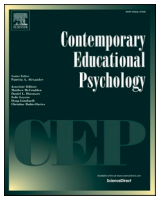
Contemporary Educational Psychology 79 (2024) 102320



Contents lists available at ScienceDirect

Contemporary Educational Psychology

journal homepage: www.elsevier.com/locate/cedpsych



It's not all about recognition and Influence: The role of communal and agentic goals and motives in science for diverse high school students

Ross C. Anderson [a,*], Jenefer Husman [b], Matthew H. Kim [c], Ed Madison [d]

[a] Creative Engagement Lab, 275 W 27th Ave, Eugene, OR 97405, United States
[b] University of Oregon, College of Education, HEDCO Education Building, Eugene, OR 97403, United States
[c] University of Kentucky, Department of Psychology, Kastle Hall, Lexington, KY 40506, United States
[d] University of Oregon, School of Journalism and Communication, Allen Hall, Eugene, OR 97403, United States

ARTICLE INFO

Keywords:
Goal congruity
Self-transcendent motives
Communal goals
Agentic goals
Science task value
Science community values
Latinx youth

ABSTRACT

In this study, we consider the intersections of the goal congruity framework and a related motivational model of self-transcendent versus self-oriented motives in learning. Each approach to understanding students' motivations in science calls attention to the value of communal orientations (helping others, working for the social good, and collaboration) and contrasts them with individualistic motives (self-promotion, wealth generation, knowledge and skill development, and recognition). Whereas the goal congruity model focuses on students' perceptions of science as a career, the self-transcendent motives model focuses on students' self-perceptions of their motivation. In a sample of racially diverse high school students with a specific focus on Latinx youth, these models help to distinguish science learning motives and goal affordances in science career paths that are more communal and self-transcendent from those that are more agentic and self-oriented. First, we evaluated the construct validity to learn if these models, operationalized through psychological measures, function adequately for diverse high school students. Next, we evaluated if and how these interrelated motivational models explained unique variance in a meaningful way with how students value science and identify with science community values. We found that students' self-oriented and self-transcendent motives in science and perceived communal goal affordances explained unique variance in students' identification with science community values. Self-oriented motives uniquely predicted intrinsic value, interest value and attainment value for science. Perceived communal goal affordances of science uniquely predicted the utility value and attainment value for science. Agentic goal affordances that were more extrinsic, such as money and recognition, did not function well enough to remain in the SEM model. Findings provide important clarifications for the specific context of science learning for diverse high school students that both build on and distinguish from past research.

1. Introduction

In recent years, critiques have addressed the incongruities between White-dominant educational psychology theories of student motivation and engagement and the cultural non-White diversity of students and learning contexts to which these theories and frameworks have been applied (Matthews & López, 2020; Usher, 2018). One perspective developed to explore women's marginalization in Science, Engineering, Technology, and Mathematics (STEM) is role congruity theory (Diekman et al., 2010), now commonly known as goal congruity theory. The theory postulates that students actively seek to match their own values and goals with those of the domains they study and examine the *goal affordances* of these domains to determine which of their goals can be accomplished by pursuing a degree or career path. The goal affordances that are highlighted within STEM often focus on individual achievement and recognition, wealth building, and competition. Researchers have argued these messages push out women and men who have communal goals (Boucher et al., 2017; Diekman et al., 2010, Diekman et al., 2017).

Another approach to considering the role that communal goals play in motivation for learning has come from work distinguishing self-transcendent and self-oriented or individualistic goals—those focused on self-development and personal agency (Yeager et al., 2014). These orientations reflect the larger cultural value systems at work, where the individualistic focus on self-interests contrasts with a collectivist

* Corresponding author.
E-mail addresses: ross@creativeengagementlab.com (R.C. Anderson), jhusman@uoregon.edu (J. Husman), matthew.kim@uky.edu (M.H. Kim), madison2@uoregon.edu (E. Madison).

https://doi.org/10.1016/j.cedpsych.2024.102320

Available online 28 October 2024
0361-476X/© 2024 Published by Elsevier Inc.

orientation emphasizing the interconnectedness of individuals and responsibility to others and the social good (Clayton & Zusho, 2016). Students' sense of self about science learning and careers, especially students of color, often reflects a collectivist orientation. It is important to include these contrasting dimensions when studying the impact of students' motives and goals on their science learning (Kim et al., 2021).

We extend this work to consider the application of communal goals in the context of motivation in school and careers for students of color, women, and other marginalized and minoritized groups. This current study seeks to understand if and how diverse high school students' motives in science and perceptions of the affordances of science career pathways can be differentiated by communal and individual dimensions in a meaningful way. Specifically, we adopt an integrative approach by considering the intersections of goal affordances research and self-transcendent research—two interrelated conceptualizations to understand students' motivations in science. Each approach calls attention to the value of communal orientations (helping others, working for the social good, and collaboration) and contrasts them with individualistic motives (self-promotion, wealth generation, knowledge and skill development, and recognition). The primary distinction between the two approaches is that self-transcendent versus self-oriented motives relate to the students' self-perceptions about what motivates them whereas communal versus agentic goal affordances relates to their perceptions about science career pathways. By studying how these factors function for students within the same model we can understand their unique and overlapping influence on how students identify with and value science. To date, research has not integrated these closely related theories and concepts.

This study aims to understand how these theories, operationalized through psychological assessments, function for diverse U.S. high school students, with a specific focus on Latinx youth. We also test how communal versus agentic goals and motives contribute uniquely to (a) students' endorsement of science community objective values (Estrada et al., 2011), such as finding scientific discovery thrilling, and (b) students' valuing of science (situated expectancy value theory [SEVT]; Eccles & Wigfield, 2020). We propose there are important relations across these underlying constructs that can inform more precise and useful theories related to science learning, motivation, and pursuits for diverse high school students. Results from this study can inform future research and intervention design targeting students' beliefs about and motivation to pursue science. In the following sections, we briefly describe the two models from past research that motivate our work—the goal congruity model and the model of self-transcendent and self-oriented motives.

1.1. The goal congruity model

The goal congruity model demonstrates how perceived social roles are important to understand why people pursue STEM goals and careers (Diekman & Eagly, 2008; Diekman et al., 2010; Diekman et al., 2017). The goal congruity model poses the question: if science is seen as a communal act by students, especially female students, and that perception aligns with communal values of students, will students be more likely to engage in science? Although researchers have examined this model with undergraduate women and have argued that it can be applied to men with communal orientations (Boucher et al., 2017), that research has not typically been extended into the context of racially and ethnically diverse high school students.

The goal congruity model defines agentic goal affordances as the perceived benefits to oneself through personal development in knowledge, skills, influence, power, financial security, recognition, competition, and autonomy in work (Belanger et al., 2020; Diekman & Benson-Greenwald, 2018; Diekman, Brown, Johnston, & Clark, 2010). According to the theory, those goal affordances are in contrast to the communal dimension focused on work in connection to others to support the greater good of society and help others, especially those in need. Although research shows variation in communality and agency across different STEM domains (Joshi et al., 2022), in general, the goal congruity model proposes that perceptions of science focused on agentic and self-oriented motives and goals can be demotivating for students, who align with more communal roles and values. Importantly, collectivist orientations are likely important for the motivation and identity of racially and ethnically diverse minoritized and marginalized students studying STEM in the U.S. education context (Oyserman & Destin, 2010). For instance, a qualitative investigation of African American secondary school students who participated in a camp designed to highlight the collaborative and altruistic aspects of engineering revealed changes in students' understanding of and interest in engineering (Lakin et al., 2022), demonstrating the importance of congruence between one's goals and the affordances provided by specific learning and professional contexts.

1.2. A closely related Model: Self-Transcendent and Self-Oriented motives

There exists a potential jingle/jangle issue of highly overlapping constructs in the literature about this individualistic-communal distinction, as is also commonly seen in other motivational constructs (e.g., Marsh et al., 2019). Adjacent to the goal congruity model, another conceptualization of this distinction was framed by Yeager et al. (2014) in their research on how self-transcendent versus self-oriented motives in learning contribute to students' academic self-regulation and achievement.

1.3. The first distinction

The main distinction between Yeager et al.'s (2014) approach and goal congruity theory rests on the type of perception measured. Goal congruity theory assesses students' perception about the affordance of science careers for goals that are agentic and goals that are communal. Yeager et al.'s (2014) scale measures how students perceive their own motives in science learning distinguishing between self-oriented and self-transcendent motives. Though this distinction in construct specificity may seem minor, the measurement of these two types of perceptions together can cast a light on the distinct roles they play in how diverse students identify with, value, and actually pursue science pathways.

Self-oriented motives for pursuing science include students' focus on their self-interest, such as developing more knowledge, pursuing areas of interest, and becoming independent thinkers (Yeager et al., 2014). Self-transcendent motives to pursue science include the desire to positively impact the world, help others, and contribute to society. Reflecting the close connection between the goal congruity model and the motives framework, experimental research has shown that students who reflected on their challenges in pursuing STEM—in light of their purpose and fundamental motives—had more positive beliefs and attitudes about their STEM major (Diekman et al., 2024). In a study focused on general academic motivations, the correlation between these self-oriented and self-transcendent factors in a sample of secondary school students was at a large effect size of $r = 0.61$ Yeager et al. (2014), which indicates a close association between motives of self-enhancement and positive contributions to the world.

1.4. The second distinction

In the motives framework, self-oriented development is operationalized as self-improvement rather than competition, money, and power, as the goal congruity model frames agentic goals. In that way, the motives framework aligns well with self-determination theory's conceptualization of intrinsic motivation. From Yeager et al.'s (2014) model, these aims toward self-improvement need not be in competition or opposition to transcendent goals beyond the self, which can also be intrinsic. Within scientific disciplines, these motives may not be seen as

mutually exclusive, so we might expect an even higher correlation. Not only might a student hold both, but self-development motives may be seen as necessary to consider communal motives—i.e., *it is necessary to develop personal knowledge and skills in science if a person is going to use science to contribute to the social good.* These points present validity issues regarding diverse high school populations in the context of science that this current study aims to address.

1.5. Disentangling these models within existing motivation theory

Social-cognitive theory (SCT; Bandura, 2006; Patall et al., 2019; Reeve, 2013) and self-determination theory (SDT; Ryan & Deci, 2000) have used the term "agentic" to refer to learner engagement and motivation that is autonomous or self-determined. Having a sense of agency is important as a resilience factor for marginalized students in different contexts (Burger & Samuel, 2017; Martin, Burns, & Collie, 2017), and protective against academic disengagement across the transition into high school (Anderson et al., 2019). However, researchers within SDT have also differentiated between "intrinsic" and "extrinsic" values. Intrinsic values are focused on helping others in need and connecting with friends and family, whereas extrinsic values are focused on material possessions, looking good to others, and externally valued success (Duriez et al., 2007). Specific to goal framing, research has demonstrated that intrinsic goal framing produces deeper engagement and persistence in learning and better conceptual understanding than extrinsic goal framing (Vansteenkiste et al., 2006). Within the goal congruity framework, we find that communal goals are conceptually similar to intrinsic goals, and agentic goals are conceptually similar to extrinsic goals.

1.6. Intrinsic versus extrinsic agentic goals

Another important distinction is that Belanger et al. (2020) operationalized *agentic* goal affordances within the goal congruity model to include power, influence, and money in addition to personal growth, autonomy, and knowledge. Four of the six items included these extrinsic themes of money, recognition, power, and competition. The other two items focused on skill mastery and autonomy at work (see Appendix for items). It may be important to distinguish between these components conceptually and structurally in measurement and analysis. Additionally, those extrinsic components may be a better fit for undergraduate students further along on their career pathway than high school students. Moreover, the extrinsic components of agentic goals (e.g., financial success and influence) in the goal congruity model do not align with other SCT-based conceptualizations, such as Reeve's (2013) model of agentic engagement in learning. This study aims to provide clarity about the implications of this misalignment.

1.7. Primary contributions of this study to theory and practice

When considering the motivation systems of diverse high school students in science, the goal of distinguishing these existing theories and constructs from one another helps us address three important questions. The first question is whether students' perceived goal affordances in science that are agentic in nature will play a different role in how students value and identify with science than their self-perceptions about their agentic motives to gain knowledge and skills in what they are curious to learn. The second question is whether perceived affordances in science that are more communal will play a stronger or weaker role than agentic goal affordances in students' valuing and identifying with science. The third question addresses whether these perceptions of communal goal affordances will be distinguishable from students' general self-transcendent motives (e.g., to help the world) in pursuing science. Clarifying this distinction is important to identify if students' perceptions about science pathways (a) play a role above and beyond their own motivations and/or (b) conflict with their motivations.

If science education aims to engage women and minoritized and underrepresented students, the message that becoming a scientist supports agency may not, on its own, support belonging and encourage students' valuing of and identifying with science (Belanger et al., 2020; Jackson et al., 2016). Rather, a message focused on how science supports communal goals may need to be included or may even be more effective on its own. Because these students might derive greater value in pursuits that prioritize their communities and broader communal goals instead of individual recognition, such messages could be particularly effective in STEM contexts. Indeed, we have seen this approach taken up by STEM interventionists, including projects focused on communal forms of support for belonging (Gray et al., 2020) and new frameworks to address cultural relevance (Kumar et al., 2018). Results from this study with a diverse sample will provide greater insight about the role of these perceived affordances.

Given the important trend toward race-reimaging in educational psychology (Matthews & López, 2020) it would be helpful to know if communal goals and agentic goals conflict for high school students from groups historically marginalized in STEM. If agentic goals are seen as self-determined and communal goals as "good for society" based on agentic and self-determined perspectives, it is likely that these messages are not in conflict. However, if the message or belief is that the goal of science is recognition and power (an agentic goal but also extrinsic) and also communal (for the betterment of society), then agentic and communal goals might have very different motivational outcomes (Belanger et al., 2020; Ryan & Deci, 2000). As this study navigates, how researchers operationalize these two dimensions of motives and goals is important. For instance, in Belanger et al.'s (2020) scale, the measurement of agentic goals conflates *power, competition*, and *money* with agentic goals that also consist of *mastery* and *autonomy*. It is possible that diverse high school students perceive these as distinct dimensions of agentic goal affordances in science. This study presents a first attempt to understand the relations between these contrasting agentic and communal dimensions with the aim of refining existing models and research tools to apply to the high school context.

1.8. Centering experiences of Latinx students in science

Our study examines these issues in a diverse sample of adolescent youth in the United States with a significant proportion of Latinx students. By doing so, we are responding to the ongoing calls for "race-reimaging" in educational psychology, defined as the process by which traditional constructs are reconceptualized to account for race and other sociocultural perspectives (Matthews & López, 2020). Latinx adolescents in the United States often navigate two cultures simultaneously: their ethnic heritage and White American culture (e.g., Phinney & Devich-Navarro, 1997). Because White American culture is often characterized by individualism and Latinx culture by a more collectivistic, familial orientation, it is important to understand science goal affordances and motives among Latinx American youth. In fact, research has applied goal congruity and cultural mismatch perspectives to examine why minority youth, including Latinx individuals, who tend to value communal goals more highly than agentic goals, might experience different STEM pathway development (Bonilla et al., 2023). Our findings might also provide insights into how these dichotomous motivational constructs might operate among non-Latinx students who may straddle two cultures.

1.9. Addressing differences by gender

Finally, our sample also allows us to examine the nature of students' varied identities to include not just ethnic heritage but also gender. The goal congruity perspective predicts that women, who on average endorse communal goals more than men, might be less likely to pursue STEM academic and career pathways, because STEM careers are not perceived as a place where communal goals can be successfully pursued

(Diekman et al., 2018). However, research examining the interaction between goal endorsement and perceived goal affordances in STEM has shown that communal goal endorsement does not moderate the relation between perceived communal affordances and intentions to persist in STEM in female undergraduates, revealing a more complex picture that could be due in part to differences in developmental period (college vs. high school or earlier; Henderson et al., 2022). Examining agentic and communal goal affordances and self-oriented and self-transcendent motives in STEM as a function of *both* race and gender during high school allows us to acknowledge the intersectionality that exists instead of ignoring this reality (see Isenegger et al., 2023, for an example of an intersectional perspective in goal congruity research). In our study, we will compare if these constructs, operationalized in existing psychological scales, function differently for Latinx and non-Latinx students and students identifying as female compared to male students.

1.10. Study context to predict identifying with and valuing science

To address our research questions, we estimated structural equation models (Kline, 2016) that included science community values endorsement and three different dimensions of task value from situated expectancy value theory (i.e., attainment, utility, and intrinsic/interest) as dependent variables.

First, Estrada et al. (2011) proposed science community values based on Kelman and Hamilton (1989) theory of social influence. They suggested minoritized students' endorsement of the objective values of the scientific community will influence their immediate choices and motivations within science. We expected that students' perceptions about goal affordances of science and their motives in science would each play distinct roles in how students' identify with some values shared by the scientific community.

Second, perceived communal and agentic affordances of science pathways should also relate to how students perceive the utility value of science, value of personal attainment in science, and intrinsic value of studying science. SEVT distinguishes between expectancy and value components in predicting students' aspirations, course selection, and academic engagement and achievement (Eccles & Wigfield, 2020). The expectancy component relates to students' self-beliefs and agency for success and aligns with efficacy expectations in SCT (Bandura, 2006), reflecting agentic and self-oriented motives and perceived goals affordances in science. A recent intervention study explicitly demonstrated for Grades 5 and 6 students how STEM can be useful for personal and communal goals in non-STEM careers and found a positive effect on students' perceived utility value of science (Shin et al., 2019). For diverse high school students, we expected that agentic and communal goal affordances would predict how students value personal attainment in science and the utility value of science in their lives. Finally, we expected that students' self-oriented motives would predict their intrinsic and interest value for science learning.

1.11. Research questions

This current study presents one of the first attempts to integrate goal congruity theory and self-transcendent motives in science to examine how diverse high school students identify with and value science learning. This study used two existing measures—(a) agentic and communal STEM goal affordances, and (b) self-oriented and self-transcendent motives in learning adapted to science—which need further validation for the high school context. This study also incorporates two additional measures used in past research—science community values and task value—to assess how students value and identify with science. In doing so, this study aimed to ensure that the scales measured the constructs of interest, effectively, with sensitivity and precision for the aspects most relevant for diverse high school learners. As such, our study can be seen as a systematic, empirical investigation into the nature and structure of conceptually-similar constructs (e.g., goal affordances and motives) that have been studied separately in previous research, towards a better understanding of the nature of these constructs in a racially diverse sample of high school students. We used structural equation measurement models to evaluate the validity of these measures for this sample and purpose.

1. Do data from diverse high school students fit goal congruity and self-transcendent and self-oriented motives models using confirmatory factor analysis? If prior models are not adequate, what changes are necessary to achieve adequate fit?
2. To what extent does the best-fitting model demonstrate scalar and metric measurement invariance for male and female-identifying students and Latinx and non-Latinx-identifying students compared to the configural model? This question is important because it allows us to determine how well the items for each scale function similarly for different groups of students whose goals and values in science might function differently.
3. In a cross-sectional structural regression model, do communal or agentic goal affordances and self-oriented or self-transcendent motives demonstrate a stronger predictive association with how students value and identify with science?

2. Methods

2.1. Sample

The analytic sample included $N = 467$ high school students in the United States. As the detailed demographic breakdown in Table 1 illustrates, the study sample was ethnically and racially diverse and had some diversity on gender identification (when we refer to the "diversity" of the sample these are the dimensions we reference). The sample was recruited for a larger study and project, called My STEM Story, funded by the National Science Foundation and designed to understand the role that exposure to near-peer stories and experiences may play in the development of identity in science for diverse high school students. All

Table 1
Demographic Characteristics of Sample.

Characteristics	Frequency ($n = 467$)
Grade	
9th	57.29 %
10th	36.73 %
11th	4.19 %
12th	1.80 %
Gender identification	
Female	41.12 %
Male	48.50 %
Genderqueer/Non-binary/third gender/agender	4.19 %
Transgender	1.00 %
Prefer to self-describe	5.19 %
Race	
Black or African American	10.38 %
White	30.14 %
Asian	8.58 %
American Indian or Alaskan Native	2.79 %
Prefer not to say	13.97 %
A race, ethnicity, or origin not listed here	26.55 %
Multiple	6.39 %
Native Hawaiian or Other Pacific Islander	0.40 %
Missing	0.80 %
Latinx	
Yes, Mexican, Mexican American, Chicano/a/x	36.33 %
Yes, Puerto Rican	1.20 %
Yes, Cuban	0.20 %
No, not of Latinx, Latino/a/x, or Spanish origin	43.91 %
Prefer not to say	6.99 %
Prefer to self-describe	2.00 %
Yes, another Latinx, Latino/a/x, or Spanish origin	8.18 %
Missing	1.20 %

students attended public schools in urban, suburban, rural schools, according to NCES school data, across two states on the west coast and one state in the south of the United States. The percentage of students eligible for free- or reduced meals ranged from 10 % to 90 % with an average of 67 % (all but one school had a percentage of 57 % and above). Schools ranged in size from 151 to 2,502 students with an average of 1,027. Generally, participating schools served a high proportion of socio-economic marginalized students.

For the purpose of measurement invariance analyses, we included students who identified as male, including those who selected transgender, in the male grouping and students who identified as female, including those who selected transgender, in the female grouping. All other gender identification groups were too small to reach the *n:q* ratio of sample size to number of items needed to conduct the proposed SEM procedures—10:1 according to Kline (Kline, 2016). Kline (2016) suggests that trustworthiness of results falls when the ratio between the sample size *n* and the number of parameters to be estimated *q* falls below a 10:1 threshold. As can be seen in Table 1, White students made up 30.11 % of the sample and the rest of the sample was distributed across other race/ethnicity categories, including those who preferred not to say or those of a race/ethnicity not listed. Generally, groups were not large enough to reach the *n:q* ratio. To conduct invariance testing with Latinx students, we pooled together students identifying as Mexican, Mexican American, Chicano/a/x, Puerto Rican, Cuban, and another Latinx, Latino/a/x, or Spanish origin. Students who preferred not to say or to self-describe and those missing were not included in the invariance test. When pooled together, the size of Latinx/Latino/a/x (56.09 % of sample) and Non-Latinx/Latino/a/x students (43.91 % of sample) were relatively similar and resulted in a large enough *n:q* ratio according to Kline (2016).

2.2. Procedures

Students completed the survey as the first task in an online, self-directed learning experience designed by the researchers (see more information at https://www.mystemstory.net/overview). The survey asked students to complete the survey items for all measures before responding to demographic questions about their race, ethnicity, gender identification, and grade level. The survey required students to complete all survey items measuring motivational factors to proceed, which resulted in no missing data for measured factors. Some demographic data, such as gender identity and race, allowed students the option to skip. The study was approved by the Institutional Review Board at the research institution leading the project, and parental consent and student assent was obtained prior to any work with human subjects.

2.3. Measures

2.3.1. Self-Transcendent and Self-Oriented motives

We drew on existing literature related to this context and included existing surveys that we believed had the potential to be relevant and valid for use in this research context with diverse high school students. We used six items from Yeager et al. (2014) with three items for self-transcendent motives, which had a$\propto = 0.75$, and three items for self-oriented motives in learning, which had a $\propto = 0.70$. We revised the items to focus on science specifically. A sample self-transcendent item was *I want to learn things in science that will help me make a positive impact on the world.* A sample self-oriented item was *I want to learn science to*

Table 2
Items for Subscales Included in the Study.

Subscale Names and Complete Items
STEM Career Goal Affordances (Communal Goals)
1. I believe science contributes to the well-being of society.
2. I believe that science helps people.
3. Science is interesting, but it does not benefit society much (reverse).
4. I believe scientists aid the needy through their work.
5. Scientists are loners who do not work to help others (reverse).
6. I believe a career in science would allow me to connect with others.
STEM Career Goal Affordances (Agentic Goals)
1. A career in science would allow me to be in a position of power.
2. I believe that scientists make a lot of money.
3. Scientists often get more recognition than people in other jobs.
4. Scientists often compete with others as part of their job.
5. I believe a career in science would allow me to be my own boss.
6. I believe a career in science would allow me to master my skills.
Self-trascendent Motives for Science Learning
1. I want to learn things in science that will help me make a positive impact on the world
2. I want to gain skills in science that I can use in a job that helps others.
3. I want to become educated in science as a citizen who can contribute to society.
Self-oriented Motives for Science Learning
1. I want to learn science to expand my knowledge of the world
2. I want to learn science to become an independent thinker.
3. I want to learn science to learn more about my interests.
Science Community Objective Values (Item stem: *How much is the person in description like you?*)
1. A person who thinks it is valuable to conduct research that builds the world's scientific knowledge.
2. A person who feels discovering something new in the sciences is thrilling.
3. A person who thinks discussing new theories and ideas between scientists is important.
4. A person who thinks that scientific research can solve many of today's world challenges.
Task Value of Science (Attainment Value)
1. It is important to me to be a person who reasons scientifically.
2. Thinking scientifically is an important part of who I am.
Task Value of Science (Utility Value)
1. Science is practical for me to know.
2. Science helps me in my daily life outside of school.
Task Value of Science (Intrinsic or Interest Value)
1. I like science.
2. Science is exciting to me.
3. I enjoy the subject of science.
4. I enjoy doing science experiments.

learn more about my interests. Students responded on a scale from one to six (1 = *Not at all true*; 6 = *Completely true*). Wording of all items for all scales can be found in Table 2.

2.3.2. Communal and agentic goal affordances of science

We used six items for communal goal affordances, which had a reliability of $\propto = 0.66$, and six items for agentic goal affordances, which had a $\propto = 0.65$, based on the study by Belanger et al., (2020). We modified with language to target science specifically. Two communal items were contraindicative and required reverse coding when preparing for analyses. A sample communal item was *I believe that science helps people.* A sample agentic item was *I believe a career in science would allow me to be my own boss.* Students answered on a Likert scale from one to six (1 = *Strongly disagree;* 6 = *Strongly agree*).

2.3.3. Endorsement of scientific community objective values

Scientific community objective values endorsement is operationalized by an individual responding to four items, which had a $\propto = 0.65$ in past research. Each item describes objective values in the science community manifest in characteristics of a person that make up part of their identity (*Rate how much the person in the description is like you*; Estrada et al., 2011). These characteristics include (a) thinking it is valuable to conduct research, (b) feeling it is thrilling to discover something new in science, (c) thinking it is important for scientists to discuss new theories, and (d) thinking scientific research can solve world challenges. That approach focuses on the alignment of how a person sees themselves with those objective community values in science through a reflective process—*Is this like me?* We used four items from Estrada et al. (2011) to measure students' identifying with and endorsement of scientific community objective values. A sample item was *A person who thinks it is valuable to conduct research that builds the world's scientific knowledge.* Students responded to the question *How much is this person in the description like you* and answered on a scale from one to six (1 = *Not like me at all;* 6 = *Very much like me*).

2.3.4. Task value of science

Task value of science questions came from a study by Linnenbrink-Garcia et al., 2018. Utility value of science is how well science learning relates to or facilitates current and future goals for a person, such as everyday life or a future career. Attainment value in science learning is the value a student places on being successful in science learning tasks in relation to a person's self-schema of how they see themselves. Intrinsic or interest value in science relates to the enjoyment a person experiences from engaging in and performing a science learning task or the subjective interest a person carries. Two items measured science utility value (e.g., *science is practical for me to know*), which had a $\propto = 0.81$; two items for attainment value (e.g., *It is important to me to be a person who reasons scientifically*), which had a $\propto = 0.80$; and four items for intrinsic or interest value (e.g., *I enjoy the subject of science*), which had a $\propto = 0.91$, according to past research (Linnenbrink-Garcia et al., 2018). Students responded to those items on a Likert scale from one to six (1 = *Strongly disagree;* 6 = *Strongly agree*).

2.4. Analytic Strategy

Analyses were completed in M*Plus* version 1.31, using the MLR estimator (Muthén & Muthén, 2010). The MLR estimator provides robust standard errors for ML parameter estimates while using all available data. In the case of this study, there were no missing data for the measured motivation factors apart from some demographic variables that offered students the opportunity to skip. We followed three steps in our analyses: (a) model comparisons in confirmatory factor analysis, (b) invariance testing for the two groups with large enough samples to reach a reasonable *n:q* ratio (i.e., *n:q* > 5:1) for sample size to number of indicators, and (c) a structural regression model (Kline, 2016). We used three fit indices to help determine the fit of the model to the data: CFI, SRMR, and RMSEA. We followed Hu and Bentler (1999) combinatorial rules for model specification of SRMR > 0.06 in combination with RMSEA > 0.06 and CFI > 0.90 to identify adequate fitting models and to balance the over-rejection and under-rejection of misspecified complex models. We set 0.40 as the minimum factor loading to retain items. A priori, we recognized that invariance testing will likely require grouping sizes that result in a suboptimal *n:q* ratio and limit the number of invariance tests that we can complete. The structural regression model will provide estimates of the unique predictive strength of each factor on the proposed dependent variables. Additionally, we report the SEM-based reliability metric, *composite reliability*, for each scale, which is preferable in SEM to using Cronbach's alpha (Kline, 2016). Effect sizes were interpreted based on standardized path coefficients, using established standards for *r* (Cohen, 1992). We also used Cohen's (1992) effect size for percent of variance in each dependent variable explained by the final model (i.e., $R^2 = 0.01$ (small), $R^2 = 0.09$ (medium), and $R^2 = 0.25$ (large). Our prespecified significance threshold was alpha = 0.05. We report the results below following the sequence of research questions and related analyses.

3. Results

3.1. Research question 1: Confirmatory factor analysis

Our first research question focused on the structural validity of the model incorporating all four scales included from past research. All parameters are reported as standardized path coefficients in the narrative and tables and figures. We ran an 8-factor model with 30 items representing published subscales; these factors represented the prespecified subscales in Table 2. This model is represented in the first row under "all students." Upon inspection of indices, all three indices did not meet the a priori thresholds for adequate fit. CFI fell below threshold 0.90, SRMR was above 0.06, and RMSEA was above 0.06 (see Row 1 in Table 3). Two items for Communal Goal Affordances (Items 3 and 5) fell below the 0.40 threshold for factor loading. Item 3, which was contraindicative and reverse-coded, was *Science is interesting, but it does not benefit society much*, which reached a factor loading of $\lambda = 0.34$. Item 5, also contraindicative, was *Scientists are loners who do not work to help others* and reached $\lambda = 0.31$. Items 3 and 5 were contraindicative, which contributed to the issue of inadequate factor loading. Conceptually, item 5 was qualitatively different from the three items with strong loadings because it targeted characteristics about a scientist rather than science. Conceptually, item 3 is also problematic because it contains two different questions in one: (a) whether science is interesting or not and (b) whether it benefits society. There was no theoretical rationale for combining them as a latent factor to test in a subsequent model, so we removed them from the model. We removed those two items and the second 8-factor model improved fit substantially with fit indices falling within sufficient ranges (see Row 2 in Table 3). See Table 4 for final factor loadings.

Upon further item-level inspection, three items for Agentic Goal Affordances (Items 2,3, and 4) were below the 0.40 factor loading threshold as well: (a) *I believe that scientists make a lot of money* ($\lambda = 0.26$); (b) *Scientist often get more recognition than people in other jobs* ($\lambda = 0.31$); (c) *Scientist often compete with others as part of their job* ($\lambda = 0.28$). The weak factor loadings of those three items required further consideration. Conceptually, those three items were different from the other three and shared similarities to each other in that these perceived affordances were extrinsic factors of agency. The original measure did not distinguish between extrinsic and intrinsic forms of agency. Therefore, in the next model, we attempted to separate those three items from the agentic goal affordances measure as a separate latent factor for *extrinsic* agentic goal affordances. We identified the remaining three items as *intrinsic* goal affordances. The *intrinsic* latent factor had a composite reliability (see calculation below) of 0.64, similar to that found in past research with middle school students (see Belanger, 2020). This model would

Table 3
Goodness-of-Fit Indices for models of the 6-Factor Model.

Model	df	χ^2	SRMR	CFI	RMSEA (90 % C.I)
All Students					
8-factor CFA (30 items)	377	1014.38*	0.069	0.899	0.060 (0.056, 0.065)
8-factor CFA (28 items)	322	757.34*	0.055	0.928	0.054 (0.049, 0.059)
9-factor CFA (28 items)	314	692.54*	0.050	0.937	0.051 (0.046, 0.056)
8-factor CFA (25 items)	247	572.68*	0.046	0.944	0.053 (0.047, 0.059)
7-factor CFA (28 items)	254	613.30*	0.047	0.938	0.055 (0.049, 0.061)
Comparing Models Separating Versus Combining Self-Transcendent and Self-Oriented Motives					
Female Studets ($N = 194$)					
8-factor CFA (28 items)	247	415.11*	0.051	0.935	0.059 (0.049, 0.069)
7-factor CFA (28 items)	254	432.01*	0.052	0.931	0.061 (0.050, 0.070)
Male students ($N = 227$)					
8-factor CFA (28 items)	247	464.82*	0.057	0.926	0.062 (0.054, 0.071)
7-factor CFA (28 items)	254	492.83*	0.058	0.919	0.064 (0.056, 0.073)
Non-Latinx students ($N = 196$)					
8-factor CFA (25 items)	247	452.70*	0.049	0.929	0.065 (0.056, 0.075)
7-factor CFA (25 items)	254	483.39*	0.068	0.920	0.068 (0.059, 0.077)
Latinx students ($N = 224$)					
8-factor CFA (25 items)	247	414.00*	0.058	0.937	0.055 (0.046, 0.064)
7-factor CFA (25 items)	254	438.87*	0.059	0.931	0.057 (0.048, 0.066)

Note. SRMR = Standardized root mean square residual; CFI = Comparative fit index; RMSEA = Root mean square error of approximation. *$p < 0.05$.

allow us to test whether distinguishing between extrinsic and intrinsic goal affordances could be meaningful for practical analytic and theoretical purposes.

This new 9-factor model—represented in the third row under "All Students" in Table 3—with 28 items reached adequate fit with slight improvements in fit indices from the previous 8-factor model (see row 3 in Table 2). However, the new latent factor of extrinsic goal affordances demonstrated the lowest factor loadings, ranging from $\lambda = 0.47$–.63 and a composite reliability of 0.54, unacceptable for the goals of our study. Due to their conceptual distinctions from the intrinsic agentic goal affordances factor and their inadequate reliability as a separate latent factor, we removed those three extrinsic agentic goal affordance items. We ran a fourth model that only retained the three agentic goal affordance items that contained more intrinsic themes and had adequate factor loadings. That 8-factor model represented in Row 4 in Table 3 reached the best fit of the models yet. Notably, the strongest factor loading of $\lambda = 0.85$ for the intrinsic agentic goal affordances focused on mastery of skills through a career in science. The other two items focused on being in a position of power and being your own boss; each had a factor loading of $\lambda = 0.54$–.56. Additionally, in the science communal goal affordance factor, Item 3 was $\lambda = 0.44$, which may be related to the fact that it was the only item that asked about scientists and not science, generally. Future use of this instrument may need to include additional items about scientists or remove this one altogether. In other latent factors, factor loadings of items were relatively stable across items. Other important implications resulted from this detection of intrinsic and extrinsic aspects of agentic goal affordances in science that we consider in the discussion.

To report reliability of each factor in the final model, consistent with the factor analysis approach, we used the composite reliability or factor rho coefficient (Raykov, 2004) from Equation (1) (Kline, 2016). Composite reliability (CR) incorporates the sum of pattern coefficients for each factor $(\Sigma\lambda_i)$, the factor variance (Φ), and the sum of residuals for each variable $(\Sigma\Theta_{\delta ii})$. It is considered a better alternative to Cronbach's alpha because it directly measures whether each item loads on a single factor.

$$\frac{(\Sigma\lambda_i)^2\Phi}{(\Sigma\lambda_i)^2\Phi + \Sigma\Theta_{ii}} \tag{1}$$

The composite reliability of each latent factor was calculated using parameters from the final 8-factor model: (a) *self-transcendent motives* (CR = 0.85), (b) *self-oriented motives* (CR = 0.87), (c) *STEM communal*

Table 4
Factor Loadings for the 8-Factor Model of Motives, Goal Affordances, Science Community Values Endorsement, and Expectancy Values of Science.

Item	STM	SOM	SCG	SIAG	SCV	SUV	SAV	SIV
STM1: Science skills for positive impact on the world	0.809							
STM 2: Science skills to use in a job that helps others	0.792							
STM 3: Science skills to contribute to society	0.828							
SOM1: Science skills to expand my knowledge of world		0.840						
SOM 2: Science skills to become an independent thinker		0.805						
SOM 3: Science skills to learn more about my interests		0.831						
SCG1: Believe science contributes to society well-being			0.760					
SCG2: I believe that science helps people			0.703					
SCG3: I believe scientists aid the needy			0.432					
SCG4: I believe science would connect me with others			0.604					
SIAG1: Science would allow me a position of power				0.540				
SIAG2: Science would allow me to be my own boss				0.560				
SIAG3: Science would allow me to master my skills				0.846				
SCV1: It is valuable to conduct scientific research					0.773			
SCV2: I am someone who likes discovering new things					0.801			
SCV3: I am someone who likes discussing new theories					0.799			
SCV4: I believe scientific research can solve challenges					0.733			
SUV1: Science is practical for me to know						0.689		
SUV2: Science helps me in daily life outside school						0.666		
SAV1: It is important to me to reason scientifically							0.850	
SAV2: Thinking scientifically is important to me							0.793	
SIV1: I like science								0.913
SIV2: Science is exciting to me								0.903
SIV3: I enjoy the subject of science								0.906
SIV4: I enjoy doing science experiments								0.601

Note. STM = Self-transcendent motives in science; SOM = Self-oriented motives in science; SCG = Science communal goal affordances; SIAG = Science intrinsic agentic goal affordances; SCV = Science community objective values; SUV = Science utility value; SAV = Science attainment value; SIV = science intrinsic or interest value.

goal affordances (CR = 0.73), (d) *STEM intrinsic agentic career affordances* (CR = 0.69), (e) *science community objective values* (CR = 0.86), (f) *science utility value* (CR = 0.63), (g) *science attainment value* (CR = 0.81), and (h) *science intrinsic and interest value* (CR = 0.90). These results indicate all factors reached sufficient reliability for this exploratory model except for the three-item STEM extrinsic agentic goal affordances factor. Additionally, reliability of science utility value was low. Implications of these results are addressed in the discussion. Given the good fit of the model to three indices, we retained these factors for this exploratory analyses recognizing that improvements need to be made to the scale in future research with diverse high school students.

Before using that 8-factor model in further analyses, we conducted one final model comparison to determine whether or not to combine self-transcendent and self-oriented factors into a single factor. The latent factor correlations between self-transcendent and self-oriented goals in science was very high at $r = 0.91$, indicating that there may not be a meaningful difference between self-oriented and self-transcendent motives for this sample of diverse high school students. Rather, these students may have held perceptions about wanting to learn science or not in general terms without differentiating the desire for self-development from the desire for impact on others. As we explored in the introduction, the aim for self-improvement could be a prerequisite for motives to benefit others. We will explore this further in the discussion but explain it here to rationalize why we held the distinction in the model, using the 8-factor model, even though the correlation was so high. Though model parsimony is important, we chose to leave these two latent factors of self-transcendent and self-oriented motives in science separate (the 8-factor model) to address Research Question 3 and identify any meaningful difference in their associations with the outcomes of identifying with and valuing science. This decision comes as a tradeoff. The distinctions the data reveal can help inform more precise theory about these interrelated constructs; however, the model is less parsimonious, which can lead to misinterpretations and results that are dependent on the sample and unlikely to replicate in future studies.

As an additional exploratory test, we reduced the model to include one latent factor of science motives (the 7-factor model in Row 5 under "All Students" in Table 3). Though fit indices worsened slightly, the model fit did not change in a meaningful way from the 8-factor model for all students. As one more sensitivity test, we compared the model fit between these two models for male and female identifying students and for Latinx and Non-Latinx identifying students. For those individual groups and all students (see additional rows in Table 3), we did not see a meaningful change in model fit by combining these two factors using the common standard of a 0.01 change in CFI. However, we did see indicators of better fit for Latinx students compared to non-Latinx students for the 7-factor model combining self-transcendent and self-oriented motives into one factor, which will be inspected further in the next analyses addressing Research Question 2. The CFI for the Latinx-only model was 0.931 and 0.920 for the Non-Latinx only model—a meaningful difference greater than 0.01.

In conclusion, the results provided some support for construct validity of these scales for this sample of students with several refinements necessary: (a) eliminate contraindicative items for perceived communal goal affordances in science, (b) separate intrinsic and extrinsic dimensions of perceived agentic goal affordances in science and remove extrinsic-focused items (as they are currently conceived), (c) use caution to interpret the distinction between self-transcendent and self-oriented motives due to the high correlation, and (d) acknowledge the low reliability for the utility task value items used from past research.

3.2. Research question 2: Measurement invariance

Our second research question focused on understanding the degree to which the measurement model was structurally invariant for different groups of students. This is important to establish whether the items and scales function similarly for different groups of students. We tested measurement invariance with the two grouping variables that were large enough to compare and contained meaningful differences in their perceptions of science based on the literature—students identifying as male or female and students identifying as non-Latinx or Latinx. Results from the final sensitivity test to Research Question 1 demonstrated that model fit for male, female, Latinx, and non-Latinx students as separate groups fell just below the adequate range for one of the three indices (see RMSEA > 0.06 for all 8-factor models by group in Table 3), which may be, in part, due to the smaller sample sizes and smaller *n:q* ratio than the full sample. We chose to complete the invariance testing as an exploratory test, even though model fit did not quite reach adequate levels.

Results indicated measurement invariance between students identifying as male and students identifying as female for all three comparisons, described in Table 5. The chi-square test was not statistically significant for the comparison between metric and configural, scalar and configural, and metric and scalar models. Those results meant that a model that constrained factor loadings to be the same between the two groups (metric) was not worse in fit than the model allowing all parameters to be freely estimated (configural). The fit of the model constraining latent factor intercepts (scalar) was also not worse than the freely estimated model or model constraining factor loadings. To further inspect measurement invariance, we included alternative fit indices for measurement invariance suggested by Chen (2007) and aligned to the fit indices already used in this study. Those thresholds are a −0.01 change in CFI, paired with changes in RMSEA of 0.015 and SRMR of 0.030 for metric invariance and 0.015 for scalar invariance. Comparing the metric to configural model, we found a change of −0.001 for CFI and RMSEA and a change of 0.005 for SRMR. Comparing the scalar to configural model, we found the same changes. Those results align to the results of the chi-square test to suggest measurement invariance across the gender groups of male- and female-identifying students.

Full measurement invariance was not substantiated for models of students identifying as Latinx and students identifying as non-Latinx. The Chi-square test of the metric and configural models was not statistically significant, indicating that factor loadings did not differ substantially between both groups. Comparing the alternative fit indices between the metric and configural models, we found a change of −0.001 for CFI and RMSEA and a change of 0.003 for SRMR, supporting the chi-square results of metric invariance. However, the Chi-square test between the scalar and configural and scalar and metric models were both statistically significant, indicating variance existed in the intercepts for the latent factors for the two groups. Comparing the alternative fit indices between the scalar and configural models, we found a change of −0.004 for CFI, 0.001 for RMSEA and a change of 0.005 for SRMR, which do not support the chi-square results of scalar invariance using Chen's (2007) cutoff criteria. However, using Meade et al.'s (2008)

Table 5
Results for Invariance Testing of Measurement.

Invariance Tests	Chi-Square	*df*	*p*	Δ Chi-Square	Δ RMSEA	Δ SRMR
Female and Male						
Metric against Configural	21.03	17	0.23	−0.001	−0.001	0.005
Scalar against Configural	39.05	34	0.25	−0.001	−0.001	0.005
Scalar against Metric	17.87	17	0.40			
Latinx & Non-Latinx						
Metric against Configural	18.86	17	0.34	−0.001	−0.001	0.003
Scalar against Configural	56.12	34	0.01	−0.004	0.001	0.005
Scalar against Metric	37.64	17	0.003			

more conservative cutoff for change in CFI of −0.002 would support the Chi-square test results of scalar invariance. That result implied that latent means should not be compared across these two groups, but associations between factors can be analyzed and interpreted. In other words, the items loaded onto the latent factors in a similar way for the two groups, so item functioning appeared to be invariant. However, the lack of scalar invariance indicates one or more constructs in the model are likely functioning differently for the two groups in a systematic way. A Latinx student would not get the same score if they were a member of non-Latinx group. In this way, the meaning of agentic and communal goal affordances may be systematically different for these different groups, which warrants further item and measure development, such as through cognitive lab interviewing.

In conclusion, we found that the scales and their items included in the final measurement model from the first stage of analyses functioned similarly for students identifying as male and female and functioned differently in the estimation of intercepts but not factor loadings for students identifying as Latinx and non-Latinx.

3.3. Research question 3: Full measurement structural regression model

Finally, our third research question aimed to understand the interrelations with other motivational constructs that approximate how students identify with science through the science community objective values scale and how they value science learning through three dimensions of task value: utility value, intrinsic value, and attainment value. This analysis allowed us to distinguish the role of the goal congruity model and self-transcendent and self-oriented motives model in explaining variance in how students identify with and value science. The full measurement structural equation model provided some important findings, illustrated in Fig. 1. Correlations among predictors showed that all factors were highly correlated ($r > 0.64$). Correlations among dependent variables were generally moderate except that science utility value was not correlated with science community objective values endorsement $r = 0.10$, $p = 0.48$.

When separating out the self-transcendent motives from self-oriented motives in science, it became clear that self-transcendent motives only played a meaningful and unique role in predicting science community objective values with a path coefficient of $\beta = 0.32$, $p = 0.042$—an association with substantial theoretical alignment. Self-oriented motives in science demonstrated statistically significant path coefficients to science community objective values at $\beta = 0.49$, $p = 0.004$, science attainment value at $\beta = 0.58$, $p = 0.011$, and science intrinsic and interest value at $\beta = 0.83$, $p < 0.001$. Science communal goal affordances demonstrated a statistically significant path coefficient to science community objective value endorsement at $\beta = 0.30$, $p = 0.001$, science utility value at $\beta = 0.39$, $p = 0.003$, and science attainment value at $\beta = 0.28$, $p = 0.009$. Science intrinsic agentic goal affordances demonstrated a negative statistically significant path coefficient with science community objective values of $\beta = -0.18$, $p = 0.007$. The variance in the dependent variables explained by the predictors was high at $R^2 = 0.84$ for scientific community objective values, $R^2 = 0.68$ for science utility value, $R^2 = 0.65$ for science attainment value, and $R^2 = 0.56$ for science intrinsic or interest value.

There are several explanations that account for this high level of explained variance for scientific community objective values. First, the predictors and this dependent variable share commonalities with a focus on the value-based good that science can do for people and society more generally. This is a contrast to the intrinsic agentic goal affordances, which is focused on the individual not others and resulted in a negative predictive path coefficient. Scientific community objective values was the only dependent variable that demonstrated statistically significant

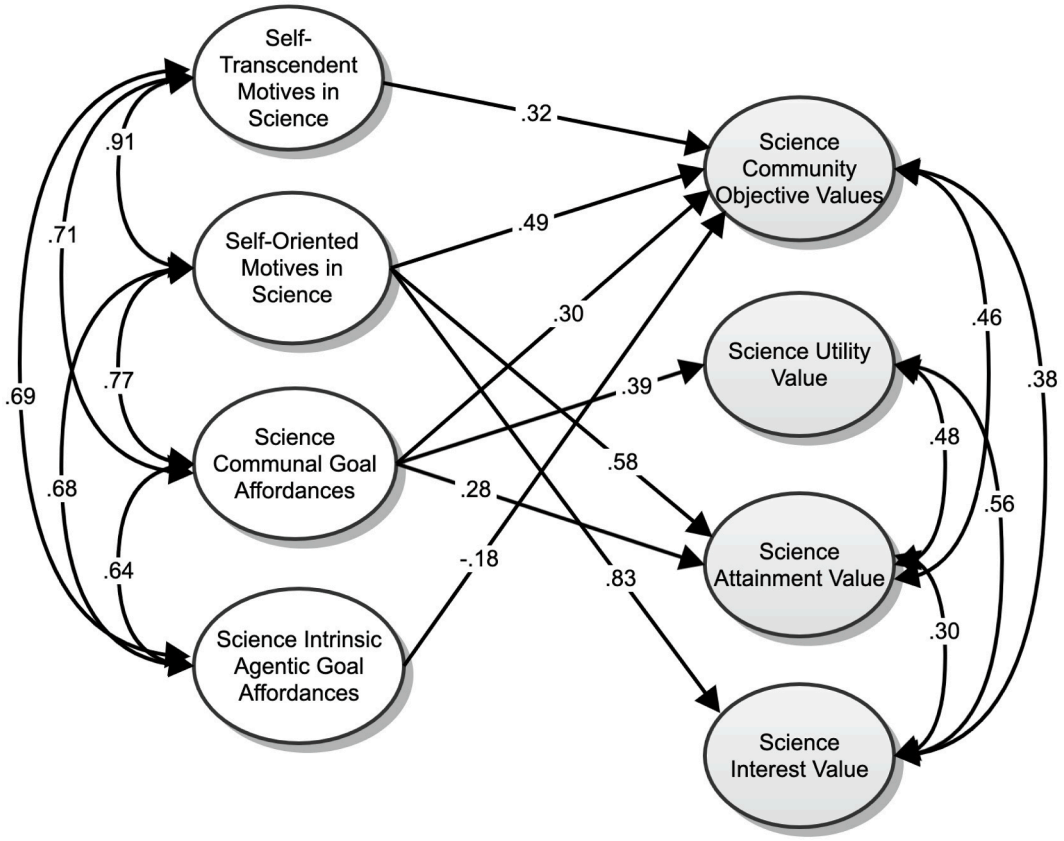


Fig. 1. Full measurement structural regression model, regressing latent factors of science community objective values endorsement and utility, attainment, and interest value of science on self-transcendent and self-oriented motives in science and science communal and agentic goal affordances. All parameters shown were statistically significant at $p < 0.05$.

paths with each predictor. Second, the medium to high correlations across most of the predictors and the conceptual similarities between the two models we tested, demonstrate how they are explaining both common and unique variance of this outcome. Third, the model demonstrated good fit across the three fit indices, so it could make sense that the R-square explained variance for some dependent variables would be quite high. This result suggests considerable conceptual overlap between the predictors, as a whole, and this particular dependent variable.

In conclusion, we found that both self-transcendent and self-oriented motives and perceived communal and agentic goal affordances explained unique variance of how students identified with science community values. Only students' self-oriented motives and perceived communal goal affordances predicted the attainment and utility value students attributed to learning science. Only self-oriented motives uniquely predicted the intrinsic and interest value students attributed to learning science.

The high correlations among some exogenous latent variables in the model suggest that multicollinearity may be an issue in the regression model. Though *Mplus* does not provide a measure of multicollinearity in SEM, past simulation research would indicate that multicollinearity may not be playing a substantial role in this model. First, Grewal et al. (2004) found that high collinearity ($r > 0.90$) between exogenous variables, as is the case in our model between self-transcendent and self-oriented motives, resulted in improper solutions when in tandem with low composite reliabilities (< 0.70), small sample sizes, and low R^2. The two factors with greatest threat for multicollinearity had high composite reliabilities, and only two latent factors in the model fell below the 0.70 threshold. In addition to being a relatively large sample, the high R^2 values suggest the multicollinearity is not likely leading to unstable estimates or an improper solution. Still, some estimates may be inflated.

4. Discussion

This study sought to understand how two interrelated motivational models function for racially and ethnically diverse high school students, with a specific focus on Latinx youth. These models attempt to distinguish between motives in science learning and goal affordances in science career paths that are more communal and self-transcendent from those that are more agentic and self-oriented. Our findings provide important clarifications for the specific context of science learning for diverse high school students that both build on and distinguish from past research. Findings also have important implications for future applications and refinements of these measures and motivational models.

4.1. Communalism and agency in students' motives in and perceptions of science

Generally, we found a distinction between students' perceived goal affordances in science that were more communal than agentic. A detail unspecified in prior use of this instrument with middle school and undergraduate students (Belanger et al., 2020), students' perceived agentic goal affordances of science appeared to distinguish between goals that were more extrinsic, such as money, recognition, and competition, and goals that were more intrinsic, such as mastery and autonomy through being one's own boss and in a position of power. That separation reflects fundamental distinctions within self-determination theory, where intrinsic goals of personal growth and community contribution differentiate from extrinsic goals focused on fame, financial success, and physical appearance (Ryan & Deci, 2000). Though the extrinsic agentic goal affordances factor did not achieve strong enough reliability to include in the model, this distinction deserves further investigation by researchers with diverse high school students. Perceptions about money and competition loaded more weakly on that factor, but perceptions about gaining recognition was stronger. What other extrinsic goals might students perceive in line with careers in science? The poor functioning of these extrinsic goals for this diverse high school sample suggests practitioners might consider de-emphasizing these goal affordances in science pathways. Additionally, motivation theorists may need to conduct qualitative research with diverse students to understand the full breadth of goal affordances in science pathways that reflect an agentic orientation.

Students' perceived intrinsic agentic goal affordances of skill mastery and being one's own boss and in a position of power were highly related to the motives in science learning that focused on self-development ($r = 0.68$); however, these goal affordances actually negatively predicted identifying with science community values. That result indicates that students who perceived these qualities and affordances in science at a higher level identified less with science community values when taking into account communal goal affordances and self-transcendent and self-oriented motives. In other words, perceptions that science careers provide those agentic factors was at odds with endorsing and identifying with science community values—evidence of a potential mismatch between student perceptions about science and identity within the field of science. This result relates to the findings from Bonilla et al. (2023) on the mismatch between students' communal goal endorsement and perceptions of opportunities to fulfill communal goals in STEM. When students' communal goal endorsement was larger than what they perceived STEM careers to offer, students had lower intentions of pursuing STEM (Bonilla et al., 2023). The negative effect of this mismatch was common for both White and Latinx students, suggesting that communal goal affordances played an overarching role for students from both cultural backgrounds.

Perceived communal goal affordances played an important role in how students identified with science community values and in the utility task value and attainment task value attributed to learning science. Additionally, both self-transcendent and self-oriented motives explained a large amount of variance in whether students identified with and endorsed scientific community values, but only self-oriented motives explained unique variance in how students valued scientific attainment and felt intrinsic interest and value in science personally. Importantly, results indicated that agentic goal affordances—operationalized in this measure to be intrinsic about gaining mastery, autonomy, and power—did not explain the task value of learning science for diverse high school students. In other words, generally feeling intrinsic motivation to learn science was a more powerful predictor than if students perceived career affordances in science toward agentic goals. That result resonates with findings from Vansteenkiste et al. (2006), illustrating how intrinsic goal framing can benefit learners more than extrinsic goal framing with higher engagement, conceptual understanding, and persistence in learning. Also, for this sample, communal goal affordances and self-transcendent motives correlated highly with students' self-oriented motives to learn science. That result suggests educators' intrinsic goal framing in science for diverse students should integrate a communal orientation (Vansteenkiste et al., 2006).

4.2. How perceptions shape how students identify with and value science

Apart from self-oriented motives, how much students perceived communal affordances of a career in science was the only other factor that played a role in how students identified with science community values and personally valued learning science. This connection reflects findings across studies at the middle school and undergraduate levels (Belanger et al., 2020; Diekman & Benson-Greenwald, 2018). Framing motivation through a communal lens for diverse adolescents may be important given the importance of social relationships to their well-being and healthy development (Dahl et al., 2018). Moreover, emphasizing this communal orientation aligns well with the urgent call to integrate multicultural perspectives into educational psychology and practice in the classroom (Usher et al., 2019). These results suggest the goal congruity perspective (Diekman & Benson-Greenwald, 2018) may fit well into the high school science context to help understand how and

why students identify with and value science.

In dissecting results further, communal goals played a role in all outcomes except for intrinsic and interest value of science, which makes sense given the clear alignment between that outcome and a self-development orientation (i.e., self-oriented motives). Perceiving communal goal affordances in science predicted students' utility and attainment value as well as endorsement of science community values. Future interventions focused on motivating students in science may need to consider carefully how to draw on this communal dimension. For instance, Hulleman and Harackiewicz (2009) found that asking students to write about the usefulness of what they were learning demonstrated a positive effect on STEM-related interest, course-taking, and achievement in secondary and post-secondary contexts. Interventions focused on task value appear to be especially beneficial for traditionally underrepresented students in STEM fields (Harackiewicz et al., 2016) and those who had lower prior performance in STEM coursework (Linnenbrink-Garcia et al., 2018).

Integrating our results into prior research suggests that linking students' interests in science to explicit communal benefits of science could benefit student motivation to pursue and persist in science. For instance, Linnenbrink-Garcia et al. (2018) included a specific focus on the real-world application of basic biology and chemistry principles showing explicitly how these principles led to the creation of drug treatments to treat common diseases such as cancer. Research has also shown that although preservice teachers perceive STEM fields as being less likely to fulfill communal goals than non-STEM fields, science lesson plans that integrate communal aspects were perceived as more likely to foster greater student engagement (Fuesting et al., 2021).

Classroom practitioners could ask students to identify science-related issues that interest them, from global warming to cancer research, and use mind-mapping techniques to reflect on possible connections between classroom content and those issues. Further, to integrate these personal interests and values into the communal goals and motives in science, teachers can ask students to reflect on how what they learn can contribute to the values in science of improving the world, benefiting society, and helping people in need. Continual reflection on these connections and possibilities may be a powerful approach, no matter the content. Additionally, this kind of reflection draws on students' existing knowledge and cultural values and experiences. Future research should investigate if and how the level of specificity in connections between communal goal affordances and students' intrinsic interests matters. The results of this current study suggest that self-oriented motives of mastery and knowledge in science may play a primary role in how students identify with and value science, but how students perceive the communal goal affordances of science plays a unique role above and beyond those self-development motives.

4.3. Students' perceptions of agency in science careers

In the study by Belanger et al. (2020), agentic goal affordances of a career in science were framed with intrinsic and extrinsic factors in their research with middle school students, specifically. The low reliability found in that study and replicated in our results suggests that perceived agentic affordances did not appear to matter as much as communal affordances and could actually be a deterrent to identifying with the field of science. This framing of agency as being in a position of power, being one's own boss, gaining recognition, and making money does not necessarily align with Bandura's framing of human agency through social cognitive theory (Bandura, 1986, 2018). For the intrinsic goal affordance factor our model identified, the item with the strongest factor loading focused on gaining mastery, which reflects an aspect of self-efficacy—the cornerstone to Bandura's framing of agency. Importantly, this framing focused more attention on the collective aspects of agency in defining and motivating purpose and engagement in life. In this way, the communal orientation in goal congruity theory operationalized in these surveys may relate as much or more to agency for some students than some of the factors of self-focused influence, recognition, and power. Results from this study suggest that conceptualizing, labeling, and operationalizing agency in this context likely needs further consideration and clarification. Our results also suggest the salience and relevance of these constructs might differ as a function of developmental stage—what is important in adolescence is likely different than early adulthood. Postsecondary learners might be better able (or more motivated) to see the link between their goals and motives and the affordances offered by different types of fields, compared to secondary students.

4.4. Limitations and future considerations of this integrated model

The cultural invariance of this integrated model for Latinx and non-Latinx students is an important finding, indicating that the meaning of and distinction between agentic and communal goals and motives in science is likely unique for Latinx students in substantial ways. Though equivalence in factor loadings (metric invariance) between the two groups suggests specific items functioned similarly, there was a lack of scalar invariance indicating a Latinx student would have different latent means if they were a member of a non-Latinx group, and vice versa. The collectivist orientation in Latinx culture may present a cultural mismatch and complexity for students when faced with the dominant perceptions of individualism in science (Bonilla et al., 2023). For instance, a Latinx student, by nature of their cultural experience and implicit values, may weigh communal goals and motives against agentic goals and motives in a different way because they perceive agentic motives and goals to be in service of communal ones. This grouping may not differentiate as neatly between these constructs as the model and existing theory proposes. This difference emphasizes the need for research on cultural specificity of both communal and agentic goals and motives. In their current forms, group comparisons should not be conducted—modeling should be limited to identifying associations between factors, such as in this current study. Similar issues might arise with other ethnically or culturally minoritized groups, so researchers should proceed with caution before assuming the scales function similarly across and within groups. Therefore, in these current analyses, it would not be appropriate to include race/ethnicity as a covariate or conduct mean comparisons between Latinx and non-Latinx students.

This study is correlational, so predictive relations in the structural regression model need to be tested in a longitudinal design to understand how these factors have direct or indirect effects across time and for students' actual behaviors and outcomes in science. Additionally, future work with large samples of diverse racial and ethnic groups will permit a better understanding of how these factors function within specific sociocultural contexts. Research on how diverse high school students respond to different modeling and messaging of communal and agentic motives and goals in science will help to understand how these factors relate to each other and evolve. This current study was limited in the possible outcomes, so further research on students' specific intentions and actual pursuit of science pathways will be important. Additionally, we were not able to collect data on students' prior achievement, coursework, or aspirations in science, which could enrich the description of the sample and interpretations of the findings. Finally, researchers should consider what additional items might be important to include in scales targeting communal and agentic goal affordances for science for the sample of interest.

5. Conclusion

Results from this study highlight the importance of considering students' communal and agentic goals and motives in learning science and pursuing career pathways in science. Perceived communal goal affordances and self-oriented, intrinsic motives each play a strong role in how students in this diverse high school sample identified with science community values and how they valued science learning. Efforts to

diversify pathways toward careers in science should consider if and how messaging, narratives, and opportunities reflect the communal dimension of positive impact on the world and the agentic dimensions of self-development that can lead to the positions of influence and action to actualize those contributions.

CRediT authorship contribution statement

Ross C. Anderson: Writing – review & editing, Writing – original draft, Visualization, Software, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Jenefer Husman:** Writing – review & editing, Methodology, Investigation, Funding acquisition, Conceptualization. **Matthew H. Kim:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Ed Madison:** Resources, Project administration, Investigation, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cedpsych.2024.102320.

Data availability

Data will be made available on request.

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