need to be knowledgeable about science. It gives me a deeper understanding about nature and why certain things are the way they are. I just find it fascinating.

The students' *self-efficacy and assessment anxiety* dimension included most of the items in the self-efficacy motivational component, and all of the items in the assessment-anxiety motivational component. As was the case with the first dimension, the students viewed the items in these two components as a set. When the students' had high self-efficacy (I am confident, I believe I can, etc.), they were not anxious about assessment (I am nervous, I worry, etc.), and this was evident in their explanations of their motivation to learn science. As one student explained:

> I've always been good at science, and I've never been intimidated by science courses and tests at the university level. I feel like science is meant to be understood generally by everyone, which is why we

> are required to take it, but I would take science courses anyway, even if I didn't have to. I find them challenging and feel good when I do well in them.

The students' *self-determination* dimension included most of the items in the self-determination motivational component and no items from other components. The students thought of these items (I put enough effort, I prepare well, etc.) as unified. The self-determination dimension refers to the control students believe they have over their learning of science. This dimension was reflected in students' explanations of their motivation to learn. For example, one student explained it this way:

> It's not easy for me to learn science, but it's doable. I work hard to learn it. I always go to class, I outline the lectures, and I keep up with the material. I usually join study groups too. Sometimes I start them. It just takes will power and good study habits. I understand I need a basic knowledge in science, and I want to get it.

The students' *career motivation* dimension included the career-related items (I think about. . .my career; I think about. . .a good job) from the extrinsic-motivation component. Although there were only two career-related items, and more are needed, the relevance or irrelevance of science to one's career was a dominant theme in the students' explanations. For example, one student, who thought of science as career relevant, explained:

> I want to be a lawyer and knowing about a science concept like DNA could be really important in a criminal law practice. I am not sure yet what kind of law I want to practice. Knowing about the body and how it works could be important in a personal injury practice. I guess knowing about physics and force could be helpful in property damage cases, like automobile wrecks. I think it probably helps lawyers to know a fair amount of science.

The students' *grade motivation* dimension included the other items from the extrinsic-motivation component (I like to do better than the other students. . ., Earning a good science grade is important. . ., and I think about how my science grade. . .) and related items involving grades and the competition students often associate with grades. The preoccupation of many students with grades was evident in their explanations. A typical one was:

> A big part of my motivation is to get good grades because I have to keep my GPA up to get into grad school. I want to get an MBA in a good program. There's lots of competition. I try to get good grades in all my courses. I want to get a scholarship or graduate assistantship, and I've got to have a high GPA to get one.

Although the items in the *grade motivation* dimension accounted for sufficient variance to be a statistical factor, their internal consistency was low, indicating that there are weak items in this group that require revision before future use.

Scales Based on Students' Dimensions

All of the factor-based scales were related to the criterion variables of high school preparation in science, college science GPA, and relevance of science to one's career. The *intrinsic motivation and personal relevance* and the *self-efficacy and assessment anxiety* scales tended to have higher relationships with the criterion variables, and these two scales were the ones that explained most of the variance in the total scores on the Science Motivation Questionnaire.

A relatively strong relationship was found between the *intrinsic motivation and personal relevance* scale and the *career motivation* scale. Careers are often thought of as extrinsically motivating (money, social status, etc.), but they can be intrinsically motivating (interest, enjoyment, etc.) as well. For example, one student explained how science relates to his future career, economics:

> My major is economics, and I think it is important for me to understand science and technology because they are really important to the economy. I think I would take some science courses even if they were not required. In most of my economics classes, the instructors talk about how developments in science and technology are driving much of what is going on in the economy. I think it is interesting how these developments come together and affect the whole country. They even affect the whole world.

As this student's explanation illustrates, intrinsic motivation (''motivation to engage in an activity for its own sake'') and extrinsic motivation (''motivation to engage in an activity as a means to an end'') can be interactive (Schunk et al., 2008, pp. 376–377). When students learn science, they can be motivated by different kinds of goals operating at the same time (Pintrich, 2003).

There were no significant differences in total scores on the Science Motivation Questionnaire between women and men, implying that they were equivalent in their overall motivation to learn science. The scores on the *intrinsic motivation and personal relevance* scale and the *grade motivation* scale did not differ either, implying that women and men were equivalent in these dimensions. The women had higher career motivation scores than the men, but the size of this difference was not meaningful. There were meaningful differences, however, on the dimensions of *self-efficacy and assessment anxiety* and *self-determination*.

The men reported more self-efficacy and less anxiety than the women; the women, on the other hand, reported more self-determination (control) of their learning. The self-efficacy and anxiety findings are similar to those in other studies (Cavallo, Potter, & Rozman, 2004; Parker & Rennie, 1998). The lower self-efficacy and greater assessment anxiety experienced by women is likely due to social-cultural factors such as too few women role models in science (Britner, in press; Ceci & Williams, 2007; Udo, Ramsey, & Mallow, 2004; Xie & Shauman, 2003). Although the women had lower self-efficacy and greater assessment anxiety than the men, these disadvantages were offset by the women's greater self-determination to learn science, which was an advantage: The result was that the women's overall motivation was equivalent to that of the men.

Directions for Future Research

The findings provided insight into how nonscience majors conceptualized their motivation to learn science: They conceptualized it differently—broader in some respects and narrower in other respects—than science education researchers have done when discussing it in the literature. The findings also provided evidence of the construct validity of the Science Motivation Questionnaire: A parsimonious set of factors was identified that described the structural relationships among the items in a concise and understandable manner.

The five statistical factors identified by the exploratory factor analysis were interpreted as dimensions by which students' conceptualized their motivation to learn science. All of the questionnaire items loaded on one of the five dimensions, but some of the items need to be revised to better fit the dimensions, and some dimensions need additional items, such as the *career motivation* dimension. Revising items and developing new ones are standard operations in the process of construct validation, which occurs over a series of studies, as noted by Pett et al. (2003):

> ''One must not assume that all of the items that define a factor have been delineated in a single study. . ..many studies must be undertaken in order to determine if all items of the factor have been derived and correctly interpreted. . ..construct validity is a never-ending, ongoing, complex process that is determined over a series of studies in a number of different ways.'' (pp. 238-239)

When items have been revised, and new ones developed and pilot tested, the next step is to cross-validate the resulting scales on new samples of nonscience majors, with sample sizes of 300 or more students, using the method of confirmatory factor analysis (Kline, 2005; Schumacker & Lomax, 2004). In contrast to the exploratory factor analysis performed in this study, a confirmatory factor analysis estimates the extent to which a hypothesized organization of a set of factors—such as the five factors identified in this study—fits the new sample data.

Although the present study found that students conceptualized their motivation to learn science in terms of five dimensions, and these dimensions explained the data well, we believe that additional dimensions certainly merit attention in the assessment of students' motivation. We have used the social-cognitive framework and research on the motivational components that influence self-regulated learning—in conjunction with student interviews and focus groups—to formulate a parsimonious pool of items, but also one that can be expanded to assess more variation in students' motivation, by examining additional motivational components, such as locus of control.

Another direction for future research is to validate the Science Motivation Questionnaire with populations of students other than nonscience majors. Because lack of motivation is a serious issue with many nonscience majors, this population has received most of our attention. Science majors score higher than nonscience majors on the Science Motivation Questionnaire (Glynn & Koballa, 2006), but more research is needed to explore the nature of motivation in science majors. Such research could play an important role in encouraging and retaining future scientists, particularly women because they are underrepresented in many of the sciences.

Motivational research is needed with other underrepresented populations of students as well. Membership in minority groups was not treated as a statistical variable in the present study because the number in each group was small, and inferences might be misleading. But, such membership merits attention in future research because understanding the motivation of students in these groups could help instructors and science education researchers to foster the students' achievement. The use of the Science Motivation Questionnaire, in combination with qualitative methods such as interviews based on the purposeful sampling of ''information-rich cases'' (Patton, 2002), could yield insights regarding the students' motivation to learn science.

Finally, it would be desirable in future research to conduct longitudinal studies to examine how students' motivation—as measured by the Science Motivation Questionnaire—changes over time in response to science instruction, and how these changes influence criterion variables such as students' grades in science courses and their belief in the relevance of science to their careers. Longitudinal studies would also make it possible to examine additional criterion variables such as the number of courses students elect to take after they have taken their required ones.

Conclusion

In conclusion, we return to Orbach's (2005) call to action: ''Scientific literacy is an essential task to which we must all contribute.'' Science education researchers and science instructors can contribute to this task by fostering students' motivation to learn science. In order to do this they need good assessment tools. The present study was an important one in a series of studies because it confirmed the overall reliability and criterion-related validity of the Science Motivation Questionnaire, provided new evidence of its construct validity, and suggested improvements in scales for measuring dimensions of students' motivation to learn science.

The intended outcome of studies with the Science Motivation Questionnaire is to provide science education researchers and science instructors with a reliable, valid, and convenient tool for assessing students' motivation to learn science and evaluating the effectiveness of instructional strategies and materials designed to increase students' motivation. For science education researchers, this tool is intended to be used in conjunction with interviews, essays, and other qualitative techniques that together lead to a comprehensive understanding of students' motivation to learn science. For science instructors, this tool is intended to be used in conjunction with individual and group advisement sessions, as part of a systematic strategy to develop and support students' motivation to learn science.

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Appendix

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In order to better understand what you think and how you feel about your college science courses, please respond to each of the following statements from the perspective of: "When I am in a college science course…"

01. I enjoy learning the science.
O Never O Rarely O Sometimes O Usually O Always

02. The science I learn relates to my personal goals.
O Never O Rarely O Sometimes O Usually O Always

03. I like to do better than the other students on the science tests.
O Never O Rarely O Sometimes O Usually O Always

04. I am nervous about how I will do on the science tests.
O Never O Rarely O Sometimes O Usually O Always

05. If I am having trouble learning the science, I try to figure out why.
O Never O Rarely O Sometimes O Usually O Always

06. I become anxious when it is time to take a science test.
O Never O Rarely O Sometimes O Usually O Always

07. Earning a good science grade is important to me.
O Never O Rarely O Sometimes O Usually O Always

08. I put enough effort into learning the science.
O Never O Rarely O Sometimes O Usually O Always

09. I use strategies that ensure I learn the science well.
O Never O Rarely O Sometimes O Usually O Always

10. I think about how learning the science can help me get a good job.
O Never O Rarely O Sometimes O Usually O Always

11. I think about how the science I learn will be helpful to me.
O Never O Rarely O Sometimes O Usually O Always

12. I expect to do as well as or better than other students in the science course.
O Never O Rarely O Sometimes O Usually O Always

13. I worry about failing the science tests.
O Never O Rarely O Sometimes O Usually O Always

14. I am concerned that the other students are better in science.
O Never O Rarely O Sometimes O Usually O Always

15. I think about how my science grade will affect my overall grade point average.
O Never O Rarely O Sometimes O Usually O Always

16. The science I learn is more important to me than the grade I receive.
O Never O Rarely O Sometimes O Usually O Always

17. I think about how learning the science can help my career.
O Never O Rarely O Sometimes O Usually O Always

18. I hate taking the science tests.
O Never O Rarely O Sometimes O Usually O Always

19. I think about how I will use the science I learn.
 O Never O Rarely O Sometimes O Usually O Always

20. It is my fault, if I do not understand the science.
 O Never O Rarely O Sometimes O Usually O Always

21. I am confident I will do well on the science labs and projects.
 O Never O Rarely O Sometimes O Usually O Always

22. I find learning the science interesting.
 O Never O Rarely O Sometimes O Usually O Always

23. The science I learn is relevant to my life.
 O Never O Rarely O Sometimes O Usually O Always

24. I believe I can master the knowledge and skills in the science course.
 O Never O Rarely O Sometimes O Usually O Always

25. The science I learn has practical value for me.
 O Never O Rarely O Sometimes O Usually O Always

26. I prepare well for the science tests and labs.
 O Never O Rarely O Sometimes O Usually O Always

27. I like science that challenges me.
 O Never O Rarely O Sometimes O Usually O Always

28. I am confident I will do well on the science tests.
 O Never O Rarely O Sometimes O Usually O Always

29. I believe I can earn a grade of "A" in the science course.
 O Never O Rarely O Sometimes O Usually O Always

30. Understanding the science gives me a sense of accomplishment.
 O Never O Rarely O Sometimes O Usually O Always

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