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Antecedents and consequences of situational interest

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Background. There is a growing body of research on situational interest (SI). Yet, we still know relatively little about how SI is supported in the classroom and the academic benefits of SI.

Aim. The current study investigated (1) contextual antecedents of SI; (2) potential benefits of SI for academic outcomes; and (3) SI as a mediator of classroom practices to academic outcomes.

Sample. Participants were 126 male and female adolescents (mean age = 14.6 years) who took part in a science course during a 3-week residential summer programme for talented adolescents.

Method. Participants completed self-report measures prior to the start of the summer programme and at the end of the programme. Summer programme instructors completed ratings of students' engagement during the programme.

Result. Multiple regression analyses were conducted to investigate the three study aims. After controlling for initial individual interest, perceived choice, instructor approachability, and course connections to real life were statistically significant predictors of SI during the summer programme, with varying associations observed based on the form of SI (triggered, maintained-feeling, and maintained-value). SI was positively related to individual interest and perceived competence in science at the end of the programme as well as teacher-rated engagement; SI also mediated the associations of classroom practices with these outcomes.

Conclusion. Results suggest that classroom practices shape SI. In turn, SI supports motivation and engagement. Moreover, differentiated antecedents and outcomes of the three sub-components of SI were identified, highlighting the utility of this three-component approach for studying SI.

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Antecedents and consequences of SI

Interest and value are important predictors of students' achievement, engagement, and subsequent career choices (Schiefele, 2001, 2009; Wigfield & Eccles, 2001). As such, it is important to understand how interest can be supported in classroom settings as a mechanism for enhancing academic outcomes and career choices. Building on recent work on interest development suggesting that enduring forms of individual interest can develop via situational interest (SI; e.g., Hidi & Renninger, 2006; Krapp, 2002; Schiefele, 2009), the current study investigated how SI can be supported in the classroom and the potential benefits of SI for academic outcomes. Specifically, the purpose of the current research was to (1) explore contextual antecedents of SI; (2) examine how SI supports individual interest, perceived competence, and engagement in academic settings; and (3) examine whether classroom practices shape individual interest, perceived competence, and engagement via SI.

Theoretical views on interest

Researchers studying interest have primarily differentiated between two main forms of interest: individual and situational. Broadly speaking, *individual interest* (also referred to as personal interest) is relatively stable and resides within the individual; it includes a deep personal connection with the domain and a willingness to re-engage in the domain over time (cf. Hidi & Renninger, 2006; Krapp, 2005; Renninger, 2009; Renninger, Hidi, & Krapp, 1992; Schiefele, 1991, 2001, 2009). Within the extant literature, there are varying views regarding the conceptualization of individual interest.[1] In the current study, we employ Schiefele's (1991, 2001, 2009) affective-evaluative orientation, which conceptualizes individual interest as including both positive feelings, such as enjoyment, towards the domain, as well as the view that the domain is personally meaningful and important.

In contrast to the relatively enduring qualities of individual interest, *SI* refers to interest that emerges from and is supported by the context (Hidi & Baird, 1986; Hidi & Renninger, 2006; Krapp, 2002; Schiefele, 2009). Individual interest can also be supported by and actualized within a particular context, but in contrast to SI, it is not dependent on situational supports and continues to exist without them. A number of theoretical conceptualizations of SI have been put forth, including the distinction between catch and hold (Mitchell, 1993) and triggered and maintained (Hidi & Renninger, 2006) SI. Linnenbrink-Garcia *et al.* (2010) extended these models to develop a three-component model of SI, consisting of triggered-SI, maintained-SI-feeling, and maintained-SI-value, which was supported by a series of empirical studies showing that these three components of SI were distinct from one another and from individual interest, and predicted changes in individual interest during the academic year. This three-component model, described below, serves as the foundation for the current research.

Triggered-SI, which is similar to Mitchell's (1993) conceptualization of catch, refers to a relatively short, heightened affective state that is generally initiated by contextual supports (Hidi & Renninger, 2006). During this phase of interest, the context may momentarily trigger engagement and attention, but it does not lead to prolonged engagement with the domain. These affective reactions likely emerge from the form of instruction itself, rather than the content of the course (Linnenbrink-Garcia *et al.*, 2010).

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[1] *See, for example, Renninger's differentiation between less- and well-developed individual interest (Hidi & Renninger, 2006; Lipstein & Renninger, 2007; Renninger, 1992, 2009).*

Triggered-SI is often relatively short-lived. It can, however, lead to maintained-SI and thus is critical in the overall development of individual interest (Hidi & Renninger, 2006; Renninger, 2009; Renninger & Hidi, 2002).

Maintained-SI, which is similar to Mitchell's (1993) conceptualization of hold, refers to situational support of an individual's more focused involvement, attention, and persistence in a domain, including finding meaning and personal connections to the domain content (Hidi & Renninger, 2006; Mitchell, 1993). In contrast to triggered-SI, maintained-SI occurs when the context supports involvement in and enjoyment of the material itself (Schiefele, 2009). During this phase, students are likely to experience positive feelings (e.g., enjoyment), but are also developing deeper value for and knowledge of the content (Renninger, 2009). Maintained-SI may be similar in structure to individual interest, in that it involves both positive feelings for and valuing of a domain (Linnenbrink-Garcia *et al.*, 2010; Schiefele, 2009; see also Tsai, Kunter, Ludtke, Trautwein, & Ryan, 2008 for a similar argument). Thus, Linnenbrink-Garcia *et al.*'s (2010) three-component model further differentiates between the feeling and value components of maintained-SI, such that *maintained-SI-feeling* refers to experiencing positive affect towards the domain via instructional support and *maintained-SI-value* to cognitively finding meaning and personal usefulness in the domain via instructional support. These two maintained-SI components are related, but represent distinct ways in which SI may emerge in the classroom.

While these two components of maintained-SI are thought to be similar in structure to individual interest, they are distinct, in that they focus on enjoyment and value that emerge as a function of contextual supports rather than enduring predispositions to find enjoyment and value in the domain. Thus, an individual experiencing maintained-SI would find the content of a course enjoyable and/or meaningful while learning in that context, but would not necessarily seek out other opportunities to learn about the domain outside of the supported environment or once the instructional unit was complete. It is only after the transition is made from maintained-SI to individual interest that individuals begin to seek out repeated additional experiences with the domain. Importantly, although both triggered-SI and maintained-SI emphasize feelings emerging from the situation, triggered-SI refers to feelings related to the *form* of instruction, whereas maintained-SI-feeling refers to feelings based on the *content* of the instruction. That is, triggered-SI is an emotional reaction to how the material is presented or experienced, whereas maintained-SI-feeling is an emotional reaction to the topic itself.

Supporting interest development

Given the potential of SI to develop into individual interest and its potential link to other important academic outcomes, it is critical to examine how these three forms of SI can be supported in educational settings. Much of the existing research on interest development focuses on identifying different phases of interest, rather than classroom supports for these phases (cf. Lipstein & Renninger, 2007; Renninger & Hidi, 2002; Renninger & Lipstein, 2006). There is also an extensive body of research examining how specific features of texts promote SI during reading (cf. Hidi & Baird, 1988; Schraw & Lehman, 2001). In a review of this work, Schraw and Lehman (2001) highlighted a number of text features that promote SI including the seductiveness, vividness, and coherence of the text (see also Schraw, Flowerday, & Lehman, 2001). While this research informs our understanding of supports for interest in the context of reading and identifies some factors

that may support SI in the classroom (e.g., lectures that include seductive details), there is a clear need to move beyond text-based studies to consider antecedents of SI in a broader range of classroom contexts. Compared with research on text-based supports for interest, the empirical base examining classroom factors leading to SI is relatively small, with very few studies considering any of the subcomponents. However, there is growing convergence of evidence identifying several critical factors for promoting SI. Below, we provide a brief review of this work.

In one of the initial studies conducted outside of text processing, Mitchell (1993) used student surveys to identify five contextual factors that could be differentiated into supports for triggered-SI (use of computers, puzzles, and group work) and maintained-SI (making mathematics meaningful and active involvement in the lesson) in secondary mathematics classrooms. Since this seminal study, other researchers have queried teachers and students about what helps them learn and what makes learning interesting (Freeman, McPhail, & Berndt, 2002; Zahorik, 1996), developed in-depth case studies or portraits of interest development (Lipstein & Renninger, 2007; Renninger & Hidi, 2002), and used field observations and interviews (Dohn, Madsen, & Malte, 2009) to describe situational supports for interest. The results from these studies suggest that active involvement (e.g., hands-on activities, building models, and experiments), course connections to real life, social connections (e.g., group work and working with friends), social support from parents and teachers, and autonomy support are key for supporting interest. Building from this qualitative and observational research, several more recent studies investigated how students' perceptions of classroom factors relate to self-reported interest (both situational and individual). These studies identified perceived autonomy support (Ciani, Ferguson, Bergin, & Hilpert, 2010; Tsai *et al.*, 2008) and perceiving the instructor as friendly, enthusiastic, and having subject-matter expertise (Frenzel, Goetz, Pekrun, & Watt, 2010; Rotgans & Schmidt, 2011b) as significant predictors of interest.

Other research has examined shifts in SI over time as a function of classroom instruction (Palmer, 2009; Rotgans & Schmidt, 2011a) or experimental intervention (Del Favero, Boscolo, Vidotto, & Vicentini, 2007; Durik & Harackiewicz, 2007; Hoffmann, 2002; Hulleman & Harackiewicz, 2009; Hulleman, Godes, Hendricks, & Harackiewicz, 2010). For instance, Palmer (2009) studied ninth grade students participating in a hands-on inquiry lesson. He found that SI varied across the lesson, with the lowest levels when students copied notes, moderate levels during the demonstration, proposal, and report phases of the lesson, and the highest levels during experiments. Using qualitative interviews, Palmer identified opportunity to learn, choice, novelty/suspense/surprise, hands-on activity, and social involvement as sources of SI. Four intervention studies experimentally manipulated relevance or connections to real life and found that targeting relevance effectively supported interest (Durik & Harackiewicz, 2007; Hoffmann, 2002; Hulleman & Harackiewicz, 2009; Hulleman *et al.*, 2010). For example, Hoffmann (2002) found that when teachers made connections between physics topics and aspects of everyday life that were likely to be especially appealing to girls, girls became increasingly more motivated to study physics. In a fifth intervention study, Del Favero *et al.* (2007) manipulated active involvement with peers by comparing the effects of engaging in problem-solving in groups through discussion or individually. Students in the discussion condition reported higher SI in participation (e.g., interest in participating in the activities) and in activities (interest stimulated by the activities), although there were no significant changes in individual interest.

Several key themes emerge from this prior work. First, the role of choice or autonomy support was observed in a number of the studies (Ciani *et al.*, 2010; Palmer, 2009;

Renninger & Hidi, 2002; Tsai *et al.*, 2008; Zahorik, 1996). Autonomy support is also identified as a key support for motivation by other major motivational theories. For example, self-determination theory proposes that the need for autonomy is one of the three primary needs underlying intrinsic motivation (Ryan & Deci, 2000). Prior research from this theoretical perspective indicates that provision of choice is an autonomy supportive practice through which feelings of interest and intrinsic motivation may be supported (see Katz & Assor, 2007; Patall, Cooper, & Robinson, 2008 for reviews). Moreover, autonomy support is also identified as central for supporting mastery goal orientations (Ames, 1992; Patrick, Anderman, Ryan, Edelin, & Midgley, 2001), which have in turn been linked to higher levels of individual interest and SI (Harackiewicz, Barron, Elliot, Carter, & Lehto, 1997; Harackiewicz, Barron, Tauer, Carter, & Elliot, 2000; Harackiewicz, Barron, Tauer, & Elliot, 2002; Harackiewicz, Durik, Barron, Linnenbrink-Garcia, & Tauer, 2008).

Thus, we hypothesize that autonomy support and the perception of having choices, in particular, can lead to higher levels of SI. While there is little empirical evidence regarding its association with the sub-components of SI, we hypothesize that it will be related to triggered-SI and maintained-SI-feeling. Providing students with procedural and material choices in the classroom should both trigger students' initial interest in the activity at the moment that the choice occurs, as well as support maintained positive feelings towards the subject being studied. In light of prior research showing little association between choice provision and high school students' reports of engaging in coursework because it is personally valued or viewed as important (e.g., identified regulation for coursework; Patall, Cooper, & Wynn, 2010), we do not expect provision of choice to enhance maintained-SI-value.

A second component of the classroom identified in our review concerned characteristics of the instructor as friendly, approachable, and supportive of a social relationship with students (Dohn *et al.*, 2009; Frenzel *et al.*, 2010; Renninger & Hidi, 2002; Rotgans & Schmidt, 2011b). At a theoretical level, instructor approachability and friendliness can support feelings of relatedness, including belongingness and feelings of close connection to the teacher (Bergin, 1999; Schiefele, 2009). Drawing from self-determination theory, the extent to which students feel social support and connection should also facilitate interest (Krapp, 2005; Ryan & Deci, 2000). As instructor approachability and friendliness focuses on the instructor rather than the content being taught, we expect that it will be more likely to facilitate feelings of triggered-SI rather than maintained-SI. That is, these characteristics of the instructor are likely to enhance students' momentary positive feelings in a particular classroom setting, but are not tied directly to enjoyment of the content being studied.

A third factor was students' opportunities to become involved in a lesson. Specifically, working in groups, doing hands-on activities, engaging in group discussion, and working with friends have all been identified as supporting SI (Del Favero *et al.*, 2007; Dohn *et al.*, 2009; Freeman *et al.*, 2002; Mitchell, 1993; Palmer, 2009; Renninger & Hidi, 2002; Zahorik, 1996). The majority of this prior work did not consider what form of SI would be supported through opportunities for involvement. However, Mitchell (1993) identified group work as a form of triggered-SI, but opportunities for deeper involvement as a form of maintained-SI. The association of involvement with the various forms of SI most likely depends on the degree to which tasks promoting involvement tie in directly with the course materials. If it is superficial (e.g., the opportunity to complete a task with friends), it will probably lead to triggered-SI; however, if involvement helps students to more actively engage in the material, it may also lead to maintained-SI. As many group activities and

opportunities for involvement emphasize complex, real-world tasks, we expect that opportunities for involvement can support both the feeling and value forms of maintained-SI.

A fourth consistent theme throughout the literature is the need to make course material meaningful and tied to everyday life (Dohn *et al.*, 2009; Durik & Harackiewicz, 2007; Hoffmann, 2002; Hulleman & Harackiewicz, 2009; Hulleman *et al.*, 2010; Mitchell, 1993; Zahorik, 1996). The majority of studies examining connections to real life looked at SI more generally. While it is possible that connections to real life grab students' attention, we hypothesize that this contextual support will be most strongly related to maintained-SI-value, as it will help highlight the value of the course material.

While our review also identified a number of other factors that might support SI (e.g., puzzles, live animals, and opportunities to learn), autonomy support, instructor approachability/friendliness, opportunities for involvement, and connections to real life were most consistently identified across the studies and align well with theoretical perspectives on the underlying components of interest development (Bergin, 1999; Hidi & Renninger, 2006; Krapp, 2005; Schiefele, 2009). As such, we focused our investigation on these four primary classroom supports for SI and sought to extend this prior work by examining how these classroom factors related to triggered-SI, maintained-SI-feeling, and maintained-SI-value.

Consequences of SI

In addition to considering possible antecedents of SI, it is also important to examine how the experience of SI can enhance key academic outcomes. One of the most important outcomes of SI is its potential for supporting interest in academic-related topics (Hidi, 2001). Indeed, the four-phase model of interest development focuses on how SI can develop into individual interest (Hidi & Renninger, 2006). However, much of the prior research on the development of interest examines shifts in interest or value across time without considering the role of SI in explaining these shifts (e.g., Fredricks & Eccles, 2002; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002).

A growing body of research provides initial evidence that SI can develop into individual interest (Favero *et al.*, 2007; Harackiewicz *et al.*, 2000, 2002, 2008; Linnenbrink-Garcia *et al.*, 2010; Randler & Bogner, 2007; Renninger & Hidi, 2002). For instance, Randler and Bogner (2007) examined interest development for eighth and ninth graders studying ecology. After controlling for initial individual interest, SI was a significant predictor of individual interest at the end of the unit. In a series of studies conducted in introductory psychology classes, Harackiewicz *et al.* (2000, 2002, 2008) examined how the sub-components of SI predicted course choices and majoring in psychology (indicators of individual interest). Across these studies, interest in the course (similar to maintained-SI), but not enjoyment of lectures (similar to triggered-SI), predicted the number of psychology courses students took as undergraduates as well as their decision to major in psychology. Linnenbrink-Garcia *et al.* (2010) also examined changes in adolescents' individual interest in mathematics as a function of the three sub-components of SI. Both triggered-SI and maintained-SI-feeling, but not maintained-SI-value, were related to increases in individual interest in the spring, controlling for initial levels of interest.

These studies provide evidence for the importance of SI in supporting individual interest and suggest that maintained-SI-feeling may be the most likely form of SI to develop into individual interest, although there was some evidence that triggered-SI was associated

with individual interest. While there is no clear empirical support, it also seems reasonable to suggest that maintained-SI-value could also support interest development. As individuals come to see the domain as useful and valuable for their understanding of the world, this should increase their longer lasting enjoyment and value of the domain (Hidi & Renninger, 2006; Schiefele, 2009). Thus, we hypothesize that all three components of SI can support interest development.

SI may also lead to other types of motivation such as perceived competence. As students come to enjoy a domain, they may become increasingly confident of their skills in that domain. Thus, SI may increase perceived competence. Perceived competence may also be an intermediary step leading to individual interest (Lipstein & Renninger, 2007; Renninger & Hidi, 2002). If SI can support perceived competence, it may be especially instrumental in helping students to shift from situational to individual interest. Indeed, perceived competence is often viewed as a precursor to interest (Marsh, Trautwein, Ludtke, Koller, & Baumert, 2005; Silvia, 2003; Wigfield & Eccles, 2001).

While this question has not been extensively studied, there is some evidence that SI supports perceived competence. Nieswandt (2007) found that SI in the fall predicted changes in academic self-concept in the spring among ninth grade chemistry students. Similarly, Durik and Harackiewicz (2007) reported that participants with high interest working on a task designed to enhance relevance had higher reports of perceived competence at the end of the task; however, they did not find a significant effect of visually stimulating materials for supporting perceived competence. Del Favero *et al.*'s (2007) research provides some evidence that SI may predict perceived competence. Using structural equation modelling, the authors reported that in classrooms designed to enhance SI via group discussions, SI predicted perceived competence; however, these effects were only observed for one set of lessons. For the other set of lessons, perceived competence predicted interest directly, but not via SI. Overall, there is growing evidence that SI may help support perceived competence; however, the exact nature of this relationship and the role of the subcomponents of SI remain unclear. As such, our investigation of the association of triggered-SI, maintained-SI-feeling, and maintained-SI-value with perceived competence is more exploratory.

Finally, there is a growing body of literature providing evidence for the benefits of SI in supporting engagement and cognitive processing (for reviews see Hidi, 1990, 2001; Schiefele, 2001, 2009; Schraw & Lehman, 2001). However, the majority of this research is conducted for text-based processing. This research suggests that SI supports increased attention, cognitive processing, and persistence (see Hidi, 1990, 2001). However, as Hidi notes, findings may vary depending on whether one examines intentional engagement versus involuntary, spontaneous effort, with SI more likely to support the latter. That is, SI may support engagement in such a way that one is not readily aware of one's engagement. In this case, the use of student self-reports may be particularly problematic. Thus, in the current study, we employed instructor ratings of students' engagement in the course materials. Moreover, we conceptualized engagement as encompassing both behavioural and cognitive engagement to capture both increased persistence and deeper cognitive engagement with curricular concepts.

Moving beyond the text processing literature, Durik and Harackiewicz (2007) examined how collative features (triggered-SI) and a relevance manipulation (maintained-SI-value) related to task involvement for undergraduates learning a new mathematics technique. Their results suggest that both triggered-SI (for participants low in initial interest) and maintained-SI-value (for participants high in initial interest) were associated with increased task involvement; neither experimental condition was significantly related to task performance.

Several recent studies found that experimentally enhancing the relevance of the content supported higher achievement among students with lower perceived competence or low prior achievement and that these effects could be explained through an increase in perceived utility value (similar to maintained-SI-value) as a result of experimentally induced relevance (Hulleman & Harackiewicz, 2009; Hulleman *et al.*, 2010).

Taken together, this recent research on classroom-based SI coupled with the prior research on SI during text-processing suggests that SI has the potential to shape students' engagement in the classroom. Notably, the majority of this research has not differentiated among various forms of SI. Drawing from this research as well as theoretical descriptions of SI, we hypothesize that all three forms of SI will support students' engagement during class activities. However, the association for triggered-SI is expected to be weaker than that observed for maintained-SI-feeling or maintained-SI-value, as the maintained forms of SI should be more likely to sustain persistence and cognitive engagement even when it is not immediately supported at that moment by the format of the instruction. In contrast, triggered-SI is likely to be more fleeting. When students experience triggered-SI, they are likely to engage, but it is unlikely that triggered-SI is experienced consistently throughout a course and thus its association with overall engagement across a course should be weaker than that observed for maintained-SI.

Current study

In summary, there is a growing body of literature examining both the antecedents and consequences of SI. The current study extends this prior research by examining the antecedents and consequences of three forms of SI in the context of a three-week summer residential programme for talented adolescents in which students were enrolled in one of several intensive, advanced science courses. By differentiating among triggered-SI, maintained-SI-feeling, and maintained-SI-value, we aim to better understand how situational factors differentially predict these forms of SI and thus shed greater clarity on the ways in which classroom contexts shape interest development. This may be especially important for helping educators determine not only how to trigger SI but also how to maintain SI in an effort to support the development of individual interest as well as perceived competence and engagement. Three primary research questions guide our work:

(1) What is the association of classroom practices (perceived choice, instructor approachability, connection of course material to real life, and opportunities for student involvement) with triggered-SI, maintained-SI-feeling, and maintained-SI-value? We hypothesize that perceived choice, instructor approachability, and involvement will predict triggered-SI. Perceived choice and involvement will predict maintained-SI-feeling, while connections to real life and involvement will predict maintained-SI-value.
(2) Do triggered-SI, maintained-SI-feeling, and maintained-SI-value predict individual interest, perceived competence, and engagement? Prior research provides grounding for the hypothesis that SI will relate positively to these outcomes, but it is not clear if the associations will be differentiated among the three forms of SI. As such, this research question is exploratory. We expect that all three SI sub-components will relate positively to individual interest, perceived competence, and engagement; however, the strength of the associations may vary such that the two forms of maintained-SI more strongly predict individual interest and engagement.

(3) As a third step, we hypothesize that SI will mediate the between classroom practices and individual interest, perceived competence, and engagement.

Method

Participants and setting

Participants in this study were adolescents attending a summer residential academic programme for talented youth. Adolescents qualified to take science courses in the summer programme by scoring well above average on the mathematics portion of standardized ability tests taken in seventh grade (SAT [M = 576.97]; ACT [M = 21.10]). The academic programme was designed to provide advanced, accelerated coursework for academically gifted adolescents and combined elements of enrichment and acceleration. All participants were enrolled in one science course during one of three summer sessions; each session lasted 3 weeks. Students attended the course for seven hours on weekdays and three hours on Saturday for a total of 120 class hours during the summer session. Class sizes for their courses were small, ranging in size from 11 to 20 students. The topics of the courses in which students enrolled varied, but included subjects such as Aerospace Engineering, Introduction to Medical Science, Marine Biology, and Pharmacology. Class activities also varied and included activities such as lecture, small group work, experiments and other hands-on and/or inquiry activities, and discussion. There was an emphasis on encouraging collaboration and creativity; grades were not assigned. When students were not in class, they participated in social activities that were offered as part of the residential programme (students were housed in dorms on a college campus throughout the 3-week session).

Course instructors varied in experience. About 70% of the instructors had taught as part of the summer programme in previous years; all instructors were required to have at least 1 year of experience at the graduate or secondary level or in professional employment related to the instructional topic. Instructors were selected based on experience level and their knowledge in the course-specific material. Each instructor was required to create a course syllabus, develop a challenging course curriculum, and attend an orientation session prior to the summer programme. As part of the training, instructors were provided with information on general principles of effective instruction and curriculum, as well as information on the unique characteristics of gifted students and the instructional approaches that might be particularly well suited to their needs. Instructors were encouraged to be aware and responsive to the aptitude of gifted students for mastering the content of classes, to ensure that the pace at which content is presented is appropriately accelerated and that content is economically presented, to focus on content that is not traditionally covered in school, and to make use of independent or self-directed learning, tasks that encourage creativity, and tasks that make use of higher level thinking skills and concepts. Detailed explanations of how these goals could be accomplished were provided.

Potential participants were contacted in May, after students enrolled in the summer programme, but before they began courses. The first phase of data collection involved a survey that was mailed to each potential participant's home; 126 participants completed this first wave. In the second phase of data collection, trained research assistants administered a questionnaire to all participating students during the final week of the summer academic programme (June or July); 110 of the 126 participants from phase 1 completed phase 2. Participants were in eighth, ninth, and tenth grades at the beginning

of the study (M_{age} = 14.6). About half of the participants were male (54%). The sample was primarily Caucasian (71%), with the remaining participants identifying their race or ethnicity as Asian American (11%), Latino or Hispanic (6%), or African American (3%). Nine percent of participants were of other ethnicities or did not provide information about their race/ethnicity. There were no statistically significant differences in gender, ethnicity, age, or any of the variables in this study among individuals who continued to participate in the study at time 2 and those who did not. The total number of participants included in any particular analysis varied from one analysis to another as analyses were conducted using participants with available data for all variables included a particular analysis; missing data were not imputed.

Measures

Students' ratings of individual interest and perceived competence were assessed at both phases of data collection (May, June/July). Student-reported SI, provision of choice, instructor approachability, connection of course content to real life, instructor support for student involvement, and opportunities for group work were assessed via a self-report questionnaire administered during the last week of the summer programme (time 2, June/July). Course instructors provided ratings of engagement during the summer programme at the end of the programme (time 2, June/July). Unless otherwise noted, all response scales ranged from 1 to 5.

SI

We measured the three components of SI (triggered-SI, maintained-SI-feeling, maintained-SI-value) using the SI Survey (Linnenbrink-Garcia *et al.*, 2010). Each sub-scale was assessed with four items. *Triggered-SI* measured participants' experiences of instruction during summer programme as exciting (α = .81; e.g., 'When we do science, my instructor does things that grab my attention'). *Maintained-SI-feeling* assessed participants' excitement for and enjoyment of the content of the course (α = .93; e.g., 'I like what we are learning in this class'). *Maintained-SI-value* measured participants' value for course content (α = .89; e.g., 'We are learning valuable things in this class'). In line with prior findings regarding the structure of this measure (Linnenbrink-Garcia *et al.*, 2010), model fit indices from a confirmatory factor analysis suggested that the three-factor solution provided an acceptable fit for the data ($\chi^2(51) = 93.24$, $p < .001$; CFI = .948; SRMR = .055).[2]

Provision of choice

The provision of choice subscale of the Rochester Assessment Package for Schools (Connell, 1990; Wellborn & Connell, 1987) was used to measure autonomy support. Seven items, such as 'My instructor allows me to choose how to do my work in the classroom,' assessed students' perceptions of the choice in the classroom. We added one item to this scale to provide a very explicit measure of the provision of choice: 'I feel that my instructor provides me with choices and options.' In an exploratory factor analysis, one problematic

[2] *The three-factor structure fit significantly better than a one-factor structure. The three-factor solution also fit better than either a two-factor solution in which a triggered-SI and maintained-SI factors were modelled or a two-factor solution in which SI-feeling (combining triggered-SI and maintained-SI-feeling) and SI-value were modelled. More details regarding these analyses can be obtained from the authors.*

item with a low initial communality ('When the instructor gives us an assignment, he or she allows us to choose which questions to answer') was dropped from the scale (α = .84).

Instructor approachability

As part of the time 2 survey, participants indicated the extent to which their instructors were approachable or personable. The four items (friendly, humorous, approachable, and enthusiastic) in this scale were introduced with the stem, 'To what extent does your instructor demonstrate the following qualities?' We examined this scale in exploratory factor analysis by itself and with all other items included in the antecedent analyses; details may be obtained from the authors. The scale had an acceptable factor structure and reliability (α = .74).

Connections to real life

Students' perception of the connection of course content to real life (α = .75) was rated with three items during the summer programme survey. The items assessed the inclusion of stories that relate course material to real life, personal anecdotes told by the instructor, and examples that relate course material to real life. Details of the exploratory factor analysis may be obtained from the authors.

Opportunities for involvement

Two measures of opportunities for involvement were employed. The first measure, *instructor support for involvement*, assessed students' perceptions that their instructor supported their involvement using two items. These items assessed whether instructors asked open-ended questions and asked students' opinions (α = .64). The second measure of involvement was a single item measuring students' perceptions of *opportunities to engage in group work*. In exploratory factor analysis, this item did not load on the same factor as the instructor support for involvement scale, so it was included as a single item.

Individual interest

We assessed participants' individual interest in science using Linnenbrink-Garcia *et al.*'s (2010) individual interest scale. This scale consisted of eight items including 'Science helps me in my daily life outside of school' and 'Science is exciting to me.' In both phases, reliability was high (time 1 α = .90; time 2 α = .91).

Perceived competence

Perceived competence was measured with the Academic Self-Efficacy in Science scale, which we adapted from the Patterns of Adaptive Learning Survey (PALS, Midgley *et al.*, 2000) to focus specifically on science. The scale included five items (time 1 α = .86, time 2 α = .88) such as 'Even if the work in science is hard, I can learn it.'

Engagement

Summer programme instructors provided a combined assessment of each participant's behavioural and cognitive engagement in the classroom. This scale consisted of three

items, including measures of students' participation in class activities, participation in class discussions, and having thought-provoking questions or comments. The response scale ranged from 1 to 5, but in practice, the measure ranged from 3 to 5 (α = .82).

Results

Preliminary analyses

We began by examining the distribution of scores on each variable for statistical outliers. Grubbs' (1950) test was applied and when outliers were identified, these values were set at the value of their next nearest neighbour. One outlier was found on each of the following measures: individual interest at time 1, maintained-SI-feeling and maintained-SI-value. Means and standard deviations for all variables and Pearson correlation coefficients are presented in Table 1.

Overview of primary analyses

The primary aim in the analyses that follow was to examine our hypotheses that classroom practices (perceived provision of choice, instructor approachability, course material connections to real life, instructor support for involvement, and opportunities for group work) would predict components of SI (triggered-SI, maintained-SI-feeling, and maintained-SI-value) and that SI would, in turn, predict other learning outcomes (individual interest, perceived competence, and engagement). For these analyses, we utilized the test of joint significance criteria recommended by MacKinnon and colleagues (e.g., MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002) for determining mediation and conducted a series of hierarchical regression analyses. In line with these recommendations, a mediated pathway exists when (1) the association between the independent and mediating variable is statistically significant; and (2) the association between the mediating and dependent variable is statistically significant, controlling for the independent variables. Notably, a direct effect between the independent variable and the dependent variable is not a requirement for mediation using this approach. In addition, we (3) tested whether the indirect effect was significantly different from zero using the Sobel (1982) test.[3]

We thus conducted a series of hierarchical regression models for each mediator (each component of SI) and each academic outcome separately. In the first set of models, we regressed each component of SI on classroom practices, controlling for individual interest at time 1. This model provided the first part of the indirect effect estimates. In a second set of analyses, we regressed each learning outcome on both classroom practices and each component of SI (using a separate model for each component of SI), controlling for individual interest and the outcome at time 1 when it was available. We decided to examine the mediating role of the three components of SI in three distinct models because we observed a high level of interrelatedness of triggered-SI, maintained-SI-feeling, and maintained-SI-value (see Table 1, r ranges from .52 to .71).[4] These models provided the second part of our indirect effect estimates, as well as estimates of the direct effects of classroom practices on each outcome. Finally, we tested the significance of this indirect

[3] *This approach for testing mediation is preferred to the Baron and Kenny (1986) method as it has greater statistical power and reduces the Type II error rate, especially in the case of a small sample size.*

[4] *The reader is referred to the discussion of the SI measure in the method section for information regarding confirmatory factor analyses indicating the preferred fit of a three-factor solution over alternatives.*

Table 1. Means, standard deviations, and bivariate correlations among variables

Measure	*N*	*M (SD)*	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Individual interest T1	117	4.17(.61)	—	—	—	—	—	—	—	—	—	—	—	—	—
2. Perceived competence T1	117	4.42(.53)	.67***	—	—	—	—	—	—	—	—	—	—	—	—
3. Perceived choice	109	3.54(.67)	.27**	.21	—	—	—	—	—	—	—	—	—	—	
4. Instructor approachability	108	4.47(.51)	.26	.20	.47***	—	—	—	—	—	—	—	—	—	
5. Connections to real life	110	3.88(.90)	.07	.04	.21	.32***	—	—	—	—	—	—	—	—	—
6. Supports involvement	109	4.12(.83)	.23	.19	.32***	.24	.10	—	—	—	—	—	—	—	—
7. Group work	110	4.53(.67)	.06	.00	.17	.18	.13	.22	—	—	—	—	—	—	—
8. Triggered-SI	110	4.11(.63)	.32***	.29**	.61***	.59***	.26**	.27**	.15	—	—	—	—	—	—
9. Maintained-SI-feeling	109	4.31(.67)	.43***	.46***	.51***	.39***	.30**	.14	.05	.71***	—	—	—	—	—
10. Maintained -SI-value	109	4.17(.72)	.37***	.31**	.41***	.30**	.35***	.29**	.02	.52***	.63***	—	—	—	—
11. Individual interest T2	110	4.16(.62)	.83***	.66***	.44***	.26**	.20	.21	.10	.55***	.63***	.57***	—	—	—
12. Perceived competence T2	110	4.34(.56)	.56***	.64***	.38***	.27**	.06	.11	−.01	.53***	.56***	.40***	.68***	—	—
13. Engagement	125	4.32(.63)	.19	.24**	.15	.18	.22	−.02	.06	.29**	.48***	.28**	.35***	.23	—

Notes. T1 = time 1, T2 = time 2.
**$p < .01$. ***$p < .001$.

path using the Sobel (1982) test. This three-step approach to examining mediation is more appropriate for small samples than are other potential approaches, such as structural equation modelling.

Because of the large number of analyses conducted, we used the Bonferroni method to adjust the *p*-value for statistical significance. Specifically, we divided the standard *p*-value of .05 by the number of tests in each model or for each set of similar research questions. Accordingly, the *p*-value for evaluating statistical significance was .008 for variables predicting triggered-SI, maintained-SI-feeling, and maintained-SI-value; .007 for variables predicting individual interest and engagement; and .006 for variables predicting perceived competence. When conducting the Sobel (1982) test of indirect effects, we only examined relations that were statistically significant in earlier analyses. We used *p*-values of .013 as the criteria for statistical significance of the four possible mediators of individual interest, .025 for the two possible mediators of perceived competence, and .05 for the one possible mediator of engagement.

Antecedents of SI

As part of the first step for testing the indirect effects for mediation, we conducted a series of multiple regression analyses to identify the contribution that perceived provision of choice, instructor approachability, course material connections to real life, instructor support for involvement, and opportunities for group work made in predicting triggered-SI, maintained-SI-feeling, and maintained-SI-value, above and beyond the contribution of initial individual interest in science. The results for these analyses can be seen in Table 2.

Triggered-SI

The first multiple regression analysis examined the antecedents of triggered-SI. As expected, both perceived choice and instructor approachability significantly predicted triggered-SI, controlling for initial individual interest and other instructional techniques;

Table 2. Regression analyses for predictors of situational interest (n = 99)

	Triggered-SI				Maintained-SI-feeling				Maintained-SI-value			
Predictor	R^2	*B*	*SE*	β	R^2	*B*	*SE*	β	R^2	*B*	*SE*	β
Model	.49**				.38**				.31**			
Individual interest T1		.10	.07	.11		.32	.09	.31**		.29	.11	.26*
Perceived choice		.31	.07	.38**		.32	.09	.35**		.21	.10	.21
Approachability		.41	.11	.35**		.12	.13	.09		.03	.15	.02
Connections to real life		.05	.05	.08		.13	.06	.19		.21	.07	.27*
Supports involvement		.02	.06	.02		−.06	.07	−.07		.11	.08	.13
Group work		−.02	.07	−.03		−.09	.08	−.09		−.16	.09	−.15

Notes. T1 = time 1.
*p < .008. **p < .001.

course connections to real life was unrelated (see Table 2). Contrary to our hypotheses, instructor support for involvement and opportunities for group work were not statistically significant predictors of triggered-SI.

Maintained-SI-feeling

The second multiple regression analysis examined the antecedents of maintained-SI-feeling. As hypothesized, perceived choice was significantly related to maintained-SI-feeling, while instructor approachability and course connections to real life were unrelated (see Table 2). Contrary to our hypotheses, opportunities for involvement (support involvement and group work) did not significantly predict maintained-SI-feeling.

Maintained-SI-value

In the regression analysis predicting maintained-SI-value, course connections to real life was the only statistically significant predictor (see Table 2). This observed association was in line with our hypotheses, but we also expected involvement (support for involvement, group work) to predict maintained-SI-value. As hypothesized, perceived choice and instructor approachability were not statistically significant predictors.

Predicting learning outcomes

Our next step was to conduct a series of regression analyses to obtain estimates of the second part of our indirect effects of triggered-SI, maintained-SI-feeling, and maintained-SI-value on individual interest, perceived competence, and engagement, as well as estimates of the direct association of classroom practices to each learning outcome (see Table 3).

Individual interest

We began by examining predictors of individual interest. Each regression controlled for time 1 individual interest and the five classroom practices. In line with our hypotheses, triggered-SI, maintained-SI-feeling, and maintained-SI-value were each positively related to individual interest at time 2 (see Table 3), thus meeting the second criterion for mediation (e.g., mediator variable significantly predicts the dependent variable after controlling for the independent variables).

These regression analyses also enabled us to examine direct effects of the classroom practices on individual interest, controlling for each sub-component of SI. Notably, these direct effects of classroom practice to individual interest are not a necessary requirement for mediation (MacKinnon *et al.*, 2002), but are still informative regarding the direct effects of classroom practices. After accounting for triggered-SI, the only statistically significant direct association of the classroom practices with individual interest was that of instructor approachability. However, this effect reflected an example of inconsistent mediation such that the direct effect of instructor approachability on individual interest was negative, while each part of the indirect effect estimate (instructor approachability to triggered-SI; triggered-SI to individual interest) was positive. Notably, the correlation between instructor approachability and individual interest was also positive, which, as we discuss later, suggests that the negative association may be due to statistical suppression. After accounting for maintained-SI-value, the direct relation of perceived choice on

Table 3. Regression analyses for predictors of individual interest, perceived competence, and engagement ($n = 99$)

	Individual interest T2				Perceived competence T2				Engagement			
Predictor	R^2	*B*	*SE*	β	R^2	*B*	*SE*	β	R^2	*B*	*SE*	β
Triggered-SI model	.79**				.54**				.10			
Perceived competence T1		n/a	—	—		.48	.11	.46**		n/a	—	—
Individual interest T1		.74	.05	.77**		.13	.10	.15		.07	.11	.07
Perceived choice		.13	.05	.15		.07	.07	.09		.03	.11	.04
Approachability		−.28	.08	−.23**		−.07	.11	−.06		.04	.17	.03
Connection to real life		.06	.03	.09		−.02	.05	−.03		.10	.07	.16
Supports involvement		−.05	.04	−.06		−.10	.05	−.15		−.08	.08	−.11
Group work		−.03	.04	−.03		−.06	.06	−.07		.00	.09	.01
Triggered-SI		.29	.07	.28**		.33	.10	.33**		.18	.15	.16
Maintained-SI-feeling model	.78**				.52**				.22**			
Perceived competence T1		n/a	—	—		.44	.11	.42**		n/a	—	—
Individual interest T1		.70	.05	.73**		.12	.10	.14		−.06	.10	−.06
Perceived choice		.15	.05	.17		.11	.07	.13		−.06	.10	−.07
Approachability		−.19	.07	−.15		.04	.10	.04		.06	.14	.04
Connection to real life		.04	.03	.06		−.03	.05	−.05		.05	.07	.08
Supports involvement		−.03	.04	−.04		−.08	.05	−.12		−.06	.07	−.08
Group work		−.02	.05	−.02		−.05	.06	−.06		.04	.09	.04
Maintained-SI-feeling		.22	.06	.24**		.21	.08	.24		.46	.11	.48**
Maintained-SI-value model	.78**				.50**				.10			
Perceived competence T1		n/a	—	—		.50	.11	.48**		n/a	—	—
Individual interest T1		.72	.05	.75**		.12	.10	.14		.05	.11	.05
Perceived choice		.18	.05	.21**		.15	.07	.19		.06	.11	.07
Approachability		−.17	.07	−.14		.07	.11	.06		.11	.15	.08
Connection to real life		.03	.04	.05		−.02	.05	−.04		.09	.07	.13
Supports involvement		−.06	.04	−.08		−.11	.06	−.16		−.10	.08	−.13
Group work		−.01	.05	−.01		−.05	.07	−.06		.02	.10	.02
Maintained -SI-value		.18	.05	.21**		.10	.07	.12		.13	.10	.15

Notes. T1 = time 1, T2 = time 2.
**$p < .001$.

individual interest was statistically significant and positive. There were no other significant direct associations of classroom practice with individual interest after accounting for the SI component mediators.

The Sobel (1982) test was employed for the indirect pathways that met MacKinnon *et al.*'s (2002) two criteria for mediation that (1) the independent variable significantly predicts the mediator (SI); and (2) the mediator significantly predicts the dependent variable (T2 individual interest). Thus, we conducted Sobel tests for those four pathways that met these criteria. The indirect path from perceived choice to individual interest via triggered-SI was a statistically significant ($z = 2.97, p < .001$), as were the indirect paths from perceived choice to individual interest via maintained-SI-feeling ($z = 2.62, p < .01$) and from instructor approachability to individual interest via triggered-SI ($z = 2.83$, $p < .001$). Using the Bonferroni correction, the indirect path from connections to real life to individual interest via maintained-SI-value was not statistically significant ($z = 2.25$, $p = .024$). Thus, there was evidence for mediation for three of the four potential pathways of classroom practices to individual interest.

Perceived competence

Next, we examined whether SI predicted changes in perceived competence (see Table 3). After controlling for time 1 perceived competence, time 1 individual interest, and classroom practices, triggered-SI was significantly related to time 2 perceived competence. Both maintained-SI-feeling and maintained-SI-value were significantly correlated with perceived competence at time 2 (see Table 1), but did not account for a significant portion of the variance after controlling for the other variables in the model. There were no significant direct associations between the classroom practices and perceived competence.

For perceived competence, two pathways met MacKinnon *et al.*'s (2002) criteria for mediation; thus, the Sobel (1982) test was employed to test the statistical significance of these indirect effects. Both of the indirect paths from perceived choice and instructor approachability to perceived competence via triggered-SI were statistically significant ($z = 2.62, p = .009$ and $z = 2.52, p = .012$). Thus, we found evidence that the triggered-SI mediated the positive associations of both perceived choice and instructor approachability with perceived competence.

Engagement

Finally, we examined the contribution of each of the three forms of SI in predicting engagement (see Table 3). These analyses controlled for individual interest at time 1 and classroom practices. Although we expected all three forms of situational to predict engagement, with the strongest associations for the maintained-SI components, maintained-SI-feeling was the only statistically significant predictor of engagement. There were no significant direct associations of classroom practices with engagement after accounting for SI. With respect to mediation, there was only one pathway (perceived choice to maintained-SI-feeling to engagement) that met MacKinnon *et al.*'s (2002) criteria for mediation. The Sobel (1982) test indicated that the indirect path from perceived choice to engagement via maintained-SI-feeling was statistically significant ($z = 2.68$, $p = .007$). Together, these analyses suggest that maintained-SI-feeling mediated the positive association between perceived choice and engagement.

Discussion

Overall, our results provide evidence that classroom practices differentially predict triggered-SI, maintained-SI-feeling, and maintained-SI-value. Moreover, these three forms of SI were differentially associated with individual interest, perceived competence, and engagement, and mediated the association of classroom practices with these outcomes. Our results suggest that SI can develop into individual interest, and that there may be other positive consequences of supporting SI in the classroom. They also extend prior research, which primarily focused on composite measures of SI, by identifying unique antecedents and consequences of the three SI sub-components.

With respect to classroom practices, autonomy support assessed via perceived choice was clearly the most important classroom predictor of SI. In line with our hypotheses, it was associated with high levels of triggered-SI and maintained-SI-feeling. Moreover, the associations of perceived choice with changes in individual interest, perceived competence, and engagement were mediated via SI. This beneficial pattern associated with perceived choice is not surprising and is consistent with the broader literature highlighting the importance of perceived choice for supporting SI (Ciani *et al.*, 2010; Palmer, 2009; Renninger & Hidi, 2002; Tsai *et al.*, 2008; Zahorik, 1996).

As expected, instructor approachability enhanced triggered-SI, but was not related to either form of maintained-SI. This highlights the importance of the instructor in grabbing students' attention. The associations of instructor approachability with both individual interest and perceived competence were mediated through triggered-SI. Interestingly, there was also a statistically significant negative direct relation of instructor approachability with individual interest. This finding should, however, be interpreted cautiously as the correlation between instructor approachability and individual interest was positive, suggesting that the observed negative association may be due to statistical suppression. The exact pattern of possible suppression is difficult to identify because many variables were included in this model. However, moderate correlations between instructor approachability, perceived choice, and triggered-SI suggest that these three variables are likely to share variance relevant and irrelevant to explaining individual interest. This shared variance could have led to an erroneous negative association between instructor approachability and individual interest. That said, it is also worth noting that there was no case in this analysis (or any other) in which suppression appeared to have inflated observed positive effects for any predictor variable. Thus, alternatively, it is possible that instructor approachability relates to individual interest through multiple pathways and when shared variance is removed, this becomes apparent. While, on one hand, instructor approachability leads to an enhanced individual interest through greater triggered-SI, on the other hand, there may be other mechanisms through which instructor approachability might detract from individual interest development. Overall, our findings highlight that specific aspects of instructors, such as their affective tone and approachability, may play an important role in triggering, but not in maintaining, SI. This helps to clarify earlier findings in which instructor characteristics were related to more general measures of situational or individual interest (e.g., Dohn *et al.*, 2009; Frenzel *et al.*, 2010; Rotgans & Schmidt, 2011b).

Our findings regarding course connections to real life highlight the potentially unique role of relevance for supporting specific aspects of SI; course connections to real life were significantly associated with maintained-SI-value, but not with the other two forms of SI. These findings are aligned with prior research highlighting the positive association between real world connections and composite measures of SI (Dohn *et al.*, 2009;

Hoffmann, 2002; Hulleman & Harackiewicz, 2009; Zahorik, 1996) as well as the few studies that considered the sub-components of SI (Hulleman *et al.*, 2010; Mitchell, 1993). However, our results extend beyond these studies by suggesting that relevance specifically targets the value component of maintained-SI. Surprisingly, while maintained-SI-value was associated with increased individual interest and connections to real life significantly predicted maintained-SI-value, the Sobel (1982) test of the indirect effect was not statistically significant using the Bonferroni adjusted significance levels. This suggests that real world connections may not enhance individual interest via SI; however, it will be important to replicate these findings with a larger sample.

Contrary to our hypotheses, neither indicator of involvement (classroom support for involvement or opportunities for group work) was associated with triggered-SI, maintained-SI-feeling, or maintained-SI-value. Prior research has suggested that involvement is an important component for supporting interest development (Del Favero *et al.*, 2007; Dohn *et al.*, 2009; Freeman *et al.*, 2002; Mitchell, 1993; Palmer, 2009; Renninger & Hidi, 2002; Zahorik, 1996). Thus, our failure to find a significant association in the current study may be the result of a weak measure of involvement. Indeed, we had originally conceptualized involvement as consisting of instructor support via the use of open-ended questions, asking for students' opinions, and opportunities for group work. However, our exploratory factor analyses did not support this conceptualization. Our difficulty in measuring this component as well as the somewhat unexpected pattern of findings may also be due to the particular classroom environment studied. All students were in summer courses that lasted approximately 7 hours each day. Due to the length of daily course sessions and the small class size, instructors were able to use a variety of classroom activities that supported active student involvement. This, coupled with the residential aspect of the programme, may have meant that all students had high feelings of relatedness and involvement with their peers. As such, there may not have been enough variability in students' reports of involvement to adequately model its relationship with SI. Thus, we would caution the interpretation of the involvement findings as suggesting that involvement does not support SI; additional research is needed to more carefully examine this issue.

Our findings further suggest that SI is an important predictor of several relevant educational outcomes. All three forms of SI were associated with increases in individual interest during the course. We find it encouraging that SI is associated with changes in individual interest during 3 weeks of intense instruction. This suggests that instructional practices support interest development, and also lends support for current conceptualizations of interest development via SI (Hidi & Renninger, 2006; Krapp, 2002).

Our finding that triggered-SI and perceived choice (via triggered-SI) supported perceived competence is also noteworthy, especially given the potential role of perceived competence in interest development (Lipstein & Renninger, 2007; Renninger & Hidi, 2002). It is interesting, however, that triggered-SI was the only form of SI that significantly predicted increases in perceived competence during the course. This suggests that targeting students' enjoyment of the instructional method may be more important than enhancing interest in the material itself. Perhaps, as Durik and Harackiewicz (2007) suggested, when students view the content taught as personally relevant or important, this undermines their perceived competence, especially if they are already questioning their abilities. When receiving challenging and advanced course content, as was the case in the current study, excitement and enjoyment surrounding the form of instruction may enable students to engage in a less threatening way than when they find the content itself to be valuable or enjoyable.

Our perceived competence findings are generally aligned with Nieswandt's (2007) and Del Favero *et al.*'s (2007) results, and help extend their work by suggesting that triggered-SI may be the most important sub-component of SI for supporting perceived competence. Our results, however, are in direct contrast to Durik and Harackiewicz's (2007) finding that the collative features condition (triggered-SI) was not significantly related to perceived competence, but the relevance condition (maintained-SI-value) significantly predicted perceived competence among individuals with high initial interest in the domain. One explanation may be that we assessed triggered-SI more broadly. Durik and Harackiewicz changed the appearance of a lab task by adding bright colours and pictures, whereas we assessed students' more general feelings of excitement in relation to the science instruction. With respect to relevance, the difference between these two studies may be due to Durik and Harackiewicz's examination of interactions with initial interest; we lacked the statistical power to test these interactions. Overall, the mixed findings suggest the need for more research to unpack the potential pathways through which the various forms of SI shape perceived competence. Future research should also examine whether perceived competence mediates the association between SI and individual interest.

With respect to academic engagement, maintained-SI-feeling was associated with high levels of instructor-reported engagement during the summer session and mediated the positive association of perceived choice with engagement. Our results are in keeping with the text-based literature, which suggests that SI alters the way in which students engage with texts (Hidi, 2001). Our findings help extend this work by considering engagement in a classroom setting, and by highlighting the particular role of choice and maintained-SI-feeling in supporting academic engagement. Contrary to our hypotheses, neither triggered-SI nor maintained-SI-value was associated with engagement. The findings for triggered-SI are not entirely surprising, in that we expected the association of maintained-SI-feeling with engagement to be stronger than triggered-SI, as the maintained-SI-feeling form of SI would be more likely to sustain engagement even when instruction itself was not exciting within a particular moment. However, our results contradict Durik and Harackiewicz's (2007) findings that use of collative features supported task involvement among participants low in initial interest. It is more surprising that maintained-SI-value was not associated with engagement, especially in light of prior research, suggesting that relevance significantly predicts achievement (Hulleman & Harackiewicz, 2009; Hulleman *et al.*, 2010) or task involvement (Durik & Harackiewicz, 2007). Our reliance on teacher ratings of engagement may explain this discrepant pattern. That is, teachers may be more likely to interpret enthusiasm and positive affect as signs of engagement, which might be observed in the way in which students with high levels of maintain-SI-feeling engage in class activities. Continued research on the potentially unique roles of the two forms of maintained-SI is needed to further clarify these findings.

Finally, our results lend support to the importance of differentiating among triggered-SI, maintained-SI-feeling, and maintained-SI-value. In particular, triggered-SI was uniquely predicted by instructor approachability and uniquely associated with changes in perceived competence. And, maintained-SI-value was uniquely predicted by course connections to real life. In line with research based in self-determination theory suggesting that provision of choice may often do little to support value-based motivation outcomes (e.g., Patall *et al.*, 2010), perceived choice predicted both triggered-SI and maintained-SI-feeling, but not maintained-SI-value. While all three forms of SI were associated with heightened individual interest, only maintained-SI-feeling was significantly related to engagement and only triggered-SI was related to changes in perceived

competence. This suggests that triggered-SI, maintained-SI-feeling, and maintained-SI-value may play somewhat unique roles in shaping students' interest, perceived competence, and engagement, and that classroom practices may differentially influence these three forms of SI. Thus, although these forms of SI are similar and highly correlated, it is useful and important to differentiate these forms, as doing so provides a more nuanced picture regarding the mechanisms for supporting SI (see also Linnenbrink-Garcia *et al.*, 2010 for a similar argument).

Directions for Future Research

Future research using classroom observations of teacher practices, especially in classes with varying levels of triggered-SI, maintained-SI-feeling, and maintained-SI-value, would be useful for expanding on the current findings. For example, observational studies could further confirm that there is actual variation in instructional practices, rather than variation in students' perceptions of classroom practices. Moreover, by conducting a qualitative analysis of instructional practices in classrooms with varying levels of SI, additional mechanisms that help support SI might be identified.

Future research is also needed to determine whether various instructional practices and subsequent SI lead to lasting changes in individual interest and perceived competence in the target domain. Future work with multiple assessments of SI across time would also allow the examination of the associations among the SI components. For example, with multiple assessments, one could investigate whether triggered-SI predicts both forms of maintained-SI. Finally, future work should also consider whether instructional supports for SI are equally beneficial for all students, as there is preliminary experimental work suggesting that the pattern may vary based on initial differences in interest, perceived competence, and prior achievement (Durik & Harackiewicz, 2007; Hulleman & Harackiewicz, 2009; Hulleman *et al.*, 2010).

Conclusion

The results of the current study are encouraging; they suggest that there are practices teachers can implement within their classrooms that may relate to the development of interest, both immediate and enduring, and in turn, other adaptive learning outcomes. We hope that the findings of this study provide a basis for further theoretical and empirical work on interest development as well as provide guidance for educational practices that support interest development.

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