ABSTRACT

CAPTIVATING THE CLASS: PREDICTORS OF SCIENCE TEACHER POSITIVITY TOWARD LESSONS WITH SCIENCE COMMUNAL AFFORDANCES

by Melissa A. Fuesting

Beliefs that science fulfills communal goals (i.e., communal affordances) foster student science motivation; integrating science communal affordances into science teachers’ lessons is thus a promising avenue for increasing student science motivation. The current work sought to understand science teacher views of lessons with communal affordances, and investigated whether communal affordances in lessons 1) foster teacher lesson positivity and 2) are perceived to impede valued teaching goals. Across 2 studies, preservice science teachers exhibited more positivity toward lessons if they perceived the lesson to include communal affordances. Compared to lessons that omitted communal affordances, lessons that included communal affordances were viewed as affording more student engagement goals (Study 2). Preservice teachers preferred to teach lessons that they viewed as fulfilling more valued engagement teaching goals. Leveraging teacher perceptions that communal affordances engage science students may be a promising route to integrating communal affordances into science curriculum and thus increasing student science motivation.
CAPTIVATING THE CLASS: PREDICTORS OF SCIENCE TEACHER POSITIVITY TOWARD LESSONS WITH SCIENCE COMMUNAL AFFORDANCES

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To prosper in the twenty-first century global economy, countries must produce new scientific innovations faster than other nations. The United States’ economic prosperity thus hinges in part on the strength of its science workforce (Rising above, 2005). Recruiting and retaining the necessary science workforce will require fostering and sustaining the science career motivation of more individuals (President's Council of Advisors on Science and Technology, 2012). Important contributors to science motivation include perceptions that science careers provide opportunities to fulfill other-oriented goals such as working with and helping others; in including these ideas, science teachers socialize student beliefs about whether science fulfills communal goals. The current work examines factors affecting science teacher motivation to teach the communal lessons that will foster student science career motivation, and thus help ensure the United States’ continued economic success.

Science Motivation and the Communal Goal Congruity Perspective

Any attempt to strengthen the science workforce must consider important factors that either serve to increase or decrease science motivation. Research from the communal goal congruity perspective posits that reduced science motivation occurs when individuals perceive a mismatch between their valued goals and whether science fulfills those goals (Diekman, Steinberg, Brown, Belanger, & Clark, 2016; Diekman & Steinberg, 2013). Understanding individuals’ value of other-oriented communal goals (e.g., working with others, helping others) and their perceptions of whether science fulfills these goals is of particular importance. Connection with others is a fundamental human need (Baumeister & Leary, 1995). Thus, a wide range of people tend to highly value communal goals. Both men and women tend to value and pursue communal goals (Diekman, Brown, Johnston, & Clark, 2010; Pöhlmann, 2001). The communal goal congruity perspective points to the importance of communal goal processes in science motivation because 1) people tend to value communal goals and 2) widespread stereotypes in the US suggest that science does not fulfill communal goals.

The prevalent value of communal goals suggests that perceptions that science fulfills these goals can foster science motivation; however, beliefs that science fulfills high degrees of communal goals may be uncommon. For instance, qualitative studies find that some young girls believe that scientists are “evil” and “steal projects” (Buck, Clark, Leslie-Pelecky, Lu, & Cerda-Lizarraga, 2008). Children asked to draw a picture of a scientist often draw the scientist working alone (Finson, 2002). Before receiving an intervention designed to highlight the importance of
collaboration in science, the majority of kindergarteners through second graders described scientists as conducting their work alone (Sharkawy, 2009).

It is not children alone who perceive science careers to impede communal goals. Undergraduate college students, young adults who are at a point in their professional lives that is crucial to decisions to pursue STEM (e.g., President's Council of Advisors on Science and Technology, 2012), report that science impedes communal goals. College students perceive scientists as less communal than either the typical adult woman or man (Carli, Alawa, Lee, Zhao, & Kim, 2016). Undergraduates perceive that traditionally male-dominated careers such as medicine and business afford more communal goals than STEM, and that traditionally female-dominated careers such as education and nursing also fulfill more communal goals than STEM (Diekman et al., 2010; Diekman et al., 2011). Stereotypes that science fulfills few valued communal goals are therefore common in the US, and are reflected in the views of individuals who are at various stages important to science career decisions.

Effects of Science Communal Affordances

Due to widespread value of communal goals, and common stereotypes that science impedes these goals, perceptions that science fulfills communal goals (i.e., science communal affordances) are important to science motivation (Diekman et al., 2016). Experimental evidence demonstrates that learning how science provides opportunities to fulfill valued communal goals increases science career positivity and motivation. Individuals who read about scientists who integrate collaboration into their careers exhibit increased positivity toward a career in science (in women: Diekman et al., 2011, Experiment 3; in men and women: Clark, Fuesting, & Diekman, 2016, Experiment 1). Men and women who learn about scientific research labs that pursue research with altruistic applications exhibit increased science motivation above and beyond learning about its agentic applications (Brown, Smith, Thoman, Allen, & Muragishi, 2015).

Other work also demonstrates the link between science communal affordances and science motivation. Science communal affordances predict undergraduate science career positivity and motivation (Brown, Thoman, Smith, & Diekman, 2015, Experiment 2). Middle school girls’ perceptions of science’s altruistic applications predict their science motivation (Weisgram & Bigler, 2006). Individuals from ethnic backgrounds traditionally underrepresented in science also exhibit more science motivation when they report higher science communal goal
affordances (Thoman, Brown, Mason, Harmsen, & Smith, 2015). In sum, a wide range of evidence demonstrates that leveraging perceptions that science and STEM fulfill communal goals is an important strategy for increasing science motivation.

**Why Examine Science Teachers as Socializers of Communal Affordances?**

Given the importance of science communal affordances for fostering science motivation and positivity, the current work examines factors affecting the socialization of these affordance beliefs. Socializers, including parents and teachers, may be particularly important sources of information about whether a domain (e.g., science) fulfills valued goals. Student perceptions of science and math’s importance are associated with parent and teacher views of science and math’s importance (Bouchey & Harter, 2005). An intervention that increased math and science motivation for some students targeted parent perceptions of math and science’s utility, and allowed parents to influence children’s views of math and science (Harackiewicz, Rozek, Hulleman, & Hyde, 2012). Socializers can thus affect perceptions of a domain by transmitting their beliefs about the world (Eccles, 2011).

Perhaps more importantly, socializers also transmit information that can confirm or disconfirm prevalent stereotypes and affect motivation (see Diekman & Fuesting, in press, for a review). For instance, parents explain scientific principles more often to their sons than their daughters at interactive science exhibits (Crowley, Callanan, Tenenbaum, & Allen, 2001). Female elementary school teachers’ math-anxious behaviors predict increases in their female students’ beliefs that girls are not good at math, which in turn predict reductions in female students’ math achievement (Beilock, Gunderson, Ramirez, & Levine, 2010). In similar ways, teachers can also shape student beliefs about science’s communal opportunities without necessarily aiming to perpetuate noncommunal stereotypes.

Even briefly highlighting how science affords communal goals may increase student beliefs that science fulfills communal goals and subsequent science career motivation (e.g., Brown, Smith, et al., 2015; Clark et al., 2016). Furthering understanding of why science teachers may be more or less willing to include communal affordances in their lessons may suggest strategies to increase the inclusion of communal affordances in science lessons, which may ultimately increase student science motivation.

**Potential Factors Affecting the Inclusion or Exclusion of Communal Affordances**
Two interlinking factors likely affect whether science teachers prefer to teach a lesson with communal affordances: whether communal affordance lessons cue lesson positivity and preference among teachers, and whether teachers view communal affordance lessons as fulfilling valued teaching goals.

**Do science communal affordances in a lesson foster teacher lesson positivity and preferences?** In the current work, I examine whether communal applications in lesson plans predict increased teacher positivity toward these lessons, and I also investigate whether communal applications in lesson plans predict increased teacher preferences to teach these lessons. If teachers are relatively positive toward lessons with communal applications, science teachers may be relatively more likely to include communal affordances in science lessons. I investigate teacher evaluations of two genetics lesson plans that are identical save one section. In the communal affordances lesson, a portion of the lesson explains the medical applications of the class material. The control lesson focuses only on covering and rehearsing more class material. This comparison is designed to mirror how high school or college science textbooks include communal applications. For instance, one textbook included several sidebars per chapter introducing readers to careers in biology that mentioned the altruistic nature of the career (Biggs et al., 2015). Two other frequently used texts contain occasional sidebars that connect biological concepts to real world applications, some of which had other-oriented aims such as diagnosing illnesses (Miller & Levine, 2010; Reece et al., 2010). Because these communal applications were all relegated to sidebars or afterthoughts in the text, it is possible that they are easily ignored by both students and teachers alike. The current work will thus compare teacher evaluations of a lesson that contains communal affordances to teacher evaluations of a lesson that devotes more time to genetics processes.

**Do teachers view communal lessons as fulfilling or interfering with their goals?** Even if communal applications in lessons do cue increased teacher positivity or preference toward science lessons, there may be another obstacle to teachers including communal affordance in their lessons. Based on the logic of the goal congruity perspective (e.g., Diekman et al., 2016), it is likely that teachers will be more interested in teaching a lesson that portrays science communal affordances if they perceive the lesson as fulfilling more valued teaching goals, and also less interested in teaching a lesson that portrays science communal affordances if they perceive the lesson as impeding their valued teaching goals. Teachers may include or exclude communal
affordances from a lesson depending on whether this decision fulfills a valued classroom goal. Clarifying how teachers view communal lessons as fulfilling or impeding their teaching goals may shed light on how best to integrate communal affordances into curriculum.

The current research examines perceptions of whether communal lessons fulfill two fundamental teaching goals: content and engagement goals. Content goals are the desires to teach and rehearse class content and skills, some of the core aspects of the teaching profession. Student engagement goals are the desires to foster student involvement with and intrinsic interest in the class topic and science at a broader level (Appleton, Christenson, & Furlong, 2008). Educational researchers posit that the ideal educational environment supports student engagement (e.g., Deci, Vallerand, Pelletier, & Ryan, 1991; Harackiewicz, Smith, & Priniski, 2016). Furthermore, teachers highly value encouraging this type of intrinsic motivation in their students (e.g., Deci, Schwartz, Sheinman, & Ryan, 1981). Because it is quite possible for one behavior to simultaneously fulfill multiple goals (Kruglanski et al., 2002), teachers may believe that lessons with and without communal applications fulfill similar levels of content and engagement goals. Teachers will likely be more amenable to teaching a lesson including communal applications if they believe it will fulfill these valued teaching goals. Similarly, if teachers believe lessons with and without communal affordances fulfill equal amounts of content and engagement goals, teachers may be less likely to opt to teach communal application lessons.

It is also possible that teachers will believe that lessons with communal applications will interfere with one or both types of these teaching goals. For instance, teachers may believe that communal applications impede content goals, because they may view teaching communal affordances as taking much needed time from rehearsing other class content. Similarly, teachers may believe communal applications will impede engagement goals if they perceive that students have little interest in the communal applications of class material, or if other uses of the time could better support student engagement.

To examine these possibilities, Study 2 investigates whether lessons with and without communal affordances are perceived to fulfill relatively more content and engagement goals. Although teachers will likely value both content and student engagement goals, individual differences in teaching goal endorsement may also affect their evaluations of lessons. For instance, if an individual prioritizes content goals over engagement goals, content goal affordances should be stronger predictors of lesson preferences than engagement goals for that
teacher. Study 2 thus also examines teachers’ value of content and engagement goals, and whether teachers prefer to teach a lesson if they perceived it to fulfill relatively more valued content and engagement teaching goals. If communal affordances in science lessons do not cue perceptions that the lesson fulfills valued teaching goals, or if communal affordances in science lessons are viewed to impede valued teaching goals, this research may suggest potential obstacles to the integration of communal applications within the curriculum.

**The Current Research**

Learning that science fulfills relatively more valued communal goals increases student science motivation (e.g., Brown, Smith, et al., 2015; Clark et al., 2016), and increasing the frequency of communal applications in science lessons may thus prove a promising intervention for increasing student science motivation. The current research investigates factors that might affect whether teachers successfully implement communal affordance interventions in their science classrooms. I thus examine whether communal affordances in science lessons foster teacher positivity toward and preferences for the lesson, and whether teachers may view these lessons as interfering with valued teaching goals, thus reducing their desire to teach these lessons. I investigate these processes in preservice science teachers, who are college students currently studying to become science teachers. Study 1 employs a between-subjects design to examine preservice teachers’ relative positivity toward lessons that include or do not include communal applications. Study 2 employs a within-subjects design to investigate preservice teachers’ preference for a lesson that includes versus excludes communal affordances. Both studies examine whether teachers’ perceptions of the whether the lesson portrays science communal affordances predict their evaluations of these lessons.

Across these studies, I examine three hypotheses.

**Hypothesis 1:** Teachers will exhibit more positivity toward lessons when they perceive lessons as portraying science as fulfilling more communal goals.

**Hypothesis 2:** Teachers will view lessons with communal affordances as fulfilling more teaching goals than lessons without communal affordances.

**Hypothesis 3:** Teachers will prefer to teach a science lesson if they perceive the lesson to fulfill their valued teaching goals.

**Study 1**
Study 1 employs a between-subjects design to examine whether teachers exhibit positivity toward lessons that portray science as providing opportunities to fulfill communal goals (Hypothesis 1). In this study, preservice science teachers were randomly assigned to read and rate one of two lesson plans that differed in the inclusion of communal affordances. I predicted that teachers would exhibit relatively more positivity toward the lesson with communal affordances compared to the lesson without communal affordances.

**Method**

**Participants.** Participants consisted of college students (n = 79, 45 men) from the US who intended to pursue a science teaching career; they were recruited via Amazon’s Mechanical Turk (MTurk) and paid $0.40 for their time. Participants aspired to teach science classes at every level from elementary (5% of the sample) to university (24% of the sample). Approximately 71% of the sample aspired to teach middle or high school science. Of all participants, 70.89% were White, 6.33% were African American, 8.86% were Asian American, 8.86% were Hispanic, 2.5% were multi-racial, 1.27% identified as another race, and 1.27% preferred not to share their racial/ethnic demographics. Due to a programming error, participant age was not collected.

**Procedure.** After responding to measures of STEM career affordances (see below), participants were randomly assigned to read one of two identical genetics lesson plans differing only in their final section (see Appendix A). The communal lesson plan outlined a lecture on the communal applications of researching genetic mutation (i.e., insulin production and predicting cancer risk), and the control lesson plan outlined a lecture on types of mutations (i.e., induced versus spontaneous). After reading their respective lesson plan, participants rated the plan on measures outlined below.

**Measures.** All items were on scales from 1 (not at all) to 7 (extremely).

**Lesson goal affordances.** Participants responded to 3 items that assessed whether they believed that the lesson demonstrated how science allows people to work with others, help others, and benefit society (α = .84). Participants also responded to 3 items assessing whether they thought the lesson demonstrated how science allows people to be successful, gain recognition, and seek new experiences (α = .87). I averaged items within affordance type to create measures of communal and agentic affordances.
Lesson positivity. Participants predicted whether students at the lesson’s level would like, enjoy, and be engaged by the lesson, as well as whether the lesson would increase students’ interest in the topic and increase students’ interest in science. I averaged these items to form a general measure of lesson positivity (α = .96).

Results

Post-hoc power analyses with G*Power (Faul, Erdfelder, & Buchner, 2007) for an alpha of .05 and medium effect sizes indicated power of .78 for multiple regressions with three predictors, power of .95 for mixed analyses of variance (ANOVAs) with four groups and two measures, and power of .56 for between-subjects ANOVA analyses with four groups.

Summary of effects due to intended teaching grade level. Participant intent to teach at a specific level did not correlate with any variables of interest, ps > .40. When performing analyses without individuals who intended to teach at the university level, the patterns of results were similar. The following analyses thus include teachers of all levels and omit their intended teaching level.

Summary of effects due to gender. Participant gender did not exhibit any significant main effects or interactions, ps > .05. Initial analyses indicated that participant gender (-1 = male, 1 = female) did not moderate regression analyses, ps > .21. Gender effects will not be further discussed; unless otherwise noted, analyses omit participant gender.

Manipulation check: Perceptions of lesson affordances. As a manipulation check, I submitted lesson communal and agentic affordances to a 2 (lesson plan type: communal, control) by 2 (participant gender) mixed ANOVA with participant gender and lesson plan type as between-subjects factors and lesson affordances type as a within-subjects factor. The key interaction between affordance type and lesson plan type attained significance, F(1, 75) = 4.41, p = .04. Participants viewed the communal lesson (M = 4.67, SD = 1.05) as possessing significantly more communal affordances than the control lesson (M = 4.06, SD = 1.45), t(68.98) = 2.15, p = .03, d = 0.49. No difference emerged in participants’ views of the communal (M = 4.20, SD = 1.40) and control lessons’ (M = 3.98, SD = 1.54) portrayal of science agentic goal affordances, t(77) = 0.67, p = .50, d = 0.15. A main effect of science affordance type also reflected that participants overall viewed the lessons as containing more communal affordances (M = 4.37, SD = 1.29) than agentic affordances (M = 4.09, SD = 1.46), F(1, 75) = 8.34, p = .005, d = 0.20.
**Lesson positivity.** I submitted teachers’ positivity toward the lesson to a 2 (participant gender: male, female) by 2 (lesson plan type: communal, control) ANOVA. Supporting Hypothesis 1, a main effect of lesson plan type emerged, $F(1, 75) = 5.39, p = .02, d = 0.54$. Participants were significantly more positive toward the communal lesson ($M = 4.98, SD = 1.15$) than the control lesson ($M = 4.23, SD = 1.63$).

**Lesson communal affordances predict lesson positivity.** To investigate whether communal and agentic lesson affordances uniquely predicted positivity toward the lesson, I regressed lesson positivity onto centered lesson communal affordances, centered lesson agentic affordances, and their interaction. Lesson communal affordances uniquely predicted positivity toward the lesson, $b = 0.57, p = .0001, \beta = .51$. Lesson agentic affordances also uniquely predicted positivity toward the lesson, $b = 0.29, p = .02, \beta = .29$. Agentic and communal lesson affordances did not interact to predict positivity toward the lesson, $b = -0.02, p = .62, \beta = -.04$.

**Discussion**

In support of Hypothesis 1, these findings demonstrated that preservice science teachers generally favored lessons with communal affordances over lessons that lacked communal affordances. Preservice teachers were more favorable toward a science lesson if the lesson portrayed science careers as allowing opportunities to fulfill communal goals even when controlling for whether the lesson portrayed agentic affordances. These findings suggest that science teachers favor lessons that may increase perceptions that STEM fulfills communal goals, which can increase students’ interest in STEM careers (e.g., Diekman et al., 2011). Study 2 next sought to examine whether these lessons are viewed as impeding valued teaching goals.

**Study 2**

Study 2 sought to examine potential obstacles to teaching communal affordances by examining teacher perceptions of whether these lessons impede valued teaching goals, such as teaching content or engaging students. Study 2 employs a within-subjects design to investigate whether teachers prefer to teach lessons that they perceive to fulfill more valued teaching goals. Study 2 also examined whether lessons with communal affordances are viewed as impeding valued content and engagement goals compared to a lesson that lacks communal affordances. Even if teachers favor lessons that portray science’s communal applications, they may be less likely to teach these lessons if they also view these lessons as impeding valued teaching goals.

**Participants**
A priori power analyses using G*Power (Faul et al., 2007) with an alpha of .05 and power of .80 indicated the need for 103 participants to power the analyses in this study. All participants were from the US.

**Recruitment.** Thirty-five participants in Miami University’s education program were recruited via email and received a $10 Amazon gift card for their participation. After exhausting the supply of Miami participants who qualified and wished to participate, I recruited the remainder of the 103 participants via MTurk. Most MTurk participants qualified for the current study by responding to a $0.10 survey that recruited preservice teachers and asked them to provide the subjects they intended to teach in order to potentially qualify for a subsequent survey. To minimize motivation for participants to lie, no information was provided signaling which intended teaching subjects would qualify participants for the subsequent higher pay survey. Participants who responded that they were intending to teach science (e.g., science, biology, middle school science) were given a qualification to take the current study in exchange for $3. An additional 3 participants qualified after the screener study concluded by emailing the lab directly and satisfactorily describing their career plans and current college studies. Participants were only able to take the current study via MTurk if they first received the qualification either through the screener or by verifying their information by emailing the lab.

**Exclusion criteria.** Although care was taken to only recruit preservice science teachers in both the Miami and MTurk sample, of the total 103 participants recruited, only 98 (32 men, 65 women, 1 not reporting; 35 Miami, 59 MTurk) provided demographic information at the end of the current study that indicated that they were indeed currently studying to become teachers and planned to teach science. Only these qualifying participants were included in analyses.

**Final sample characteristics.** Twelve percent of participants identified as Hispanic or Latino/a, with the remainder identifying as not Hispanic or Latina/o. Participants also provided their racial identification, and 7.1% identified as Asian or Asian American, 4.0% identified as Black or African American, 1.0% identified as multi-racial, and 82.7% identified as White. The remainder of the sample identified as other. Many participants were earning a broad certification in science that encompassed either K-12 or middle and high school grade levels, and thus 44% of participants did not have a target grade level at which they intended to teach science. Of the remainder of the sample, 5% intended to teach elementary science, 13% intended to teach middle
school science, 16% intended to teach high school science, and 15% intended to teach science at the university or college level.

Procedure

After giving informed consent, participants responded to a series of items assessing their own teaching goals. They then rated two lesson plans that were identical except for one key section that served as the manipulation. The key section of the communal affordance lesson plan called for a discussion of the altruistic applications of the lesson material. The control lesson plan contained no communal affordance information, and its key section devoted class time to rehearsal of material covered previously in the lesson (see Appendix B). All participants rated both lesson plans, but the order was counterbalanced.

Measures

Unless otherwise noted, all measures were on scales from 1 (not at all) to 7 (extremely).

Participant beliefs and goals.

Teaching goal endorsement. Participants rated the importance of a lesson fulfilling content goals (i.e., cover new class content, cover broad class concepts, rehearse class concepts, practice skills; $\alpha = .80$) and engagement goals (i.e., increase student engagement with the topic, increase student engagement with science, increase student interest in the topic, increase student interest in science; $\alpha = .89$). I then averaged items within goal type.

Explicit teaching goal priorities. Participants responded to two items measuring their teaching goal priorities that asked them to choose between course content goals and student engagement goals (i.e., if I had to decide, I would prioritize making sure I teach my students class content and skills over making sure they are interested and engaged and if I had to decide, I would prioritize making sure my students are interested and engaged over making sure I teach them class content and skills). These items showed poor reliability, $\alpha = .13$, and were not examined further.

Lesson ratings.

Lesson goal affordances. Participants responded the measures used in Study 1 that assessed whether the communal and control lesson respectively portrayed science as fulfilling communal goals ($\alpha = .88, .91$) and agentic goals ($\alpha = .88, .91$).

Lesson teaching goal affordances. Participants rated whether each of the lessons fulfilled the verbatim teaching endorsement goals (e.g., rehearse class concepts). For each
lesson, I separately averaged items within teaching goal to create measures of content affordances (α = .89 for both) and engagement affordances (α = .97, .98) for the communal and control lessons respectively.

**Lesson self-efficacy.** For each lesson, participants rated, “To what degree do you think this lesson covers a topic you are confident teaching,” “To what degree do you think this lesson covers a topic you know well,” and “To what degree do you think this lesson requires resources or supporting material that you know you can easily find.” I averaged these items within lesson to create a self-efficacy index (α = .83, .85).

**Preference for the lessons.** For each lesson, participants rated whether they would likely teach this lesson, consider teaching this lesson, and be interested in teaching this lesson if they taught students at its level (α = .96, .94).

**Lesson recommendation.** Participants were asked to choose which of the two lessons to recommend to the publishing company for inclusion in supplementary materials for science teachers.

**Results**

**Summary of potential moderators.**

**Collection site.** MTurk participants consistently demonstrated significantly higher mean scores than Miami participants, but collection site only significantly moderated two effects (all other ps > .05). MTurk participants viewed both lessons as affording more engagement goals than Miami participants, $\eta^2_p = .06 - .08$, but MTurk and Miami participants viewed the lessons as affording similar levels of content goals, $\eta^2_p < .01$, interaction $p = .0004$. Furthermore, MTurk and Miami men, as well as MTurk women, responded similarly in their preferences for the lessons, but Miami women preferred both lessons to a lesser extent than the other three groups, interaction $p = .04$. The following analyses collapse across collection site.

**Intended teaching grade level.** Intended teaching grade level only correlated with one variable of interest (all other ps > .26). Participants who intended to teach higher levels of science were more likely to choose to recommend the lesson without communal affordances to the publisher, $r(47) = -.30$, $p = .05$. Analyses collapse across intended teaching grade level.

**Participant gender.** Gender did not exhibit any main effects, and only moderated one effect (all other ps > .07), which will be noted below. All analyses omit participant gender unless otherwise noted.
Manipulation check. I submitted communal lesson affordances (communal affordances, agentic affordances) and control lesson affordances (communal affordances, agentic affordances) to a repeated measures ANOVA.

The key interaction between target lesson and affordance type emerged, $F(1, 91) = 5.56, p = .02, \eta_p^2 = .06$. As indicated by the significant interaction between lesson and affordance type, participants believed that the communal lesson plan ($M = 4.22, SD = 1.57$) portrayed science as fulfilling significantly more communal goals than the control lesson ($M = 3.83, SD = 1.72$), $F(1, 92) = 12.95, p = .0005, d = 0.37$, and though participants also believed that the communal lesson plan portrayed science as fulfilling more agentic goals ($M = 4.30, SD = 1.57$) than the control lesson ($M = 4.14, SD = 1.69$), this effect was smaller, $F(1, 91) = 4.23, p = .04, d = 0.21$. A main effect of affordance type indicated that participants thought the lessons were more likely to portray communal than agentic affordances, $F(1, 91) = 6.02, p = .02, \eta_p^2 = .06$. A main effect of lesson type also emerged, $F(1, 91) = 10.20, p = .0019, \eta_p^2 = .10$, indicating that participants believed that the communal lesson portrayed science as fulfilling more goals than the control lesson.

Replication of Study 1: Lesson communal affordances predict lesson positivity. To conceptually replicate Study 1, I examined whether perceptions that one lesson fulfilled more agentic or communal goals than another predicted increased preferences for the lesson (Hypothesis 1). I regressed relative preference for the communal lesson onto perceptions that the communal lesson portrayed science as fulfilling relatively more communal and agentic goals than the control lesson. Relative communal affordances emerged as a significant predictor of communal lesson preference, $b = 0.30, p = .0001, \beta = .43$, as did relative agentic affordances, $b = 0.19, p = .05, \beta = .22$.

Teacher perceptions of science lessons.

Lesson plan teaching goal affordances. I next examined whether participants viewed the lesson plans as differing in their fulfillment of content and engagement teaching goals (Hypothesis 2). I submitted perceptions of the communal and control lessons’ content and engagement goal affordances to a 2 (lesson type: communal, control) by 2 (affordance type: communal, agentic) repeated measures ANOVA. As seen in Figure 1, a significant interaction between lesson and affordance type emerged, $F(1, 96) = 3.98, p = .05$. Participants believed that the communal lesson ($M = 4.85, SD = 1.69$) would be more likely to engage students than the
control lesson ($M = 4.60, SD = 1.70$), $F(1, 96) = 5.59, p = .02, d = 0.24$. However, participants believed that the communal lesson ($M = 5.28, SD = 1.07$) and control lesson ($M = 5.24, SD = 1.09$) would similarly fulfill content goals, $F(1, 96) = 0.40, p = .53, d = 0.06$.

Two main effects also emerged. The main effect of affordance type, $F(1, 96) = 18.94, \eta^2_p = .16$, indicated that participants thought that the lessons would fulfill more content teaching goals than engagement teaching goals. The lesson type main effect indicated that participants viewed the communal lesson as fulfilling more teaching goals than the control lesson, $F(1, 96) = 4.16, p = .04, \eta^2_p = .04$.

**Teacher lesson evaluations.** I examined differences in teacher self-efficacy and lesson preference in two separate repeated measures ANOVAs. Participants did not report higher self-efficacy on one lesson versus the other, $F(1, 96) = 0.02, p = .88, \eta^2_p < .01$. However, participants preferred to teach the communal lesson ($M = 4.98, SD = 1.51$) over the control lesson ($M = 4.82, SD = 1.48$), $F(1, 96) = 3.81, p = .05, d = 0.20$. Performing a Chi-square analysis comparing the frequency of recommending the communal lesson (57%) or the control lesson (43%) to chance suggested that participants were not more likely than chance to recommend one lesson over the other for inclusion in a textbook’s supplementary materials, $\chi^2(1) = 1.67, p = .20$.

**Predictors of lesson preference.** To investigate Hypothesis 3, I next examined whether perceptions that one lesson compared to the fulfilled more teaching goals predicted increased lesson preference. I regressed preference for the communal lesson onto centered relative content affordances, centered relative engagement affordances, and their interaction. Perceptions that the communal lesson fulfilled relatively more content teaching goals than the control lesson emerged as a significant predictor of communal lesson preference, $b = 0.27, p = .01, \beta = .23$. Similarly, perceptions that the communal lesson fulfilled relatively more engagement teaching goals than the control lesson also emerged as a significant predictor of communal lesson preference, $b = 0.38, p < .0001, \beta = .49$. Teaching goal affordances did not interact to predict lesson preference, $b = -0.11, p = .17, \beta = -.12$.

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1 When controlling for engagement affordances, participant gender (effect coded: -1 = male, 1 = female) moderated the relationship between content goal affordances and teaching preferences, $b = -0.26, p = .01, \beta = -.21, \Delta R^2 = .04$. Content affordances were a significant predictor of lesson preference for men, $b = 0.66, p = .0002, \beta = .55$, but not for women, $b = 0.15, p = .19, \beta = .13$. The low power of this analysis should be kept in mind when interpreting this finding.
To investigate whether data aligns with other goal congruity patterns, I examined whether participants who value teaching goals at the highest levels would exhibit even stronger preference than other participants for the lesson they viewed as fulfilling relatively more teaching goals. When controlling for lesson content affordances, individual differences in engagement goal endorsement did not moderate the relationship between lesson engagement affordances and teacher lesson preferences, $p = .19$. In a similar fashion, when controlling for engagement affordances, individual differences in content teaching goal endorsement did not moderate the relationship between lesson content goal affordances and teacher lesson preference, $p = .13$.

**Predictors of lesson choice.** I finally turned to examining whether relative affordances would predict teachers’ preferences for the lessons on the forced choice measure. Using logistic regression, I regressed lesson recommendation choice onto relative content affordances (centered), relative engagement affordances (centered), and their interaction. Engagement affordances did not significantly predict responses on the forced choice measure, $b = .35, p = .16, \beta = .21$, and neither did content affordances, $b = -.16, p = .66, \beta = -.06$. Content and engagement affordances did not interact to predict teachers’ forced choice lesson preferences, $p = .50$.

I then examined whether goal congruity patterns would arise in teachers’ forced choice responses by investigating whether those who most strongly valued teaching goals would exhibit significantly more likelihood of choosing to recommend the lesson they viewed as fulfilling those teaching goals. Using logistic regression, I regressed lesson forced choice onto centered engagement affordances, centered engagement goal endorsement, and their interaction, controlling for lesson content affordances. Engagement goal endorsement and engagement affordances did not interact to predict lesson choices, $p = .53$. In a separate logistic regression, I regressed lesson forced choice onto content goal affordances (centered), content goal endorsement (centered), and their interaction, controlling for engagement affordances. Content goal endorsement and content affordances did not interact to predict lesson preferences as measured by the forced choice response, $p = .60$.

**Discussion**

Similar to Study 1, teachers preferred to teach a lesson if they perceived the lesson as containing more communal affordances than another lesson (Hypothesis 1). Study 2 also partially supported Hypothesis 2. The communal lesson compared to the control lesson was
viewed as fulfilling significantly more engagement teaching goals, but similar amounts of content teaching goals (partial support of Hypothesis 2). Study 2’s results suggest that teachers view communal affordance lessons to fulfill more engagement goals than the control lesson, and that the communal and control lessons similarly fulfill content goals.

In support of Hypothesis 3, preservice teachers exhibited relatively more preference to teach a lesson if they viewed it to fulfill valued content and engagement goals. In line with goal congruity predictions (Diekman et al., 2016), participants preferred to teach lessons that they believed afforded their valued goals. However, teachers’ continuous ratings of their lesson preferences were better able to detect the relationship between teachers’ perceptions that the lesson afforded valued goals and their preferences for a lesson. Teachers’ perceptions that the lessons fulfilled valued content and engagement goals did not predict their lesson preferences on the forced choice measure.

Indeed, the current study may have had some measurement limitations. Although the continuous measures of lesson preferences demonstrated the hypothesized relationship between lesson affordances and lesson preferences, the forced choice measure of lesson preferences did not demonstrate this relationship. Individual differences in goal endorsement did not moderate whether teaching goal affordances predicted preferences to teach the lesson; individuals preferred to teach the lesson that they perceived to afford valued engagement and content goals, regardless of how strongly they valued engagement and content goals. However, participants on average valued both engagement goals ($M = 6.52$, $SD = 0.64$) and content goals ($M = 5.68$, $SD = 0.85$) so strongly that mean endorsements were near the tops of the scales. The ceiling effects in goal endorsement may make it difficult to detect whether goal endorsement moderates the relationship between perceived lesson goal affordances and lesson preferences. Future work can delineate whether measurement limitations may account for the lack of these predicted effects.

**General Discussion**

Across two studies, perceptions that a science lesson portrayed science as providing opportunities to fulfill communal goals predicted increased teacher positivity and lesson preference (Hypothesis 1). Communal affordance lessons likely elicited more teacher positivity and lesson preference because communal affordances in lessons predicted teachers’ perceptions that the lesson fulfilled valued student engagement goals (Hypothesis 2), and teachers preferred to teach lessons that they perceived to fulfill valued engagement goals (Hypothesis 3).
Theoretical Implications

Implications for general motivation. The current work extended goal congruity processes to teachers’ evaluations of lessons. This extension builds on goal congruity evidence that individuals are more motivated to pursue careers that fulfill their valued goals, and demonstrated that teachers preferred to teach a lesson when it fulfilled more valued content and engagement goals. Empirical evidence of goal congruity patterns in teachers’ lesson preferences suggests the goal congruity perspective may provide a valuable framework for understanding teacher preferences. Considering teachers’ valued goals and the behaviors that afford those goals may provide valuable insight into why teachers exhibit preferences to shape their classes and courses in specific ways.

The current work also bolsters to prior evidence that the goal congruity perspective may not only further understanding of STEM career motivation and positivity, but may also further understanding of motivation in other domains. Indeed, like other work demonstrating goal congruity patterns in politics (Schneider, Holman, Diekman, & McAndrew, 2015) and business (McCarty, Monteith, & Kaiser, 2014), these findings demonstrate the goal congruity perspective can provide a valuable framework for understanding motivation underlying small choices within the workplace. Further research is necessary to understand when and where goal congruity processes underlie motivation, but this work adds to evidence that goal congruity processes may underlie motivation in domains beyond career motivation.

Implications for the socialization of science communal affordances. The current work is among the first to investigate potential reasons why teachers might include communal information in science lessons. Teachers exhibited more preference and positivity toward lessons when they portrayed more science communal affordances because they viewed these lessons as fulfilling more valued student engagement goals. A growing body of experimental evidence (Brown, Smith, et al., 2015; Clark et al., 2016; Diekman et al., 2011) suggests that teacher beliefs that communal affordances will increase their students’ science engagement, motivation, and positivity are accurate.

Interestingly, when teachers were asked to directly choose one lesson over the other, teachers did not favor one lesson over the other. Indeed, participants were more likely to prefer the lesson without communal affordances to the lesson with communal affordances if they intended to teach at a higher grade level; although teachers evaluated the communal affordance
lessons positively, they still may not choose to teach the lesson with communal affordances. It is likely that there are obstacles to teachers implementing communal affordances in their classrooms that this initial exploration did not address, such as colleague and administrator approval of teaching lessons with communal affordances, or the availability of resources (e.g., lesson plans, materials on the communal applications of science) that would make integrating communal affordance into lessons more straightforward. Another possibility is that the choice measure did not capture what teachers would do in their own classrooms. Some teachers may have been willing to teach a communal lesson in their class, but reluctant to recommend a communal affordance lesson to a textbook publisher. Textbooks often relegate communal information to sidebars, avoiding communal affordances in the main text (e.g., Biggs et al., 2015; Miller & Levine, 2010; Reece et al., 2010), suggesting that publishers tend to a higher value on the material and not its applications.

Although teachers were not more willing to recommend the communal lesson to the textbook publisher, teachers in both studies demonstrated a consistent pattern of preferring the lesson with communal affordances compared to a lesson without communal affordances. Teachers favored communal affordance lessons because they believed these lessons would be more likely to foster student engagement than a similar lesson without communal affordances. Teachers valued engaging their students even more highly than conveying content to their students. Together, these findings reaffirm that teachers can be powerful partners to those who aim to implement curricular interventions designed to increase student engagement and motivation.

Indeed, the current work suggests that efforts to increase communal affordances (or other material that will increase student motivation) in curriculum both at the small (e.g., one classroom) and large (e.g., a school district or beyond) scales should attend to teachers’ goals and how the intervention can help fulfill those goals. Providing teachers with a number of lesson plans that include communal affordances and asking them to teach these lessons may temporarily increase the integration of communal affordances in the classroom, but may not have a lasting impact once teachers are no longer asked to teach the intervention lessons. Instead, demonstrating to teachers how communal affordances foster student motivation and engagement may motivate science teachers to include science communal affordances in multiple aspects of their teaching, and may allow teachers to integrate communal affordances in the classroom in
manners that suit their teaching style and students. If teachers are motivated to continue including communal affordances in their lessons even once a formal intervention period is over, it will likely have a more lasting impact on student motivation.

**Limitations and Future Directions**

Most dependent variables in this work are evaluations or behavioral intentions, and not teachers’ choices or behaviors. Future avenues of research will examine whether preservice science teachers’ evaluations of communal affordance lessons also influence their lesson choices for their own classrooms, and thus increase or decrease their likelihood of including communal aspects in their lessons. Study 2 provided some evidence that teachers were not more likely to recommend a communal affordance lesson compared to a lesson without communal affordances to a publisher, regardless of increased interest in teaching the communal affordance lesson. Furthering understanding of how teachers’ evaluations of and reported preference to teach a lesson correspond with their choices will be essential in future work.

Future research will investigate how communal lesson choices (e.g., pictures of working alone versus together) affect students. Although past evidence suggests that even briefly highlighting science communal affordances can foster science positivity and motivation (e.g., Brown, Smith, et al., 2015; Clark et al., 2016), it is still important to document these effects in classroom environments. Recent work (Master, Cheryan, & Meltzoff, 2016) demonstrates that classroom environments that challenge science stereotypes increase sense of belonging for high school girls. Further work investigating whether increasing science communal affordances in classrooms increases student interest is thus warranted.

Future directions must also investigate potential barriers to teachers choosing communal lessons over lessons without communal affordances; even if teachers are aware that communal affordance lessons will increase student motivation, various barriers may prevent them from implementing communal affordances into their curriculum. Obstacles to implementing communal applications in the classroom may be similar to teachers’ perceptions of the costs to implementing information technology (e.g., television or computers) in their classrooms. For instance, teachers perceived lack of resources as a barrier to adding technology to their classrooms (Mumtaz, 2000); perceptions that it would be difficult or time consuming to obtain materials for a lesson on science’s communal applications may also prevent teachers from opting to discuss science communal affordances in class.
Teachers also perceive lack of social support as a barrier to implementing new technology. Teachers perceive support from colleagues and their schools as essential to implementing new information technology practices in the classroom, and also as a barrier to implementing information technology if there is reduced support (Mumtaz, 2000; Levin & Wadmany, 2008). Social support buffers against professional burnout (Halbesleben, 2006). Social normative processes are also important in decisions. Classic social psychological research demonstrates that an environment’s social norms can have powerful effects on individuals’ behavior (Cialdini & Trost, 1998). Teachers’ views of whether their colleagues would support or approve of their efforts to teach communal applications in the classroom may therefore also be an important predictor of willingness to teach communal affordances. Future work will thus examine the availability of communal affordance materials, as well as teacher perceptions of their colleagues’ support for teaching these lessons, as potential barriers to integrating communal affordances in curriculum.

**Conclusion**

Beliefs about whether science can fulfill communal goals such as working with and helping others are robust predictors of science motivation (Diekman et al., 2016), but stereotypes persist that science impedes communal goals (Diekman et al., 2011). Teachers can serve as important socializers of beliefs important to academic motivation (e.g., Bouchey & Harter, 2005), and this work thus investigated potential factors affecting teacher preferences to include communal affordances in their lessons. Teachers consistently exhibited more positivity and preference toward lessons that they believed portrayed science as fulfilling communal goals. Communal affordance lessons were viewed as fulfilling more valued engagement goals than lessons without communal affordances, and teachers preferred to teach lessons that they perceived to fulfill these valued engagement goals. Leveraging teacher perceptions that communal affordances increase student motivation in science may be a promising route to integrating communal affordances into science curriculum and in turn increasing student science motivation.
References


Clark, E. K., Fuesting, M. A., & Diekman, A. B. (2016). Enhancing interest in science:


**Figure 1.** Differences in content and engagement affordances between lessons with and without communal affordances (Study 2).

![Bar chart](chart.png)

*Note. Affordance measures were on scales from 1 (*not at all*) to 7 (*extremely*). Error bars denote ±1 standard error.*
Appendix A  
Study 1 Lesson Plans

Note: Underlined text only appeared in the communal framing. Italicized text only appeared in the control.

Mutation Lesson Summary: This lesson will help students explore different types of genetic mutations. This lesson will also discuss how mutations affect organisms at the molecular, systemic, and population levels.

Goals and Objectives: Students should be able to demonstrate how mutations change an amino acid sequence. They will also be able to explain the differences between mutation types. Finally, they will understand how mutations affect organisms at the molecular, systemic, and population level.

Standards: Biology 4c: students should learn how mutations in DNA sequences of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein.

Length: 50 Minutes

Prerequisite Knowledge: Students need to understand the rules of DNA / RNA base pairing. They should also understand protein synthesis and how to use a codon table.

Teacher Background Knowledge: Mutations are important in many issues in biology. They can be induced (i.e. created) by researchers who use mutagens such as chemicals or radiation, and they can also occur spontaneously (i.e. randomly or naturally) due to errors in DNA replication or chemical instability of bases. Regardless of how they happen, mutations work for populations by increasing genetic diversity and increasing species odds for survival in varying environments. They also work against us in bacterial resistance to antibiotics, sickle cell anemia, and cancer.

Genetic mutations occur when bases of a DNA or RNA sequence are changed. This often occurs during DNA replication in preparation for cell division or when mistakes are made during transcription and translation in protein synthesis. Point mutations occur when changes in DNA bases do not affect the triplet reading frame of tRNA. Substitution or inversions are point mutations. Though they may change one or two amino acids, the majority of the DNA sequence is unaltered. Silent mutations are point mutations that do not alter the amino acid outcome. Often, more than one codon will code for a certain amino acid, so silent mutations are harmless. Frameshift mutations like deletions and insertions change the entire codon reading frame by shifting each base over one position. Frameshift mutations can be disastrous.

Materials: Pencils, Paper, Notecards, Mutation Practice Worksheet Handouts

Procedures:
1. Review with the class about point mutations and differences between frame shift and base substitution (10 minutes)
2. Have students complete worksheet on their own (see end of document), (20 minutes)
3. Lecture: Why Genetics Matters (see general outline below) (20 minutes)

Lecture Outline: Why Genetics Matters
The Real World Applications of Mutation and Genetics

Scientists are currently working together to see how understanding genetics can help treat and prevent diseases. How?

- Harnessing genetics for insulin production
  - Importance of insulin for diabetics
  - Tomorrow's technology today: Genetically-engineered bacteria and insulin production

- BRCA1 or BRCA2 gene mutations increase cancer risk, but knowing about and understanding the mutation can help an individual engage in behaviors to prevent cancer
  - Increased Cancer Screening
  - Chemoprevention drugs
  - Risk-reducing surgery

Lecture: How Mutations Occur
The Processes Through Which Mutations Occur

Scientists are currently working to understand how mutations occur. What have they found so far?
- Induced Mutations (Scientist or researcher created mutations)
  - Researchers can create mutations with chemicals that create point mutations
  - Researchers can also create mutations with radiation that affect many base pairs

- Spontaneous Mutations (randomly or naturally created mutations)
  - In nature, mutations can occur due to chemical instability of a base pair
  - Mutations can also occur in nature due to errors in DNA replication

Mutation Worksheet

Definitions

__________________________ – any change in the genetic sequence.
__________________________ – when a change in the genetic code changes the amino acid sequence.
__________________________ - when a change in the genetic code doesn’t change the amino acid sequence.

Kinds of mutations

___________________________ – change in just one nucleotide  ex.  AAA mutates to AAG
  Original: THE CAT AND THE RAT ARE TOO FAT
  Mutated: THE CAT AND THE BAT ARE TOO FAT

___________________________ – change in sequence by adding one or more bases.
  Original: THE CAT AND THE RAT ARE TOO FAT
  Mutated: THE CAT AND THE RAT ARE TO FATT

___________________________ – change in sequence by taking out one or more bases.
  Original: THE CAT AND THE RAT ARE TOO FAT
  Mutated: THE CAT AND THE RAT ARE TOO FA

____________________________ – the result of an insertion or deletion that moves the codons down and changes all the amino acids
  Original: THE CAT AND THE RAT ARE TOO FAT
  Mutated: THE CAA NDT HER ATA RET OOF AT.
  OR: THE ECA TAN DTH ERA TAR ETO OFA T.

1. Original DNA: AGA GCA CTT AAA AGG
   a. Amino Acid sequence: ________________________________
   b. Mutated sequence: AGA GCG CTT AAA AGG
   c. Amino Acid sequence: ________________________________
   d. Type of mutation: ________________________________
   e. Gene alteration: ________________________________

2. Original DNA: AGA GCA CTT AAA AGG
   a. Amino Acid sequence: ________________________________
   b. Mutated sequence: AGA GCA CTT AAT AGG
   c. Amino Acid sequence: ________________________________
   d. Type of mutation: ________________________________
   e. Gene alteration: ________________________________

3. Original DNA: AGA GCA CTT AAA AGG
   a. Amino Acid sequence: ________________________________
   b. Mutated sequence: AGA CAC TTA AAA GG
   c. Amino Acid sequence: ________________________________
   d. Type of mutation: ________________________________
   e. Gene alteration: ________________________________

4. Original DNA: AGA GCA CTT AAA AGG
   a. Amino Acid sequence: ________________________________
b. Mutated sequence: AGA GCA ATC CCG TTC GGG CTT AAA AGG  
c. Amino Acid sequence: ________________________________  
d. Type of mutation: ________________________________  
e. Gene alteration: ________________________________  

5. Original DNA: AGA GCA CTT AAA AGG  
a. Amino Acid sequence: ________________________________  
b. Mutated sequence: AGA GCA AAA AGG  
c. Amino Acid sequence: ________________________________  
d. Type of mutation: ________________________________  
e. Gene alteration: ________________________________  

6. When a point mutation results in the same amino acid sequence, is it still considered a mutation?
Appendix B
Study 2 Lesson Plans

Communal Lesson

**Mutation Lesson Summary:** This lesson will help students explore different types of genetic mutations. This lesson will also discuss how mutations affect organisms at the molecular, systemic, and population levels.

**Goals and Objectives:** Students should be able to demonstrate how mutations change an amino acid sequence. They will also be able to explain the differences between mutation types. Finally, they will understand how mutations affect organisms at the molecular, systemic, and population level.

**Standards:** Biology 4c: students should learn how mutations in DNA sequences of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein.

**Length:** 50 Minutes

**Prerequisite Knowledge:** Students need to understand the rules of DNA / RNA base pairing. They should also understand protein synthesis and how to use a codon table.

**Teacher Background Knowledge:** Mutations are important in many issues in biology. They can be induced (i.e. created) by researchers who use mutagens such as chemicals or radiation, and they can also occur spontaneously (i.e. randomly or naturally) due to errors in DNA replication or chemical instability of bases. Regardless of how they happen, mutations work for populations by increasing genetic diversity and increasing species odds for survival in varying environments. They also work against us in bacterial resistance to antibiotics, sickle cell anemia, and cancer.

Genetic mutations occur when bases of a DNA or RNA sequence are changed. This often occurs during DNA replication in preparation for cell division or when mistakes are made during transcription and translation in protein synthesis. Point mutations occur when changes in DNA bases do not affect the triplet reading frame of tRNA. Substitution or inversions are point mutations. Though they may change one or two amino acids, the majority of the DNA sequence is unaltered. Silent mutations are point mutations that do not alter the amino acid outcome. Often, more than one codon will code for a certain amino acid, so silent mutations are harmless. Frameshift mutations like deletions and insertions change the entire codon reading frame by shifting each base over one position. Frameshift mutations can be disastrous.

**Materials:** Pencils, Paper, Notecards, Mutation Practice Worksheet Handouts

**Procedures:**
1. Review with the class about point mutations and differences between frame shift and base substitution (10 minutes)
2. Have students complete worksheet on their own (see end of document). (20 minutes)
3. Lecture: Why Genetics Matters (see general outline below) (20 minutes)
Lecture Outline: Why Genetics Matters
The Real World Applications of Mutation and Genetics

Scientists are currently working together to see how understanding genetics can help treat and prevent diseases. How?

- Harnessing genetics for insulin production
  - Importance of insulin for diabetics
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- BRCA1 or BRCA2 gene mutations increase cancer risk, but knowing about and understanding the mutation can help an individual engage in behaviors to prevent cancer
  - Increased Cancer Screening
  - Chemoprevention drugs
  - Risk-reducing surgery

Mutation Worksheet

Definitions
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__________________________ – when a change in the genetic code changes the amino acid sequence.
__________________________ - when a change in the genetic code doesn’t change the amino acid sequence.

Kinds of mutations
___________________________ – change in just one nucleotide ex. AAA mutates to AAG

Original: THE CAT AND THE RAT ARE TOO FAT
Mutated: THE CAT AND THE BAT ARE TOO FAT

___________________________ – change in sequence by adding one or more bases.

Original: THE CAT AND THE RAT ARE TOO FAT
Mutated: THE CAT AND THE RAT ARE TOO FAT

___________________________ – change in sequence by taking out one or more bases.

Original: THE CAT AND THE RAT ARE TOO FA
Mutated: THE CAT AND THE RAT ARE TOO FAT

____________________________ – the result of an insertion or deletion that moves the codons down and changes all the amino acids

Original: THE CAT AND THE RAT ARE TOO FAT
Mutated: THE CAA ND THER ATA RET OF F AT.
OR: THE ECA TAN DTH ERA TAR ETO OFA T.

1. Original DNA: AGA GCA CTT AAA AGG
   a. Amino Acid sequence:
   b. Mutated sequence: AGA GCG CTT AAA AGG
   c. Amino Acid sequence:
   d. Type of mutation: ________________________________
   e. Gene alteration: ________________________________

2. Original DNA: AGA GCA CTT AAA AGG
   a. Amino Acid sequence: ________________________________
   b. Mutated sequence: AGA GCA CTT AAT AGG
   c. Amino Acid sequence: ________________________________
   d. Type of mutation: ________________________________
   e. Gene alteration: ________________________________

3. Original DNA: AGA GCA CTT AAA AGG
   a. Amino Acid sequence: ________________________________
   b. Mutated sequence: AGA CAC TTA AAA GG
   c. Amino Acid sequence: ________________________________
d. Type of mutation: ____________________________________________
e. Gene alteration: ____________________________________________

4. Original DNA: AGA GCA CTT AAA AGG
a. Amino Acid sequence: _________________________________________
b. Mutated sequence: AGA GCA ATC CCG TTC GGG CTT AAA AGG
c. Amino Acid sequence: _________________________________________
d. Type of mutation: ____________________________________________
e. Gene alteration: ____________________________________________

5. Original DNA: AGA GCA CTT AAA AGG
a. Amino Acid sequence: _________________________________________
b. Mutated sequence: AGA GCA AAA AGG
 c. Amino Acid sequence: _________________________________________
d. Type of mutation: ____________________________________________
e. Gene alteration: ____________________________________________

6. When a point mutation results in the same amino acid sequence, is it still considered a mutation?

Control Lesson

Mutation Lesson Summary: This lesson will help students explore different types of genetic mutations. This lesson will also discuss how mutations affect organisms at the molecular, systemic, and population levels.

Goals and Objectives: Students should be able to demonstrate how mutations change an amino acid sequence. They will also be able to explain the differences between mutation types. Finally, they will understand how mutations affect organisms at the molecular, systemic, and population level.

Standards: Biology 4c: students should learn how mutations in DNA sequences of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein.

Length: 50 Minutes

Prerequisite Knowledge: Students need to understand the rules of DNA / RNA base pairing. They should also understand protein synthesis and how to use a codon table.

Teacher Background Knowledge: Mutations are important in many issues in biology. They can be induced (i.e. created) by researchers who use mutagens such as chemicals or radiation, and they can also occur spontaneously (i.e. randomly or naturally) due to errors in DNA replication or chemical instability of bases. Regardless of how they happen, mutations work for populations by increasing genetic diversity and increasing species odds for survival in varying environments. They also work against us in bacterial resistance to antibiotics, sickle cell anemia, and cancer.

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Materials: Pencils, Paper, Notecards, Mutation Practice Worksheet Handouts

Procedures:
1. Review with the class about point mutations and differences between frame shift and base substitution (10 minutes)
2. Have students complete worksheet on their own (see end of document). (20 minutes)
3. Lecture: Why Genetics Matters (see general outline below) (20 minutes)

Lecture: How Mutations Occur
Mutation Processes

Scientists are currently working to understand how mutations occur. What have they found so far?

- Induced Mutations (Scientist or researcher created mutations)
  - Researchers can create mutations with chemicals that create point mutations
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Kinds of mutations
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  Original: THE CAT AND THE RAT ARE TOO FAT
  Mutated: THE CAT AND THE BAT ARE TOO FAT

_________________________ – change in sequence by adding one or more bases.
  Original: THE CAT AND THE RAT ARE TOO FAT
  Mutated: THE CAT AND THE RAT ARE TO FATT

_________________________ – change in sequence by taking out one or more bases.
  Original: THE CAT AND THE RAT ARE TOO FAT
  Mutated: THE CAT AND THE RAT ARE TOO FA

_________________________ – the result of an insertion or deletion that moves the codons down and changes all the amino acids
  Original: THE CAT AND THE RAT ARE TOO FAT
  Mutated: THE CAA NDT HER ATA RET OOF AT.
  OR: THE ECA TAN DTH ERA TAR ETO OFA T.

1. Original DNA: AGA GCA CTT AAA AGG
   a. Amino Acid sequence: ______________________________
   b. Mutated sequence: AGA GCG CTT AAA AGG
   c. Amino Acid sequence: ______________________________
   d. Type of mutation: ______________________________
   e. Gene alteration: ______________________________

2. Original DNA: AGA GCA CTT AAA AGG
   a. Amino Acid sequence: ______________________________
   b. Mutated sequence: AGA GCA CTT AAT AGG
   c. Amino Acid sequence: ______________________________
   d. Type of mutation: ______________________________
   e. Gene alteration: ______________________________

3. Original DNA: AGA GCA CTT AAA AGG
4. Original DNA: AGA GCA CTT AAA AGG
   a. Amino Acid sequence: 
   b. Mutated sequence: AGA GCA ATC CCG TTC GGG CTT AAA AGG
   c. Amino Acid sequence: 
   d. Type of mutation: 
   e. Gene alteration: 

5. Original DNA: AGA GCA CTT AAA AGG
   a. Amino Acid sequence: 
   b. Mutated sequence: AGA GCA AAA AGG
   c. Amino Acid sequence: 
   d. Type of mutation: 
   e. Gene alteration: 

6. When a point mutation results in the same amino acid sequence, is it still considered a mutation?