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Using Choice and Utility Value to Promote Interest: Stimulating Situational Interest in a Lesson and Fostering the Development of Interest in Statistics

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What can educators do to trigger and maintain their students' interest during a class or lecture, and how can they help students develop an interest that persists when instruction ends? In the present research, we conducted a series of seven laboratory experiments (total $N = 2{,}019$), in which undergraduate students learned about statistics. In these studies, we tested two manipulations, each theorized to promote a different phase of interest development: (a) we provided students with meaningful choices as they learned, hypothesized to trigger and maintain situational interest, and (b) we presented students with information about the utility value (i.e., usefulness) of the topic for commonly valued goals, an instructional practice theorized to promote the development of longer term interest. An internal meta-analysis of these experiments showed that both manipulations independently promoted situational interest in the topic, but only the choice manipulation was effective at promoting self-reported attention and engagement during the session. In contrast, only the utility value manipulation led students to request resources about statistics (e.g., a list of statistics courses at the university, information about a data-science major), a behavioral indicator of interest in the topic that extended beyond the session. This evidence suggests that beliefs about the usefulness of academic content for personal goals can play an important and unique role in the development of enduring interest, and it points to the promise of multifaceted instructional approaches that can catch and hold students' interest via multiple, distinct mechanisms.

Educational Impact and Implications Statement

We conducted a series of seven laboratory experiments in which college students learned about statistics, and we examined two different teaching practices that might help students develop an interest in the material: (a) We provided participants with meaningful choices as they learned and (b) presented them with information about the utility of the topic for various careers. Although both practices promoted interest in statistics, only the provision of choice enhanced interest in the statistics lesson itself, and only the information about utility value led students to seek further resources about statistics on campus, indicating the beginnings of a more stable interest that extended beyond the learning situation. This evidence suggests that beliefs about the usefulness of academic content for valued personal goals can play an important and unique role in the development of enduring interest, and it points to the promise of combining teaching practices to catch and hold students' interest.

Keywords: interest, interest development, motivation, utility value, choice

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How do students make academic choices? What leads a college student to choose a particular major or decide to change majors? Why do some algebra students enthusiastically participate in class and go above and beyond what is asked of them, whereas other students are disengaged during lessons, neglect homework assignments, and even skip class altogether? These questions are important not only for psychologists who wish to understand human motivation, but also for educators who want their students to engage in learning, for policy makers who aim to grow and diversify various fields, and for the many students who feel like school is a waste of their time.

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The answers to these questions vary widely for different students, but for many, they revolve around interest. When students are interested in particular courses or topics, they tend to engage with them voluntarily and happily, persisting even when obstacles arise (Renninger & Hidi, 2016). This is the type of motivation that educators hope to inspire, but how can we encourage its development? The present research focuses on two educational practices that should influence students' interest in a particular content area: (a) helping students understand that learning a topic is useful for important personal goals, and (b) providing students with meaningful choices as they learn. These two practices are theorized to promote the development of interest through different processes and may be effective for different groups of students. Accordingly, in the present research, we test the independent and combined effects of these practices on different types of interest, both to test theoretical assumptions about the emergence and development of interest and to evaluate practical interventions to help a larger number of students develop an interest in the content of their courses.

Theoretical Background

Hidi and Renninger (2006) proposed a four-phase model of how a person's interest in a particular topic or content develops over time. In this model, interest is both a cognitive and affective state and a motivational variable (Renninger & Hidi, 2016). Interest is content-specific, which is to say that an individual cannot be "interested" in general, they must be interested in a particular aspect of the environment (e.g., a topic or task; Hidi & Renninger, 2006). Critically, the four-phase model differentiates between two main kinds of interest: situational (Phases 1 and 2 of the model) and individual interest (Phases 3 and 4).

Situational interest is a relatively transient psychological state that arises in response to environmental stimuli. This state consists of alertness, concentration, and affect (Hidi & Renninger, 2006; Schiefele, 2009). For example, as 10th-grade chemistry students fixate on a flashy chemical reaction at the start of a unit on combustion, they are experiencing situational interest in the lesson itself, and possibly chemistry as well. Whereas triggered situational interest (Phase 1) is thought to primarily involve emotions and cognitions that facilitate attention and engagement in a particular situation, maintained situational interest (Phase 2) is thought to involve positive emotions that are related to content (e.g., enjoyment or excitement) and emerging beliefs that content is important or meaningful (Linnenbrink-Garcia et al., 2010; Schiefele, 1991). Thus, situational interest can motivate a student to engage with a lesson and its contents for a short period of time (Renninger, 2000; Schiefele, 2009). As their names imply, triggered and maintained situational interests are typically confined to a specific situation, fading when the environment no longer supports them, although they can strengthen under the right circumstances (Linnenbrink-Garcia et al., 2010).

Over time, an individual can develop a more well-established, "individual" interest in a topic that lasts beyond a particular situation. In the four-phase model, Phase 3 is emerging individual interest, and Phase 4 is well-developed individual interest. In these later two phases, interest becomes an internalized motivational variable (Renninger & Hidi, 2016). A person with an individual interest in a topic is less dependent on situational cues or supports to trigger or maintain their interest. Instead, they will be intrinsically motivated to pursue the relevant topic or task, choosing to reengage with it over time (Hidi & Renninger, 2006; O'Keefe et al., 2017; Renninger, 2000).

Promoting Interest

In the four-phase model, individuals do not skip phases of interest development: interest must be triggered before it can be maintained, and it must be maintained before it can become internalized and persist beyond a situation (Hidi & Renninger, 2006). Accordingly, it is crucial to think about instructional practices that can trigger situational interest in new topics and practices that can help students at different phases of interest development advance to the next phase. To capture students' attention and thereby promote triggered situational interest, teachers can capitalize on perceptual properties like complexity and novelty (Berlyne, 1958). As reviewed by Renninger et al. (2019), research has identified many teaching practices that can trigger students' situational interest in a lesson. These practices include hands-on activities, group work, use of new or varied instructional methods and materials, use of materials that evoke emotional reactions, providing challenges, giving students an opportunity to role play (e.g., as scientists), and allowing students to take ownership or make personal connections during a lesson (Renninger et al., 2019).

Instructional conditions that allow students to make choices should also facilitate situational interest. According to self-determination theory, autonomy is a basic psychological need, and students will disengage from learning experiences when this need is thwarted (Ryan & Deci, 2000). Choice can be a powerful way to support the experience of autonomy. When students are allowed to make choices about their learning experiences (e.g., a book that they will read, a piece of music they will learn, or a worksheet that they will complete), it can trigger situational interest and promote positive affect and engagement with the activity. In addition, the provision of choice in a lesson can help students align a topic with their existing, personal interests. For example, a runner should experience greater situational interest in a math lesson on unit conversions when they have chosen practice problems about race times and pacing.

There has been less work examining the development of interest from triggered situational interest to more-enduring phases. However, expectancy-value theory (Eccles & Wigfield, 2020; Wigfield & Eccles, 2000) can be utilized to think about how interest in a task or topic can be maintained and internalized. According to this theory, students choose to pursue academic tasks that they (a) expect to succeed in, and (b) find personally valuable. Within the expectancy-value framework, there are four subjective task values: perceived properties of a task that influence whether students find it valuable.

First, a task is said to have intrinsic value if students view it as enjoyable or interesting. Second, a task can have utility value if students believe that it is useful for achieving their goals. Third, a task can have attainment value if students come to view the attainment of the task as part of their identities (e.g., self-identified "math people" see themselves as people who take and succeed in math courses). Eccles et al. (1983) also identify a negative task value, cost, which represents negative beliefs about the task (such as lost alternative opportunities).

When it comes to promoting interest that might extend beyond a particular situation, perceptions of value are theorized to play an important role (Harackiewicz & Hulleman, 2010; Harackiewicz et al., 2014; Hidi & Renninger, 2006; Hulleman et al., 2010; Mitchell, 1993; Priniski et al., 2018). Dewey (1913) argued that a "genuine interest" in a topic emerges through an "identification" process, in which an individual comes to believe that engaging with the topic will confirm a valued aspect of the self. If this is the case,

instructional practices that help students see the utility value of course material for important personal goals should promote identification and interest. Mitchell (1993) drew upon Dewey's ideas about identification to argue that students will experience maintained interest in a topic when they believe that it can empower them to achieve their personal goals. If students choose to take a chemistry class because it helps them understand climate change or another topic that is important to them, they will likely maintain their interest in chemistry even in the absence of flashy demonstrations (Durik & Harackiewicz, 2007). Longitudinal and cross-sectional studies support this idea; students' utility value beliefs predict maintained situational interest (Hulleman et al., 2008), as well as related outcomes like intentions and course-taking behavior (Meece et al., 1990; Updegraff et al., 1996).

To be clear, not all types of utility value will help students develop individual interest in academic content. For instance, when a teacher tells students to pay attention because what they are teaching will be on the next exam, the teacher is communicating the usefulness of the material in a way that purely appeals to extrinsic motivation. This type of utility value is unlikely to promote interest in the topic, and could even come across as coercive, threatening students' sense of autonomy and undermining their interest in the lesson and its contents. However, if instructors can help students see the utility value of course content for important personal goals, students should progress from triggered situational interest to subsequent phases of interest development in which attention is maintained, positive emotions are experienced, tasks and topics are valued, and students begin to voluntarily reengage with course content without a situational trigger.

Whereas well-developed individual interest, the final phase of the four-phase model, is thought to emerge gradually as an individual independently engages with a topic or task over time (Hidi & Renninger, 2006), the first three phases of the model are important and reasonable targets for instructors. By triggering situational interest, instructors can facilitate enthusiastic participation, an outcome that should improve students' experiences and learning and promote maintained situational interest. By giving students opportunities to think about the value of course content for important personal goals, teachers may support the maintenance of situational interest and even create conditions that bring about the development of emerging individual interest.

The four phases of interest development are theorized to involve different processes, suggesting that educators may best support their students' interest development by combining different instructional practices that promote different phases of interest. Practices that engage students' attention should be most effective at triggering situational interest; practices that help students experience positive emotions and value what they are learning should help maintain situational interest, and practices that allow students to find value and meaning in what they are learning should be critical for supporting the development of emerging individual interest.

In prior research related to the development of interest, a number of teaching practices have been experimentally tested, including the use of visually stimulating materials (Durik & Harackiewicz, 2007) and the use of digital materials personalized to students' interests (Bernacki et al., 2021; Walkington, 2013). However, the two teaching practices that have been experimentally tested most extensively are (a) providing students with choices and (b) emphasizing the utility value of academic content for important personal goals (Patall et al., 2008; Rosenzweig et al., 2022). One helpful feature of both practices is that they can be integrated into all kinds of existing instruction (e.g., art, math, science, or history) with relatively minimal modifications to existing lessons. Instructors do not need graphic design skills or technological support to implement these practices in their courses, and they do not need to make curricular overhauls (Asher et al., 2023).

These two teaching practices should promote different phases of interest development. Whereas providing students with choices should support feelings of autonomy and promote triggered and maintained situational interest, manipulations that emphasize the personal utility value of academic content should promote the second and third phases of interest development (i.e., maintained situational and emerging individual interest). Previously, researchers have tested these manipulations separately, examining their consequences for either triggered or maintained situational interest. This work serves as the experimental background for the present research.

Choice Manipulations

In studies of academic choice, students are provided with opportunities to determine aspects of their educational experiences (Patall et al., 2008). Across studies, some of these choices have been instructionally relevant (e.g., about the topic of a lesson, or the theme for a writing assignment), whereas others have concerned peripheral aspects of the learning experience (e.g., the design of an avatar in an online learning environment, or the color of the pen that a participant uses). Although instructionally relevant choices can tap into students' existing interests and goals, irrelevant choices still provide students with a sense of autonomy and can help them express their identities (Patall et al., 2008; Reber et al., 2018; Ryan & Deci, 2000). Thus, there is reason to expect that students can experience triggered situational interest if given either type of choice.

Research supports the link between choice and situational interest. For example, in a study of instructionally irrelevant choices, Cordova and Lepper (1996) manipulated whether students could select their in-game name, the icon that represented them, and the name of their opponent. Compared to students who could not choose these features, those who were given choice reported that they enjoyed the computer game more, demonstrated higher levels of task involvement with the game on several behavioral measures, and performed better during the session.

In studies of instructionally relevant choices, Høgheim and Reber (2015, 2017) manipulated whether students could choose the examples used in mathematical word problems, rather than having them assigned. In their initial (2015) study, this type of choice increased students' triggered and maintained situational interest in the learning material and their self-reported effort. In a larger follow-up study, Høgheim and Reber (2017) found an overall effect of an example choice manipulation on triggered situational interest in the material, but no effects on maintained situational interest or effort.

In addition to the evidence from the studies discussed above, systematic reviews support the connection between the provision of choice and triggered situational interest and engagement during a lesson. In a meta-analysis of 41 studies, Patall et al. (2008) found that choice manipulations consistently affected participants' self-reported enjoyment, $d = 0.36$, their interest, $d = 0.18$, and their engagement in activities (indexed with measures such as time on task), $d = 0.30$. Taken together, these studies suggest that when students are provided with choices, this practice can trigger situational interest in topics and change how participants engage with academic work.

Utility Value Manipulations

In laboratory studies, researchers have tested two general strategies to help students realize and appreciate the utility value of specific academic content: (a) directly communicated utility value (D-UV) presentations, in which students are given information about the usefulness of the content, and (b) self-generated utility value writing activities, in which students are asked to reflect about the content's personal usefulness. Most of these studies have used a paradigm in which students are taught a technique for performing rapid mental multiplication of two-digit numbers, first developed by Barron and Harackiewicz (2001) as a means of studying motivation and learning in a laboratory setting.

Durik and Harackiewicz (2007) used a presentation to directly communicate how knowledge of the multiplication technique could be useful for topics like personal banking and math coursework. This manipulation promoted beliefs that the technique was useful, and it also increased task involvement and maintained situational interest in the multiplication technique for participants who entered the session with higher levels of initial interest. However, Durik, Shechter, et al. (2015) later raised the possibility that confidence, not interest, may be the more important moderator of the manipulation.

Confident students might be more motivated by a presentation about utility value because a skill like the multiplication technique can only be seen as useful to the extent that someone believes they can perform it. Furthermore, D-UV might even be threatening for less confident students (Durik, Hulleman, et al., 2015; Durik, Shechter, et al., 2015). Durik, Shechter, et al. (2015; Study 1) found evidence for this hypothesis when they tested both initial interest and confidence as moderators in the same regression model. In this analysis, the utility value manipulation increased maintained situational interest and performance for confident students but decreased these outcomes for less confident students.

Hulleman et al. (2010) used the same mental math paradigm to test a self-generated approach for promoting utility value. In this study, participants who were asked to reflect about the usefulness of the multiplication technique reported stronger perceptions of the technique's usefulness, greater feelings of maintained situational interest in the technique, and were more likely to agree when asked if they might use the technique in the future. In contrast to the directly communicated manipulation, the benefits of the self-generated utility value intervention were largest for those with lower levels of initial confidence. In a study that examined both types of utility value manipulations together, Canning and Harackiewicz (2015) replicated that D-UV information undermined performance and situational interest for less-confident participants, but that self-generated utility had positive effects for this group.

Finally, Hecht et al. (2021) tested utility value manipulations with two studies in a new paradigm in which participants learned about the biology of fungi. In these studies, a D-UV manipulation taught participants about the usefulness of fungi for beer making, baking, and gardening. In Study 1, this manipulation promoted beliefs about the usefulness of learning about fungi, with larger effects for students who reported higher levels of interest at baseline. The manipulation also promoted triggered situational interest in the lesson, and it increased performance on an end-of-session test for those with higher levels of initial interest. In Study 2, a version of the manipulation in which students reflected on usefulness for the distant future showed benefits for participants with higher levels of initial interest: this group reported higher levels of situational interest in the lesson and stronger intentions to use knowledge about fungi in the future.

Considered together, what do these studies tell us about the effects of utility value manipulations on interest development? First, they illustrate the challenges of convincing students that academic content is useful. In the studies reported above, most effects on beliefs about utility value were moderated—the utility value manipulations rarely worked for everyone. Directly communicated approaches typically worked better for more confident or more interested students than they did for less confident or less interested students. Self-generated or combined approaches, on the other hand, showed more promise for less-confident students than they did for more confident students.

Second, when utility value manipulations increased perceptions of utility value (either overall or for a subgroup), researchers typically found a corresponding benefit on measures of maintained situational interest in the content. In addition, two studies reported positive effects of utility value manipulations on participants' intentions to use what they had learned in the future (Hecht et al., 2021; Hulleman et al., 2010). By showing that beliefs about utility value are linked to maintained situational interest and intentions to reengage with content, these studies provide evidence that utility value may play a role in moving students past triggered situational interest toward more advanced phases of interest development.

Finally, it should be mentioned that all studies except Hecht et al. (2021) took place in the same context: a lab study paradigm in which participants were taught a mental multiplication technique. The specific patterns of effects in these studies may reflect characteristics of the mental math topic. Specifically, baseline confidence may have emerged as a particularly important moderator in this context because the mental math paradigm teaches participants a skill that requires high levels of mastery to be useful; a person must be both very accurate and fast to forgo the use of a calculator and benefit from a mental math technique. This point was raised by Hecht et al. (2021) as they discussed why confidence may have played a smaller role when students were learning about the biology of fungus, a topic that might be perceived as useful even without high levels of mastery.

Promoting Interest Development: Current Evidence and Next Steps

The studies reviewed above demonstrate that choice and utility value manipulations can support interest development. They also suggest that these manipulations may affect different types of interest and have different downstream consequences. Choice manipulations consistently triggered situational interest in lessons. Students who were given choices about their learning were more likely to report that lessons grabbed and held their attention (e.g., Cordova & Lepper, 1996; Høgheim & Reber, 2015). As for downstream consequences, when choice manipulations triggered situational interest, they also tended to affect measures of moment-to-moment engagement in learning sessions (e.g., self-reported task involvement and effort), and they sometimes affected performance as well.

In contrast, few laboratory studies of utility value manipulations reported effects on triggered situational interest or engagement. Instead, these studies focused on maintained situational interest as a dependent variable, finding that D-UV promoted maintained situational interest for participants with higher levels of baseline interest or confidence (or both), and self-generated utility value raised

maintained situational interest for less confident students. Whereas few directly communicated manipulations influenced learning (as assessed by test performance), self-generated manipulations often did.

The Need to Assess Emerging Individual Interest

In nearly every study reported above, researchers focused exclusively on the initial two phases of interest development: triggered and maintained situational interest, with different emphases. In studies of utility value manipulations, researchers did not examine whether beliefs about usefulness could promote triggered situational interest or engagement in a learning session. In contrast, studies of choice manipulations often reported effects on these outcomes, but they did not often measure maintained situational interest or emerging individual interest in academic content, the type of interest that might continue beyond a session.

Given that choice manipulations are situational by design and intended to change a student's experience during a learning session, it makes sense to first examine effects on situational outcomes rather than longer term interest. Utility value manipulations, on the other hand, are far less situational. When students learn or write about how academic content might relate to their lives and goals, it is reasonable to expect that this might promote interest that goes beyond the learning session (Dewey, 1913; Hidi & Renninger, 2006; Mitchell, 1993).

However, the most common laboratory utility value paradigm (in which participants learn a mental multiplication technique) has limited generalizability to college-level academics (Hecht et al., 2021). Moreover, connections to other activities or opportunities for deeper involvement are difficult to establish in this laboratory paradigm, making it difficult to assess emerging individual interest. In an educational setting, a lecture or lesson is typically embedded in a course or curriculum and could therefore promote interest in a broader topic, but this is not the case with the stand-alone mental math paradigm. Thus, a new laboratory paradigm is needed to explore the effects of instructional practices that target the first three phases of interest development. This paradigm must afford measurement not only of students' triggered and maintained situational interest in a topic but also their authentic, longer term intentions to reengage with the topic (i.e., emerging individual interest). In the present research, we developed a new laboratory paradigm to test the effects of utility value and choice manipulations on the first three phases of interest development. This research was guided by the theoretical model shown in Figure 1.

The Present Research

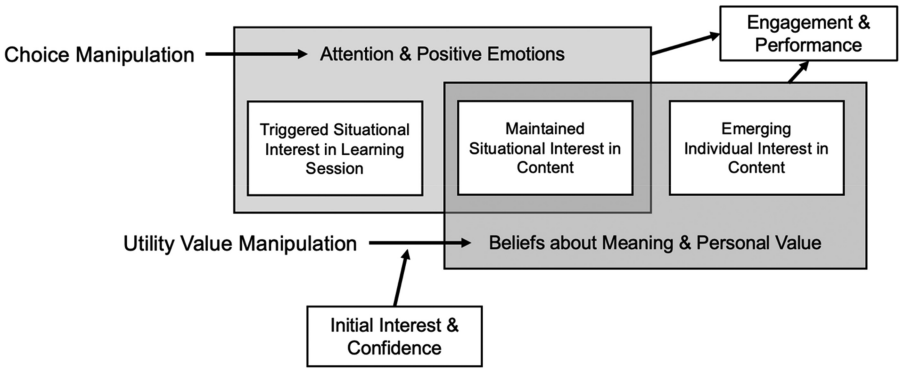
With the goals of (a) reliably and powerfully manipulating participants' beliefs about the usefulness of academic content, (b) creating a context in which we could test educational practices such as D-UV and the provision of choice, and (c) assessing not only situational interest but also emerging individual interest, we developed a new laboratory paradigm built around a new topic: multiple regression. In this paradigm, all participants watch an instructional video that introduces the topic of linear regression and teaches them how to conduct and interpret analyses involving one continuous predictor and one dichotomous predictor.

Because career exploration is a valued personal goal for many college students (Perez et al., 2014), and because regression is a genuinely useful topic for many careers, we reasoned that a utility value manipulation could be powerful in this context for promoting emerging individual interest. In addition, statistical analysis is a growing focus at the university where this research was conducted (the university introduced a new "data science" major in 2020), so a regression-based paradigm provided us with the opportunity to examine the effects on emerging individual interest by assessing whether students would want to learn more about on-campus statistics opportunities.

Using the multiple regression paradigm, we conducted seven laboratory experiments that tested and compared the effects of utility value and choice manipulations on the first three phases of interest development. The individual studies were sequentially designed to replicate and build upon one another with independent (i.e., nonoverlapping) samples, using the same paradigm and testing the same outcomes throughout.

Rather than reporting each study separately, we meta-analyze the studies to enable more powerful and precise tests of our research questions. If we were to report analyses of individual studies, one at a time, inconsistent findings would surely arise (i.e., p values that might be significant in larger studies and nonsignificant in smaller studies). By taking the extra step to formally synthesize these results, a meta-analysis can provide statistical power and clarity. This should be particularly important for research questions involving moderators, because tests of interactions are particularly underpowered and therefore unreliable in smaller samples (McClelland & Judd, 1993; Sommet et al., 2023). In addition, by meta-analyzing the effects of utility value and choice manipulations,

Figure 1
Theoretical Model for the Current Research



we can answer research questions about the relative effects of each type of manipulation on different phases of interest development. For example, we can ask which kind of manipulation is more effective at promoting engagement and triggered situational interest, and which kind is more effective at promoting later phases of interest development. We begin with a description of shared procedures, manipulations, and measures. Then we provide an overview of the individual studies, discussing how they evolved and differ.

Method

Participants

This study was approved by the Institutional Review Board at the University of Wisconsin–Madison. Table 1 displays an overview of demographic information for participants in each study. Participants were undergraduates enrolled in an introductory psychology course at a large Midwestern university. In total, Studies 1–7 consisted of 2,019 participants, 59.2% women, 40.5% men, and <1% nonbinary. In terms of race/ethnicity, 74.2% of participants identified as White, 20.8% as Asian, 8% as Hispanic, 3.6% as Black, and 1% as belonging to an indigenous group. The sample consisted of mostly first-year college students (84% of participants, average age = 18.7 years). All participants completed the studies for course credit.

Standard Procedures

The following procedures were held constant across all seven studies. Participants were run individually by an experimenter who greeted them, gave a brief overview of the study, and set them up with a Qualtrics session. The remainder of the study was delivered over the computer. Due to the COVID-19 pandemic, Studies 2 and 3 were conducted over video sessions; all other studies were conducted in person.

The general procedure for Studies 1–7 is summarized in Figure 2. Participants first completed a baseline questionnaire that assessed their initial confidence in math and interest in statistics. Next, participants were exposed to experimental manipulations, which varied by study, before watching a recorded lesson about multiple regression. In all studies, the lesson was built around several research topics as it taught the basics of linear regression. Specifically, the lesson covered how to interpret the output from regression software to understand relationships between variables, make predictions, and answer research questions. Details about the lesson are reported in the online supplemental materials.

Next, participants filled out a questionnaire assessing their triggered situational interest in the lesson and their feelings of maintained situational interest in regression. We also included a self-reported measure of distraction during the regression lesson as an indicator of participants' behavioral and cognitive engagement (Fredricks et al., 2004). After completing these self-report measures, participants in all studies completed a behavioral measure of emerging individual interest in statistics. Specifically, participants were asked if they wanted to request resources related to regression and statistics opportunities on campus (e.g., a list of relevant courses, information about a new data science major). This measure was designed to capture voluntary reengagement with statistics that extended beyond the situation (Hidi & Renninger, 2006). Finally, participants completed a 12-min timed regression test on concepts from the lesson.

Measures

Table 2 displays sample items and the reliability of each scale. Table 3 displays average correlations between measures. The online supplemental materials contain text and anchors for all items, as well as descriptive statistics, alphas, and correlation matrices for all measures in each individual study.

Measures of baseline interest and confidence were adapted from Durik, Shechter, et al. (2015) and Hecht et al. (2021). All interest-related measures were adapted from Linnenbrink-Garcia et al. (2010), Durik, Shechter, et al. (2015), and Hecht et al. (2021). It is important to note that we assessed triggered situational interest in the learning session, and maintained situational interest in regression, the session's topic. The measure of perceived autonomy was adapted from the Intrinsic Motivation Inventory (Ryan, 1982). For the behavioral indicator of emerging individual interest in statistics, we recorded whether participants requested information about regression resources (a binary outcome). End-of-session tests were scored on a 1–21 scale using a rubric.

Manipulations in Each Study and Preliminary Results

D-UV Manipulation

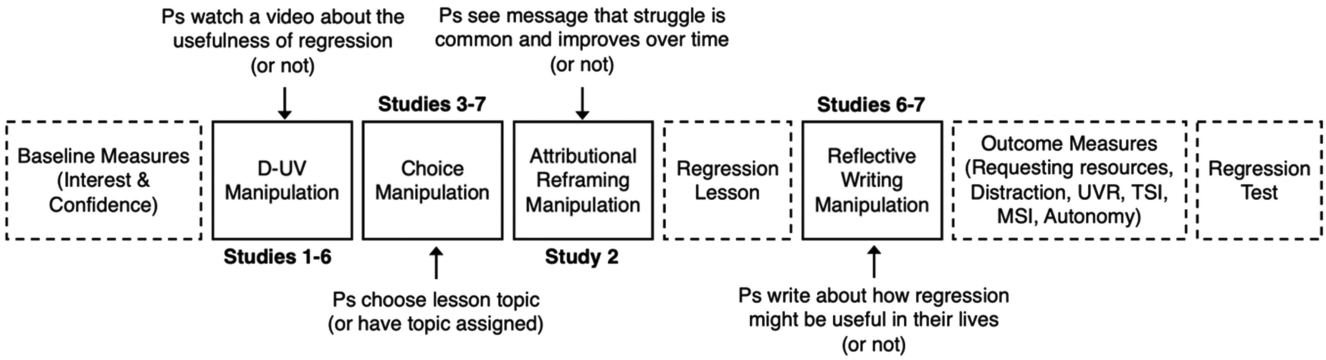
In Study 1 ($N = 115$), we piloted the new, D-UV manipulation, testing it against a control condition in a two-cell design. This manipulation took place before the regression lesson, and it consisted of an approximately 3-min video in which an instructor explains how linear regression has become a useful skill in many careers. Specifically, the instructor discusses how linear regression can be useful in medicine (for evaluating treatments and examining the causes of disease), politics (for forecasting voter behavior), and psychology (for answering questions about the causes of human behavior). We selected these topics to relate to personal goals and interests held by many of our participants. Medicine and psychology are common fields of interest for students who take introductory psychology, and we included politics

Table 1
Information About Participants in Studies 1–7

Study	Term	*N*	Women (%)	White (%)	Hispanic (%)	Black (%)	Asian (%)	Indigenous (%)	First year (%)	Average age
1	Spring 2020	115	67.0	72.2	9.6	2.6	22.6	0.0	84.4	19.1
2	Fall 2020	256	54.7	77.0	10.6	2.0	17.6	0.4	77.3	18.6
3	Spring 2021	100	57.0	81.0	5.0	1.0	15.0	1.0	79.0	19.1
4	Fall 2021	673	59.6	74.2	6.5	3.9	21.3	1.2	86.2	18.5
5	Spring 2022	171	57.3	77.2	5.3	2.3	22.2	1.2	78.4	18.9
6	Fall 2022	377	58.4	72.7	7.7	4.0	22.3	1.6	85.4	18.5
7	Fall 2022	327	61.8	71.3	11.0	5.8	21.1	0.9	87.2	18.7
All		2,019	59.2	74.2	8.0	3.6	20.8	1.0	84.0	18.7

Figure 2

Summary of the Procedure for Studies 1–7



Note. Ps = participants. Regarding manipulations: D-UV = directly communicated utility value. In Studies 6 and 7, reflective writing was added to D-UV for some participants to form a "combined" utility value manipulation. Regarding outcomes: UVR = utility value for regression; TSI = triggered situational interest in the learning session; MSI = maintained situational interest in regression.

because the study began when national news revolved around an upcoming U.S. presidential election. In Study 1, we established that this manipulation was convincing: compared to control participants who watched a 3-min video about the history of regression, those in the utility value condition reported that regression was more useful, $d = 0.40$.

Study 2 ($N = 256$) was designed and preregistered (https://aspredicted.org/3zy5j.pdf) to replicate the effect of the utility value manipulation on utility value perceptions, to test if the utility value manipulation was threatening for less confident participants, and to examine if any negative effects for this group of students could be mitigated by simultaneously bolstering students' confidence. Study 2 utilized a 2 × 2 design, crossing the utility value manipulation with an attributional reframing message in which students learned that struggles with regression are common, unstable, and controllable (see Perry et al., 2014; Weiner, 1985). Specifically, participants were told that research shows "statistics classes are challenging for almost everyone at first, even those who wind up doing very well," and that "confusion is temporary, even for the most concerned students." Contrary to our predictions, we found no evidence that the utility value manipulation threatened or undermined interest, engagement, or performance for less confident participants. Instead, at all levels of confidence (on average), students who received the utility value manipulation indicated stronger beliefs about the usefulness of regression and stronger feelings of maintained situational interest in regression.

Choice Manipulation

We crossed the D-UV manipulation with a choice manipulation in Study 3 ($N = 100$) and Study 4 ($N = 673$). In the choice manipulation, participants were asked to choose between three versions of the regression lesson, each built around a different data set. The choice took place before the instructional video but after the utility value manipulation (if applicable), so participants would immediately receive their chosen version of the lesson. Figure 3 displays the choice that participants were given.

The three videos were built around different data sets and research questions, but all contained the same regression content in the same sequence, data sets with the same number of observations, similar scripts, and stylistically identical animations and figures.

After making a choice, participants were shown the video that they selected. To control for the possibility that the videos differed in their intrinsic appeal to participants, we utilized a yoked design to ensure that each video would be assigned in control conditions the same number of times as it was chosen in the utility value conditions (see Patall et al., 2008). In Study 3 and all subsequent studies

Table 2

Summary of Scales Used in Studies 1–7

Measure	Sample item	Cronbach's α	Details
Baseline moderators			
Baseline confidence in math	How good at math are you?	.86–.92	Studies 1–7: three items
Baseline interest in statistics	How interesting do you find statistics?	.86–.95	Studies 1–7: three items
Outcome measures			
Distraction	I got distracted as I watched the regression video.	.79–.86	Studies 1–7: three items
Utility value for regression	How useful do you think linear regression could be in your future?	.79–.86	Studies 1–7: four items
TSI in learning session	It was fun to watch the video.	.72–.92	Studies 1–6: two items Study 7: six items
MSI in regression	How interesting do you find linear regression?	.80–.89	Studies 1–7: three items
Perceived autonomy	I felt I had some choice about how to learn regression today.	.69–.86	Studies 3–6: four items, Study 7: six items

Note. TSI = triggered situational interest; MSI = maintained situational interest.

Table 3
Average Correlations Between Measures in Studies 1–7

Measure	1	2	3	4	5	6	7	8	9
1. Baseline confidence in math	—								
2. Baseline interest in statistics	.43	—							
3. Distraction	−.08	−.15	—						
4. Utility value for regression	.21	.38	−.20	—					
5. TSI in learning session	.09	.32	−.57	.38	—				
6. MSI in regression	.28	.63	−.37	.59	.65	—			
7. Perceived autonomy	.01	.16	−.37	.30	.54	.44	—		
8. Requested resources	.07	.21	−.13	.23	.24	.31	.12	—	
9. Performance (test score)	.43	.24	−.07	.15	.06	.19	−.03	.03	—

Note. TSI = triggered situational interest; MSI = maintained situational interest.

of choice, each participant who was randomly assigned to a choice condition was paired with a "no-choice" participant, and whatever video the first participant chose was assigned to the other. Study 3 confirmed that the choice manipulation increased participants' perceived autonomy during the session, $d = 0.66$, and the results suggested that the choice manipulation may also have affected participants triggered situational interest in the lesson, $d = 0.34$ (although this effect was nonsignificant).

In a preregistered analysis for Study 4 (see https://aspredicted.org/NZB_LP4 and Asher & Harackiewicz, 2023), we (a) replicated the effects of choice from Study 3 (with significant effects on perceived autonomy and triggered situational interest), (b) found that the choice manipulation decreased self-reported distraction during the lesson and increased maintained situational interest in regression, (c) found that the utility value manipulation affected participants' feelings of maintained situational interest in regression but not their triggered situational interest in the lesson (replicating Study 2), and (d) found that the utility value manipulation increased the likelihood that participants requested resources about statistics opportunities on campus.

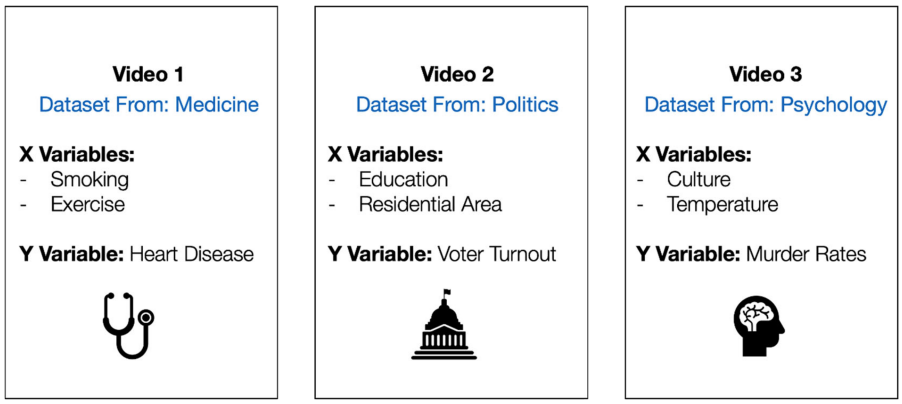
In Study 5 ($N = 171$), we introduced a "perceived choice" condition in which participants were given a choice between only two regression lessons, one of which had been pilot tested to be unappealing for most participants: a video with a "materials science" data set involving the relationship between properties of embedded fibers and the strength of plastic. Specifically, we yoked each participant in this condition to a participant in the standard choice condition, so they could choose between the materials science lesson and the choice of their yoked partner (or a randomly selected second option, if their partner selected the materials science lesson). With this condition, we hoped to disentangle the extent to which the choice manipulation triggered situational interest by promoting feelings of autonomy versus by allowing participants to learn about regression in a context that matched their interests. We predicted that participants in the perceived choice condition would experience a sense of autonomy, but they would be unable to pick a video that matched their interests to the same extent that participants in the standard choice condition could. To test for replication of prior findings, we also included a standard choice + D-UV condition and a control condition.

The perceived choice manipulation worked: as predicted, participants in the perceived choice condition were much less likely to opt for the materials science lesson than the alternative video offered, but they did not differ significantly from participants in the standard choice condition on perceived autonomy. In addition, there were no significant differences between the standard and perceived choice conditions on triggered or maintained situational interest, suggesting that the effects of the choice condition may have been driven more by perceived autonomy rather than interest matching.

Combined Utility Value Manipulation

Finally, in Studies 6 and 7 we explored whether the D-UV manipulation could be enhanced by combining it with a reflective writing

Figure 3
Choice Manipulation: The Three Videos That Participants Were Asked to Choose Between



Note. See the online article for the color version of this figure.

activity that was administered at the end of the learning session. In these studies, a set of three quotes was added to the D-UV manipulation. Each quote was attributed to a college student, and each discussed the usefulness of regression. These quotes, which are provided in the online supplemental materials, were shown to participants after the regression lesson concluded. In the combined utility value condition, participants used these quotes as the starting point for a reflective writing activity. In this activity, participants were asked to select the quote that they related to most, explain why they selected this quote, and then write about how knowledge of regression might be useful in their own lives.

In Study 6 ($N = 377$), participants in a directly communicated condition (the reference group) were compared to those in the new combined condition. Two additional conditions were also run for the sake of replication: (a) a control condition (allowing for an additional test of D-UV vs. control) and (b) a condition with both D-UV and choice (allowing for an additional test of the combined effects of D-UV and topic choice).

In Study 7 ($N = 327$), participants in a combined utility value condition served as the reference group and were compared to a combined utility value condition with a brief version of the reflective writing activity. In this version, participants completed the personal reflection but were not asked to select the quote that they related to most and discuss why this was the case. The purpose of this condition was to test if any effects of reflection were in fact due to quote choice, as opposed to personal reflection. Two additional conditions were also run to test for replication: (a) a D-UV condition (enabling another test of combined utility value vs. directly communicated only), and (b) a condition with D-UV and task choice (providing another test of adding choice). Unlike Studies 1–5, Studies 6 and 7 were not analyzed prior to this meta-analysis.

Analysis Plan

Studies 1–7 were analyzed in two stages: first, an initial analysis of each study using a common model, and second, a meta-analysis of the results from Stage 1. This meta-analytic procedure, described below, was preregistered at https://osf.io/h953d. With it, we address four broad research questions about the D-UV and choice manipulations and test several corresponding, narrower predictions.

Research Question 1: How did the two primary manipulations tested in Studies 1–7 (D-UV and choice) affect triggered situational interest and task engagement (i.e., distraction) during a learning session? Based on prior choice research, we hypothesized that the choice manipulation would promote triggered situational interest and decrease distraction, and we wished to explore how the effects of the utility value manipulation compared. Relatedly, did the manipulations improve performance on an end-of-session test about regression?

Research Question 2: How and by what mechanisms did the two primary manipulations affect measures of maintained situational and emerging individual interest? Because beliefs about utility value and meaningfulness are thought to be implicated in the development of these second and third phases of interest development, we expected that the D-UV manipulation might have stronger effects than the choice manipulation on measures of these constructs, with effects mediated through measures of perceived utility value.

Research Question 3: Did the D-UV manipulation have stronger effects for more confident participants, and was it more impactful for participants who entered the session with higher levels of initial interest? We predicted that this manipulation might only benefit confident participants (because a skill might only be perceived as useful if individuals believe they can perform it), and we expected that utility value might only promote later phases of interest development for participants with higher levels of initial interest (because interest must first be triggered before it can be maintained and internalized).

Research Question 4: Do the two manipulations interact? On one hand, if both manipulations increase interest through similar mechanisms for the same group of students, their combined effects may be redundant and therefore weaker than the sum of their separate effects. On the other, if the two manipulations promote different types of interest or help different groups of students (i.e., students who have more vs. less initial interest or confidence in the topic), the two manipulations might have additive benefits.

In addition to these research questions that focus exclusively on the effects of the D-UV and choice manipulations, our meta-analysis also investigated the impact of the combined utility value manipulation that was given in Studies 6 and 7. All research questions, analyses, and results that pertain to this manipulation are reported in the online supplemental materials.

Analysis Stage 1: Individual Study Regressions

In Stage 1 of the analytic process, Studies 1–7 were analyzed with multiple regression, using a general linear model for continuous outcomes and logistic regression for the behavioral indicator of emerging individual interest (whether participants requested regression resources), a dichotomous outcome. Table 4 displays the regression model for each study.

Prior to these initial analyses, each continuous dependent variable was standardized using its residual standard deviation after accounting for the effects of experimental manipulations (i.e., the residual standard error from a model regressing the dependent variable on all condition contrasts from the study). This type of standardization, combined with the decision to unit weight all condition contrasts (either −0.5/0.5 or 0/1), means that regression coefficients for all condition contrasts can be interpreted as standardized mean differences between conditions. Results from analyses of individual studies are shared at https://osf.io/8b6s3.

Analysis Stage 2: Metaregression

Mixed effects metaregression models were fit using the metafor package in R (Viechtbauer, 2010). To address Research Questions 1 and 2, which involve the overall effects of each manipulation, we fit a set of models (one per outcome variable). Each model analyzed coefficients for the D-UV and choice contrasts from the initial analyses of Studies 1–7, regressing them on a fixed intercept and a fixed effect for manipulation type (D-UV = 0 vs. choice = 1), and including a by-study random intercept and a by-study random slope for

Table 4
Regression Models for Initial Analysis of Studies 1–7

Study	Contrast 1	Contrast 2	Contrast 3
1	D-UV versus control (.5, −.5)[a]		
2	D-UV versus control (.5, −.5)[a]	Attributional reframing versus control (.5, −.5)	D-UV × Reframing
3	D-UV versus control (.5, −.5)[a]	Choice versus control (.5, −.5)	D-UV × Choice
4	D-UV versus control (.5, −.5)[a]	Choice versus control (.5, −.5)	D-UV × Choice
5	D-UV + choice versus choice (D-UV contrast) (1, 0)[a]	Control versus choice (choice contrast) (1, 0)[a]	Perceived Choice versus choice (1, 0)[a]
6	Control versus D-UV (D-UV contrast) (1, 0)[a]	D-UV + choice versus D-UV (choice contrast) (1, 0)[a]	Combined UV versus D-UV (combined UV contrast) (1, 0)[a]
7	Combined UV (brief) versus combined UV (1, 0)[a]	Combined UV + choice versus combined UV (1, 0)[a]	D-UV versus combined UV (combined UV contrast) (1, 0)[a]

Note. For each study, regression models contain the condition contrasts displayed in the table above. No additional predictors are included in the models. Cells are shaded to indicate regression contrasts that we subsequently meta-analyze in four models. The blue (dark gray) and yellow (light gray) contrasts in Columns 1 and 2 are meta-analyzed in separate models to test the effects of adding D-UV to a lesson and providing choice, respectively. In Column 3, the green (dark gray) combined UV contrasts and red (light gray) D-UV × Choice interactions are meta-analyzed in separate models to test the effects of (a) adding reflective writing to a utility value manipulation and (b) combining D-UV and choice, respectively. All analyses involving the combined UV contrasts are reported and discussed in the online supplemental materials. D-UV = directly communicated utility value. See the online article for the color version of this table.
[a] All contrasts are interacted with participants' baseline confidence in math and interest in statistics.

manipulation type. Each metaregression model also used the variance–covariance matrices from the individual regressions as estimates of the sampling variances for each effect-size estimate and the covariances between nonindependent effect-size estimates in the same study (i.e., dummy codes).

To test for the average main effect of the D-UV manipulation on each outcome, we examined the intercept of each model. To test if the choice manipulation had stronger or weaker effects on each outcome, we examined the fixed effect for manipulation type in each model. To explore if the choice manipulation had a significant effect on each outcome, we refit the models with the moderator-recoded choice = 0, D-UV = 1.

To test if the D-UV manipulation was more effective for more interested or more confident students (Research Question 3), two metaregression models were fit for each outcome: one meta-analyzing the D-UV × Interest interaction coefficients and another meta-analyzing the D-UV × Confidence interaction coefficients (from Studies 1 to 6). These models included a fixed intercept, a by-study random intercept, and no additional fixed or random effects.

To test if the D-UV manipulation interacted with the choice manipulation (Research Question 4) we fit models meta-analyzing the D-UV × Choice contrasts from Studies 3 to 4.

Transparency and Openness

We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study. All data, analysis code, and research materials are available at https://osf.io/hnptv (Asher & Harackiewicz, 2024) Data were analyzed using R, Version 4.3.1 (R Core Team, 2023). Studies 2 and 4 were preregistered at the links provided in the text, as was our meta-analytic procedure. Studies 1, 3, and 5–7 were not preregistered.

Results

Results from all meta-analyses are displayed in Table 5 and summarized in Figures 4–6.

Effects of the D-UV and Choice Manipulations

For each outcome, Figure 4 displays the overall effects of the D-UV manipulation (left panel), the overall effects of the choice manipulation (center panel), and the difference between the two manipulations (right panel). Figure 5 displays the meta-analyzed coefficients for interactions between the D-UV intervention and both baseline interest (left panel) and baseline confidence (right panel).

Utility Value for Regression

Across all studies, the D-UV manipulation had a strong, positive effect on participants' beliefs about the usefulness of regression, increasing reported beliefs by over 0.4 *SD*s relative to control ($d = 0.41$, $p < .001$). This overall effect was unmoderated; the D-UV manipulation did not significantly interact with participants' baseline confidence in math or interest in statistics ($ps \geq .474$). The choice manipulation was significantly less effective at promoting utility value beliefs ($p < .001$), and it had no significant effect on utility value beliefs relative to control ($d = 0.09$, $p = .239$).

Effects of Manipulations on Perceived Autonomy

Relative to control, the D-UV manipulation had no significant effect on perceived autonomy ($d = 0.12$, $p = .079$). In addition, the D-UV manipulation did not interact with participants' baseline confidence in math or interest in statistics ($ps \geq .376$). The choice manipulation was significantly more effective at increasing participants' perceptions of autonomy during the learning session ($p < .001$), increasing perceived autonomy by more than 0.9 *SD*s relative to control ($d = 0.92, p < .001$).

Triggered Situational Interest in the Lesson

Relative to control, the D-UV manipulation had no significant effect on triggered situational interest in the regression lesson ($d = 0.08$, $p = .094$). It also did not interact with participants' baseline confidence in math or interest in statistics ($ps \geq .125$). The choice manipulation increased triggered situational interest by 0.24 *SD*s

Table 5
Results From Meta-Analyses of Studies 1–7

Term	*d*	*SE*	*T*	*p*
DV: utility value				
D-UV versus control	0.41	0.07	6.00	.000
Choice versus control	0.09	0.07	1.18	.239
Choice versus D-UV	−0.33	0.08	−4.13	.000
D-UV × Choice	0.17	0.29	0.58	.561
D-UV × Interest	−0.06	0.08	−0.72	.474
D-UV × Confidence	0.02	0.06	0.30	.764
DV: perceived autonomy				
D-UV versus control	0.12	0.07	1.76	.079
Choice versus control	0.92	0.06	15.01	.000
Choice versus D-UV	0.81	0.10	7.83	.000
D-UV × Choice	0.04	0.14	0.26	.795
D-UV × Interest	−0.03	0.12	−0.24	.813
D-UV × Confidence	0.06	0.07	0.89	.376
DV: triggered S.I.				
D-UV versus control	0.08	0.05	1.67	.094
Choice versus control	0.24	0.05	4.49	.000
Choice versus D-UV	0.16	0.08	2.03	.043
D-UV × Choice	−0.28	0.50	−0.56	.573
D-UV × Interest	−0.09	0.06	−1.53	.125
D-UV × Confidence	0.02	0.06	0.36	.716
DV: distraction				
D-UV versus control	0.01	0.06	0.15	.881
Choice versus control	−0.15	0.06	−2.39	.017
Choice versus D-UV	−0.16	0.08	−1.92	.055
D-UV × Choice	0.07	0.14	0.46	.644
D-UV × Interest	−0.07	0.06	−1.20	.231
D-UV × Confidence	0.17	0.06	2.76	.006
DV: maintained S.I.				
D-UV versus control	0.15	0.04	3.79	.000
Choice versus control	0.16	0.04	3.67	.000
Choice versus D-UV	0.01	0.06	0.15	.881
D-UV × Choice	0.09	0.10	0.87	.382
D-UV × Interest	−0.08	0.05	−1.74	.082
D-UV × Confidence	0.04	0.05	0.89	.371
DV: requested resource				
D-UV versus control	0.30	0.15	2.03	.042
Choice versus control	0.02	0.15	0.14	.885
Choice versus D-UV	−0.28	0.19	−1.50	.134
D-UV × Choice	0.24	0.31	0.76	.450
D-UV × Interest	0.04	0.19	0.22	.824
D-UV × Confidence	0.01	0.14	0.05	.962
DV: performance				
D-UV versus control	0.03	0.05	0.73	.463
Choice versus control	0.04	0.05	0.74	.458
Choice versus D-UV	0.00	0.07	0.04	.967
D-UV × Choice	−0.05	0.13	−0.39	.695
D-UV × Interest	−0.01	0.11	−0.12	.908
D-UV × Confidence	−0.04	0.06	−0.64	.523

Note. For each outcome, results from multiple metaregressions are compiled in this table. Contrast names indicate the two conditions being compared, and the level of the contrast that is coded "high" is listed first. Thus, positive values of *d* indicate higher scores for the first condition (e.g., positive values of *d* for choice vs. D-UV indicate higher scores in the choice condition than the D-UV condition). DV = dependent variable; D-UV = directly communicated utility value; S.I. = situational interest.

relative to control ($p < .001$), and this effect size was significantly stronger than that of the D-UV manipulation ($p = .043$).

Self-Reported Distraction

Participants in the D-UV condition reported comparable levels of distraction during the lesson as those in the control condition ($d = 0.01$, $p = .881$). This manipulation did not interact with participants' baseline interest in math ($p = .231$), but it did interact with their baseline interest in statistics ($b = 0.17$, $p = .006$), suggesting that the D-UV manipulation decreased distraction for participants with lower levels of initial interest, but it also increased distraction for those with higher levels of initial interest. The choice manipulation decreased distraction by 0.15 *SD*s relative to control ($d = -0.15$, $p = .017$).

Maintained Situational Interest in Regression

Relative to control, the D-UV manipulation increased participants' feelings of maintained situational interest in regression by 0.15 *SD*s, $d = 0.15$, $p < .001$. The choice manipulation increased maintained situational interest by 0.16 *SD*s, $d = 0.16$, $p < .001$. These two effect sizes did not significantly differ ($p = .881$). The effect of the D-UV manipulation on maintained situational interest was not moderated by participants' baseline confidence in math ($p = .371$). A negative but nonsignificant interaction between the D-UV manipulation and baseline interest ($b = -0.08$, $p = .082$), suggests that the manipulation may have been more effective at promoting maintained situational interest for participants who entered the session with lower levels of initial interest in statistics.

Emerging Individual Interest in Regression

On average, the D-UV manipulation increased the odds that participants requested regression resources by 1.35 times relative to control ($OR = 1.35$, $p = .042$), suggesting that the manipulation promoted emerging individual interest in statistics. Overall, 39.2% of participants in D-UV conditions requested resources versus 33.2% of those in control conditions. In contrast, the choice manipulation had no influence on this outcome ($OR = 1.02$, $p = .885$). The difference between the odds ratios for the two manipulations was not significant ($p = .134$). The overall effect of the D-UV manipulation was unmoderated; the manipulation did not significantly interact with participants' baseline confidence in math or interest in statistics ($ps \geq .824$).

Performance

Relative to control, there was no significant effect of the D-UV manipulation on performance ($d = 0.03$, $p = .463$), nor was there an effect of the choice manipulation ($d = 0.04$, $p = .458$). The D-UV manipulation did not interact with participants' baseline confidence in math or interest in statistics to influence performance ($ps \geq .523$).

D-UV × Choice Interactions

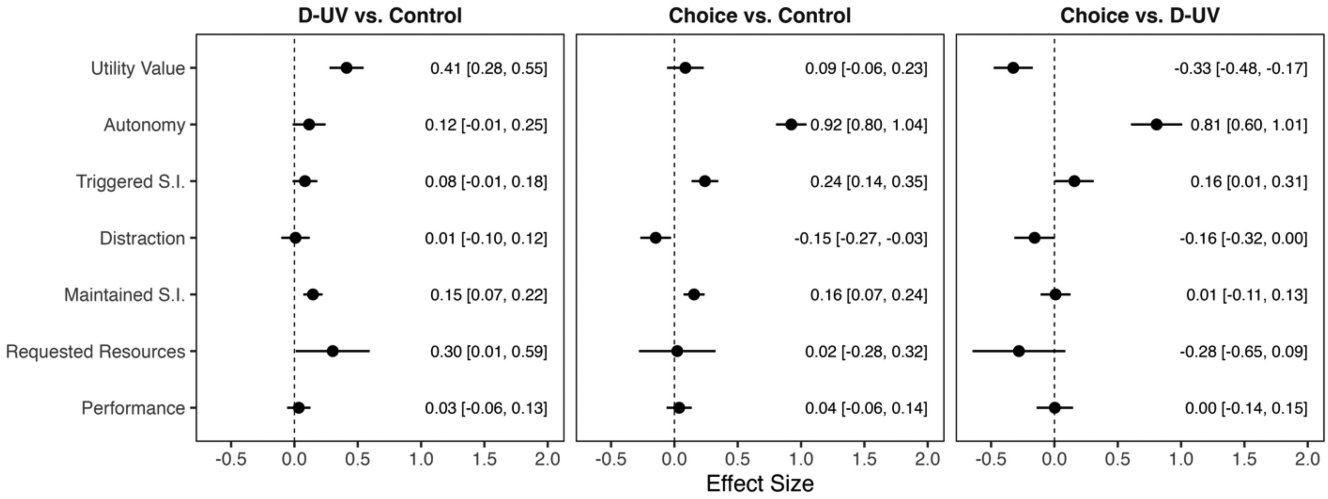
Figure 6 displays the average D-UV × Choice interaction coefficient from Studies 3 and 4 for each outcome (combined $N = 773$). For all outcomes, there were no significant interactions between the two manipulations ($ps \geq .382$).

Mediation of Effects on Triggered Situational and Emerging Individual Interest

In Studies 1–7, both the utility value and choice manipulations increased participants' self-reported maintained situational interest in regression, and the utility value manipulation also increased the

Figure 4

Effects of D-UV and Choice Manipulations (Research Questions 1 and 2)



Note. Points display effect size estimates and whiskers indicate 95% confidence intervals. D-UV = directly communicated utility value; S.I. = situational interest.

likelihood that participants would request resources about statistics on campus, an indicator of emerging individual interest. To explore mechanisms by which these effects may have emerged, we tested the indirect effects depicted in Table 6. We conducted this analysis in two stages. First, we used the lavaan package in R (Rosseel, 2012) to fit path models in each of the seven studies to calculate the indirect effects, controlling for all predictors and interactions from the primary models and using percentile bootstrapping to obtain standard errors. Second, we meta-analyzed these indirect effects, using their standard errors (squared) as estimates of their sampling variances.

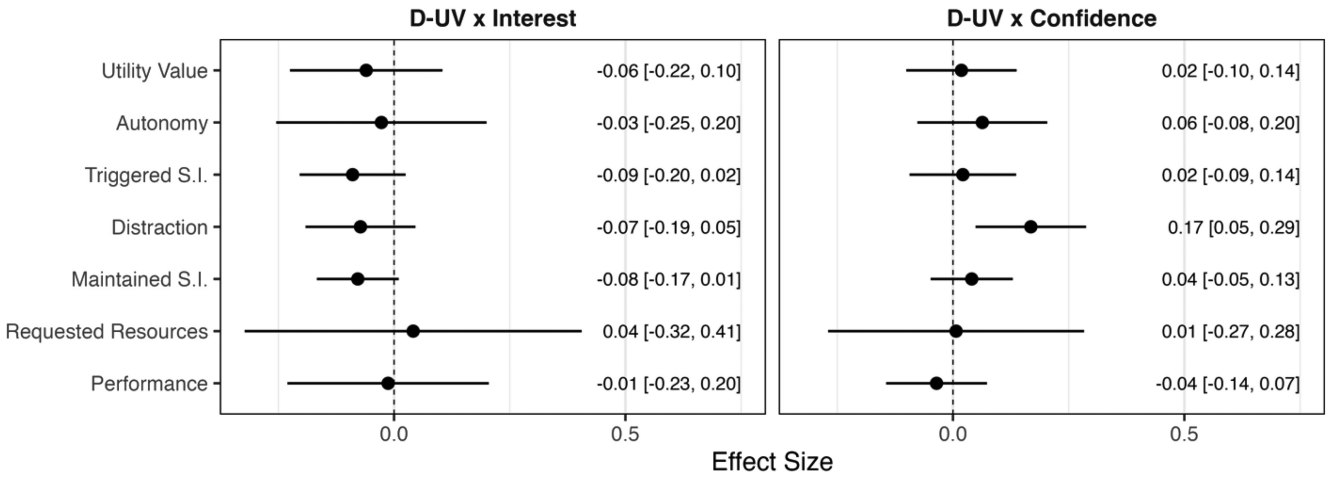
In this meta-analysis, we found evidence that perceived utility value mediated effects of the utility value manipulation on maintained situational interest in regression ($b = 0.16$, $p < .001$), and resource requests, our behavioral indicator of emerging individual interest ($b = 0.03$, $p < .001$). We also found evidence that the choice manipulation may have promoted maintained situational interest in regression via two different mediators: perceived autonomy ($b = 0.29$, $p < .001$) and triggered situational interest during the lesson ($b = 0.06$, $p = .009$).

Discussion

Our research demonstrates the promise of conducting internal meta-analyses of a series of programmatic studies; with this approach, we were able to gain considerable power, see through the noise that would arise from separately analyzing and verbally synthesizing seven studies, and answer research questions about the relative magnitude of different manipulations for promoting

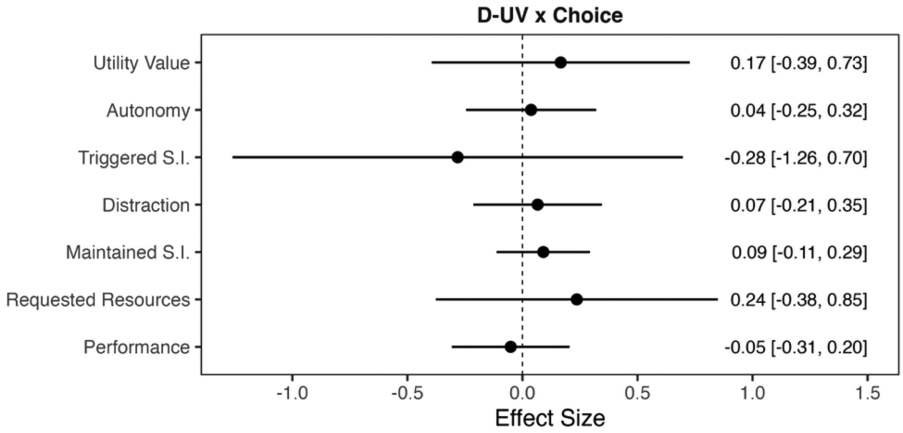
Figure 5

Moderation of D-UV Effects by Participants' Baseline Interest and Confidence (Research Question 3)



Note. Points display effect size estimates and whiskers indicate 95% confidence intervals. D-UV = directly communicated utility value; S.I. = situational interest.

Figure 6
D-UV × Choice Interactions (Research Question 4)



Note. Points display effect size estimates and whiskers indicate 95% confidence intervals. D-UV = directly communicated utility value; S.I. = situational interest.

different phases of interest development. Meta-analysis of Studies 1–7 shows that a D-UV manipulation discussing the career-based usefulness of linear regression can have strong, positive, and unmoderated effects on undergraduates' beliefs that regression is useful. Regarding the other outcomes in these studies (i.e., the potential downstream consequences of changing this belief), an interesting pattern of results emerged.

Overall, the D-UV manipulation had no significant effect on participants' triggered situational interest in the regression lesson ($d = 0.08$), and on average it did nothing to prevent participants from becoming distracted while watching the lesson ($d = 0.01$) or improve performance on the end-of-session test, $d = 0.03$ (Research Question 1). However, the D-UV manipulation had significant and positive effects on the two measures of maintained situational and emerging individual interest (Research Question 2). Participants in D-UV conditions reported stronger feelings of maintained situational interest in regression ($d = 0.15$), and their odds of requesting statistics-related resources were 1.35 times higher than those of participants in control conditions.

Taken together, these findings suggest that direct communications about usefulness for important personal goals may do little to trigger situational interest in a learning session (and therefore have small or null effects on situational engagement and learning), but at the same time, this type of D-UV may be an effective means of promoting maintained situational interest, emerging individual interest, and longer term engagement with content. Given the well-documented gap between individuals' intentions and subsequent actions (Webb & Sheeran, 2006), it is unlikely that the effects of the D-UV manipulation on resource requests translated to differences in participants actually signing up for statistics courses. However, the fact that a 3-min message about the usefulness of regression made participants more likely to provide their email address and request resources 20 min later suggests that utility value can play a role in promoting emerging individual interest that begins to go beyond a situation.

In contrast, the choice manipulation had a strong effect on participants' feelings of autonomy during the learning session ($d = 0.92$) and had a different pattern of effects on the other outcomes. The choice manipulation increased triggered situational interest in the regression lesson ($d = 0.24$), and it decreased self-reported distraction during the video ($d = -0.15$). These two effects significantly differed from the null effects of the D-UV manipulation on the same outcomes (Research Question 1). Like the D-UV manipulation, the choice manipulation promoted maintained situational interest in regression ($d = 0.16$). However, it had no impact on students requesting resources about regression, our behavioral indicator of emerging individual interest, $OR = 1.02$ (Research Question 2). Like the utility value manipulation, the choice manipulation had no significant effect on end-of-session performance ($d = 0.04$).

The present research provides experimental evidence that supports several predictions from theories of interest development. In the four-phase model of interest development, triggered situational interest involves attention and engagement (Hidi & Renninger, 2006). By allowing participants to select a video that was interesting

Table 6
Indirect Effects of the Manipulations on Triggered Situational and Emerging Individual Interest

Indirect effect				
Independent variable	Mediator	Dependent variable	*b*	*p*
D-UV manipulation	Utility value for regression	Maintained S.I. in regression	0.16	.000
D-UV manipulation	Utility value for regression	Requested resources	0.03	.000
Choice manipulation	Perceived autonomy during lesson	Maintained S.I. in regression	0.29	.000
Choice manipulation	Triggered S.I. in lesson	Maintained S.I. in regression	0.06	.009

Note. D-UV = directly communicated utility value; S.I. = situational interest.

to them, the choice manipulation attracted participants' attention, thereby promoting engagement and triggered situational interest in the lesson. The D-UV manipulation, on the other hand, did little to appeal to attention—it simply informed participants that regression is useful and valuable—and it did not promote engagement or trigger situational interest.

Both the utility value and choice manipulations promoted maintained situational interest in regression during the session, a construct that is theorized to involve positive affect and the belief that content is important or meaningful (Linnenbrink-Garcia et al., 2010; Schiefele, 1991). Mediation analyses suggest that the two manipulations may have increased maintained situational interest by each targeting a different factor; the choice manipulation enhanced positive emotions during the lesson (i.e., triggered situational interest in the regression video) and perceptions of autonomy, and the D-UV manipulation influenced beliefs about importance and meaning. However, only the D-UV manipulation affected interest in a manner that might extend beyond the situation. Dewey (1913), Mitchell (1993), and Hidi and Renninger (2006) all suggest that individual interest begins to emerge when a person comes to identify with content and believes that it can empower them to achieve their goals. The finding that the D-UV manipulation made participants more likely to request resources about regression opportunities provides some preliminary evidence for this process. In the present research, perceptions of a topic's usefulness for valued personal goals played a more important role than feelings of autonomy or positive affect in promoting emerging individual interest. Although autonomy may play an important role in well-developed interests (see Krapp, 2002), our research highlights the particularly important role that value can play in the beginnings of an emerging individual interest.

But why did the D-UV manipulation have unmoderated main effects on measures of maintained situational interest and emerging individual interest (Research Question 3)? The four-phase model of interest development suggests that students do not skip phases of interest; interest must be triggered before it can be maintained, and it must be maintained before it can become internalized and persist beyond a situation (Hidi & Renninger, 2006). Why then, was not the D-UV manipulation less effective for participants with low levels of baseline interest, as we predicted?

There are several possibilities that might explain this finding. First, it could be the case that a large majority of participants had enough initial interest in statistics that the D-UV manipulation was effective, overall. This explanation for the lack of moderation appears to be unlikely; baseline interest in statistics was assessed on a 1–7 scale, and 53% of participants reported a level of baseline interest that was below 4, the scale's midpoint. However, it is possible that even a small amount of initial interest was sufficient for beliefs about value to promote subsequent stages of interest development. Second, and more likely, is that even with over 2,000 participants, this study was underpowered to detect interactions with baseline interest or confidence. To investigate this possibility, we conducted a post hoc power analysis with simulated data. The results of this analysis suggest that even when analyzed as a set, Studies 1–7 had less than 30% power to detect Condition × Interest (or Condition × Confidence) interactions on continuous outcomes like maintained situational interest. That we experienced this low level of power with a total sample of more than 2,000 participants illustrates the limitations of testing continuous moderators in psychological science (McClelland & Judd, 1993; Sommet et al., 2023). The assumptions, code, and results of this power analysis are detailed in the online supplemental materials.

A lack of power to detect interactions could also have contributed to the finding that the D-UV and choice manipulations combined in an additive (rather than interactive) manner to influence each outcome (Research Question 4). However, it makes conceptual sense that the two manipulations can work independently of each other. Except for maintained situational interest, the two manipulations influenced different outcomes. And although they both promoted maintained situational interest in regression, they likely did so via different mechanisms (utility value vs. autonomy and affect). This evidence points to the promise of multifaceted instructional approaches that promote interest via multiple mechanisms.

Another important question is why neither manipulation improved students' performance on the end-of-session test (Research Question 1). First, the utility value manipulation increased measures of maintained situational and emerging individual interest, which were characterized by positive feelings about the content and a desire to reengage in the future. This type of interest should improve performance over time as students choose to return to the relevant content more frequently, but in our relatively brief learning session, there was no opportunity for this type of self-regulated reengagement. The choice manipulation, on the other hand, increased triggered situational interest in the learning session and decreased distraction during the lesson, attention-related variables that could increase learning in the short term. However, the effects we observed of the choice manipulation on triggered situational interest and distraction, $d \leq 0.24$, were likely too small to bring about significant indirect effects on performance. Again, it is important to note that in a longer learning session, there might be more opportunity for even relatively small differences in attention to influence performance over time.

Limitations and Future Directions

Studies 1–7 have several important limitations that should be addressed with future research. First, although we placed a large focus on later phases of interest development in these studies, there was much more measurement of maintained situational interest (Phase 2 of the four-phase model) than there was of emerging individual interest (Phase 3). Emerging individual interest was assessed with a single, dichotomous measure—whether participants requested resources about statistics opportunities on campus. In future research, studies could incorporate continuous measures of interest in on-campus statistics courses, or behavioral measures of whether participants review information about statistics opportunities during the laboratory session itself.

Second, the present research was also limited by a reliance on self-report measures for triggered situational interest. Triggered situational interest is largely characterized by attention and engagement, but the laboratory studies had no behavioral measures of engagement with the lesson. In future studies, it will be important to assess behaviors that indicate engagement (e.g., whether students pause and rewind the video during dense sections or take notes as they watch) or disengagement (e.g., whether students navigate to additional browser tabs). It could also be beneficial to incorporate problem sets into the paradigm so researchers can track behavioral engagement during these practice sessions.

Third, the present research could have benefited from an exploration of how participants' prior knowledge might play a role in

moderating the effects of utility value and choice manipulations. The four-phase model of interest development characterizes individual interest as consisting of both stored knowledge and value (Hidi & Renninger, 2006). Thus, it may be important to examine if teaching practices that emphasize value are better at promoting individual interest for students with higher levels of initial knowledge. To address this limitation, the regression paradigm could be modified to include a pretest of prior knowledge about regression.

Finally, the generalizability of the present research is limited by the context in which it was conducted. For example, these studies were all conducted with college students and cannot directly answer questions about interest development for younger students. Theories of interest development suggest that beliefs about the meaningfulness of content should promote the emergence of individual interest for students of all ages (Dewey, 1913; Mitchell, 1993; Renninger & Su, 2012). However, the type of future-based usefulness we communicate in Studies 1–7 would likely be less effective with a younger group of students, who think less about themselves in the future than older adolescents do (Nurmi, 1991; Piaget, 1955). To help younger students develop lasting interest in academic content, researchers should design and test manipulations that focus on the usefulness of the content for more proximal personal goals.

Conclusion

It is critically important that educators think about interest development. Learning environments such as classrooms and online courses should not only prepare students with skills they will need for the future but also help students develop interests in topics that can become careers and passions. Moreover, if educators can help students develop an interest in course material, students will be more likely to engage deeply and enthusiastically over time. The present research suggests that educators can trigger students' interest by providing them with meaningful choices, and that brief utility value messages can independently help promote longer term interest. Future work should continue exploring how to effectively combine instructional practices that trigger, maintain, and strengthen interest to promote meaningful change in students' experiences and outcomes.

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