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Is constructivism risky? Social anxiety, classroom participation, competitive game play and constructivist preferences in teacher development

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Abstract

Constructivism in practice is a challenging endeavor that invites teachers and students to engage in problems that elicit uncertainty. This article investigates the relationship between preferences for constructivist approaches and other classroom behaviors that influence the development of future teachers. The theoretical premise for this relationship is that preferences for constructivist activities are associated with other behaviors that are characterized as social risks. Preservice teachers who are 'risk averse' may engage in behaviors that perpetuate their conservatism, leaving them ill prepared for current developments in educational reform. In addition to proposing this unique theoretical question, evidence is presented showing that social risk aversion is behaviorally pervasive, influencing preservice teachers' willingness to participate in classroom discussions, their behavior in a socially competitive game and their natural preference for inquiry-based mathematics problems. Given this pervasiveness, teachers who are 'shy' of contemporary educational reform may unknowingly socially insulate themselves against it. Support strategies are suggested along with appropriate directions for future research and reflection by teacher educators.

Keywords: *Anxiety; Constructivism (Learning); Decision Making; Teacher Attitudes; Teacher Participation*

Introduction

While there has been ample discussion of students at risk, mathematics education at risk and nations at risk, there has been limited discussion of teachers' willingness to take risks in mathematics and science education (but see Clifford, 1988; Clifford *et al.*, 1990). Student-centered learning implies perceived risks by both students and

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teachers, who are asked to produce solutions to open-ended problems that have fuzzy criteria for correctness. It follows that individuals who have different perceptions of social risk may respond differently to 'challenging' environments and require correspondingly different mechanisms or levels of support.

Broadly, risk can be defined as the uncertainty associated with an outcome in a given situation. Risky situations involve high uncertainty. Risk aversion would therefore represent a preference for 'safe' situations that are familiar and for which outcomes are predictable. For teachers, risky behaviors might include asking questions for which the answer is not already known, choosing an open-ended project or demonstration that hasn't already been demonstrated as effective and allowing students to 'explore' problems without giving them explicit instructions about how to answer them. Because teachers' behaviors are evaluated socially—by students, parents, other teachers and administrators—the risks teachers take involve significant social uncertainty. This is important, because social risk has been identified as an important dimension for predicting behavior in social situations involving uncertain outcomes (Jackson *et al.*, 1972; Weber *et al.*, 2002, see below).

Different teachers are likely to make different decisions about when to choose particular educational approaches and their choices may stem from their experiences as preservice teachers. Why preservice teachers make the decisions they do is a deeper question, but it may be related to their willingness to take risks in social situations. If this is true, then understanding social risk perception is likely to provide us with new insights into how to teach educational reform in light of the fact that constructivism in practice 'is a concept situated in ambiguities' (Windschitl, 2002, p. 131)—ambiguities which imply uncertainty and risk.

With respect to preservice teachers, this realization is critical. What it means is—to the extent that educational reform supports behaviors that represent 'risks' to future teachers—what we, as teacher educators, are likely to witness is a divergence of teaching styles and beliefs along the dimension of perceived risk. At one end is the teacher who prefers constructivist approaches to education and who pursues them fervently. At the other end is the teacher who perceives constructivist activities as highly risky and who avoids them at all costs. Most teachers will lie along the range between the two extremes, but their behavior is likely to belie their underlying attitudes and, according to the risk literature, is likely to carry over to other kinds of behaviors and influence what they learn about education (see below). There is therefore an inherent feedback mechanism, where teachers who are most likely to benefit from training are also the least likely to receive it. This is the real risk, because what preservice teachers learn about education will ultimately influence their success as teachers.

Constructivism, disequilibrium and assumed risks

The National Science Teachers Association (2003) describes inquiry according to Resnick (1987) as requiring 'the use of non-algorithmic and complex higher-order thinking skills to address open-ended problems. Multiple solutions may be possible, and the inquirer must use multiple, sometimes conflicting, criteria to evaluate his or

her actions and findings. Inquiry is characterized by a degree of uncertainty about outcomes' (NSTA, 2003, p. 18). Similarly, Lave *et al.* (1988, p. 61) suggest that with respect to mathematics education 'the goal would be to generate dilemmas, opportunities for invention, discovery, and understanding in patterns of activity, rather than to prescribe exercises on specific problem types and procedures'. Challenging environments are also frequently cited in educational psychology as positive motivational factors (Brophy, 1998; Pintrich & Schunk, 2002) and generalized levels of challenge have been proposed (Atkinson, 1957).

According to the work of Piaget, Dewey, Bruner and others, engaging confusion (i.e. disequilibrium) is the mainspring of learning. Appropriate levels of internal conflict drive individuals to resolve that conflict with better solutions. Reiman (1999, p. 610) puts it the following way with respect to teacher education: 'Disequilibrium needs to be better understood as a central process in teacher development and teacher reflective activity. Substantial learning occurs in periods of conflict, confusion, surprise, and over long periods of time'. Tolerance for risk taking is critical to teacher change (Hubbard, 2001).

Teachers' willingness to confront change is not only relevant for their abilities to manifest constructivism in practice. It is also relevant to their long-term survival in a field that is constantly in the ebb and flow of reform. The ability to incorporate innovative practices into one's classroom is both a function of external support mechanisms and an internal willingness to go where one hasn't gone before (Rogers, 2000; Davis, 2002). While external factors are extremely important, ultimately 'the individual teacher must be willing to take risks' (Norum *et al.*, 1999, p. 202).

But teaching teachers how to take risks requires that teacher educators understand the systemic nature of risk perception and its underlying pervasiveness. For example, tolerance for risk and uncertainty is embedded in individual self-perception and goals (Trope, 1986; Sedikides & Strube, 1995). Individuals who differ in whether they are seeking mastery or performance goals frequently differ in their willingness to engage in challenging situations (Ames *et al.*, 1977; Nicholls *et al.*, 1985; Dweck, 1986; Elliott & Dweck, 1988). Ames and Archer (1988) observed that learners' willingness to take risks is associated with their perceptions of whether or not they are focusing on developing new skills (mastery goals) or on identifying personal ability and doing well on assessments (performance goals) (also see Trope, 1986). 'When students perceived emphasis on mastery goals, they reported using more learning strategies, [and] preferred tasks that offered challenge' (Ames & Archer, 1988, p. 263). However, when students perceived performance goals—involving assessment and evaluation—they used fewer learning strategies and avoided challenging problems.

What is not yet well understood is how these individual preferences and behaviors in general are related to constructivist methodologies. Evidence suggests that students and teachers generally avoid uncertainty (Covington, 1992). They may deliberately choose 'self-enhancing' problems for which they already know the answer (Brown, 1990). But simply knowing this and teaching it to future teachers in a general way is not enough—understanding individual differences is critical. If social risk aversion is strongly associated with aversion for open-ended activities and participation in

classroom discussion—perceived as 'threats to competence'—then risk-averse students and teachers may suffer not only because they do not respond well to uncertainty, but also because they do not make their preferences known (Ryan *et al.*, 2001).

In the following section, I provide evidence for a three-point argument to suggest that the above issues should be serious concerns for teacher educators who hope to go beyond 'preaching to the choir.' First, there is well-established evidence that social risk is a valid and reliable construct with significant individual differences. Second, these individual differences are associated with predictable differences in preferences and behavior in social situations. Third, the preferences and behavior among socially risk-averse individuals are associated with a need for rigid structure and avoidance of challenging problems—situations potentially in direct contrast to constructivism in practice. The evidence strongly suggests that preservice teachers' behaviors are directly related to their constructivist preferences and willingness to engage in situations that may be regarded as threats to competence. Teacher educators who use open classroom discussions to form their beliefs about students' progress are therefore likely to be misinformed. Furthermore, aversion to constructivist activities is very likely to be associated with other behaviors, like pursuing non-challenging math and science problems, leading socially risk-averse preservice teachers to not prepare themselves well for inquiry-guided learning even if they hope to employ it.

Social risk, tolerance for ambiguity, and constructivism

At various times, researchers have found evidence supporting a unitary risk dimension (Maner & Schmidt, 2006) and evidence supporting risk as a multidimensional trait (Slovic, 1964; Weber *et al.*, 2002). Still other studies have found evidence for both (Jackson *et al.*, 1972). Consistently, however, researchers find evidence for a single, reliable social risk construct (Jackson *et al.*, 1972; Weber *et al.*, 2002). Weber *et al.* (2002) developed a domain-specific risk-attitude scale and found significant reliability and factor independence for five risk domains (financial decisions, health/safety, recreational, ethical and social). Of their five domains, social risk was the one most clearly related to decisions involving the evaluations of others and behavior in public situations; subjects were asked to indicate the likelihood of engaging in activities like the following: 'Speaking your mind about an unpopular issue at a social occasion' and 'Wearing unconventional clothes' (p. 287). Weber *et al.* also found significant validity for social risk by asking subjects to self-report their engagement in behaviors associated with social risk taking. Jackson *et al.* (1972) found similar evidence for the multidimensionality of risk—including a unitary social risk construct, based on subjects' evaluation of different situations that might be 'embarrassing'.

Multiple forms of evidence suggest that social risk is associated with anxiety related to making a positive impression and avoiding exclusion or negative perceptions by others (Schlenker & Leary, 1982; Leary & Kowalski, 1995). In an empirical study, Baldwin and Main (2001) showed that a person's social interactions were perceived to be more self-conscious when the social interaction was paired with an unconscious tone that had been previously associated with negative evaluations.

The self-consciousness was perceived both by the subject—who felt as if they were behaving more self-consciously—and by the person they were interacting with (a confederate) who was unaware of the tone's negative or positive association. This is consistent with the Ames and Archer (1988) findings described above, where learners who perceive an evaluative environment prefer less challenging tasks and use fewer learning strategies.

The effects of social anxiety on behavior have been observed repeatedly and are associated with specific individual differences (Baldwin & Main, 2001; Weber *et al.*, 2002; Baldwin & Kay, 2003; Maner *et al.*, 2007). In the study by Baldwin and Main (2001), the high self-conscious individuals (as measured by self-report questionnaires) were much more sensitive to the positive or negative association of the tone, whereas individuals with low self-consciousness were unaffected by the tone (also see Baldwin & Kay, 2003). High social anxiety has also been associated with risk avoidance in a risk-eliciting interactive game (The Balloon Analogue Risk Task described below, see Maner *et al.*, 2007). Higher levels of social anxiety and threats of negative evaluation have also been found to reduce people's willingness and ability to speak in front of an audience (Pavio & Lambert, 1959; Levin *et al.*, 1960; Pavio, 1964)—a behavior critical to student and teacher development. Moreover, teacher educators use feedback from preservice teachers to guide discussions, to determine what topics students are interested in and to establish what kinds of material need more attention. If social anxiety is related to a preference for more structured and less constructivist activities, and is simultaneously leading students with these perspectives to refrain from making their preferences known, then teacher educators who use open forum classroom feedback are likely to be highly misinformed.

But what is the evidence that preferences for more structured, simple and unambiguous situations are related to social risk and anxiety? People who self-report being high in social anxiety, as measured by the Social Anxiety subscale of the Self-Consciousness Scale (Fenigstein *et al.*, 1975), also have a strong preference for situations and environments with 'simple structure', as measured by the Personal Need for Structure Scale (Neuberg & Newsom, 1993). The Personal Need for Structure Scale evaluates a person's preference for 'structure and clarity' and their likelihood to feel discomfort in situations of 'ambiguity'. In other words, social anxiety is directly related to a preference for unambiguous situations. There is also a negative correlation between scores on the Need for Cognition Scale and the Self-Consciousness Scale (a measure of social anxiety) (Osberg, 1987; Neuberg & Newsom, 1993). Need for cognition is positively associated with 'curiosity' (Osberg, 1987), 'desire for new experiences' and the 'ability to generate a higher number of task relevant thoughts,' whereas it is negatively correlated with a 'need for structure,' 'closed mindedness' and the tendency to 'avoid, ignore, or distort new information' (cited in Nair & Ramnarayan, 2000, p. 306). Overwhelmingly, social anxiety appears to have a direct negative relationship with preferences and behaviors that are ostensibly constructivist. The descriptions of need for cognition and personal need for structure use language that is strikingly similar to that quoted above by Lave *et al.* (1988),

Reiman (1999) and the National Science Teachers Association (2003) in their discussions of appropriate situations for constructivist learning.

The above forms of evidence strongly support the need for educational research to investigate a relationship between individual differences in social anxiety and preservice teachers' preferences for constructivism and their willingness to take risks in social situations. These social risks are likely to include willingness to actively participate in open discussions, a willingness to take risks in a competitive situation and general preferences for structure and unambiguous situations.

Understanding the pervasiveness of constructivist preferences

The overarching goal of this article is to inspire teacher educators to think beyond broad generalizations of teachers, developing teachers, and students as embodying general risk-related behaviors—like entering 'survival mode' or being 'shy'—and to instead pay more attention to individual differences and the consequences of those differences for constructivist approaches in the classroom. Ultimately, this will improve our support mechanisms for teacher development and improve the outcomes of our future students. To do this we need to begin to understand how pervasive risk-related behaviors are. The ideas and evidence presented here are *not* meant to be the last word in risk among preservice teachers. Quite the contrary, they are meant to provide a ground for reflective inquiry and future research.

To begin to understand the pervasiveness of risk-related behavior among preservice teachers, the research from the social risk literature needs to be extended to the decisions of preservice teachers during typical coursework. The empirical evidence presented here uses three different forms of analysis and takes a quantitative perspective in an effort to provide a broad overview of individual differences among preservice teachers. This research also takes advantage of new technologies for quantifying decisions in a group environment (see below).

In the present case, a quantitative approach best captures the crossover research needed to bring social risk-related behavior from a quantitative social risk domain to the attention of the educational community. It also allows us to better differentiate individuals with respect to that literature, which can then be used to inform more detailed qualitative approaches. It is hoped this approach will better allow educational researchers to leverage the power of previous scholarly work on social risk to gain a better understanding of how these issues influence teacher development. Ideal future research will use this work as a guide to a mixed methodological approach towards developing appropriate grounded theory.

The basic research outline follows. Using an interactive computer simulation, preservice teachers' decisions in a classroom-based risk-eliciting investment game were recorded—this task is designed as a social variation of a risk-eliciting behavior task well established in the psychology literature (Lejuez *et al.*, 2002, see below). These data were compared with a data-blind evaluation of preservice teacher participation in open discussions and the results of a survey addressing constructivist preferences in science and mathematics as well as general risk preferences. These data

were used to evaluate the relationship between risky behaviors, participation, preferences and the role of gender.

The sample cohort

Data were collected from two undergraduate classes of students preparing for teacher certification (N = 35). Fifty-three percent of subjects were male and 47% female (mean age approximately 20.5 years). Two students were missing from the investment game (N = 33) and one student missed the survey (N = 34); only students with complete data are included in the relevant analyses. Students were all in their second or third year of undergraduate education, and had been in the teacher certification program for at least one year. The classes were not restricted to future math or science educators, but included fewer than five students in computer science and physical education; because of small class sizes, collecting these data would have violated confidentiality. All data were collected in accordance with appropriate ethical standards by the human subjects boards at the University of Texas at Austin. The course addressed the range of approaches to education from behaviorism to constructivism and provided numerous opportunities for students to reveal their constructivist preferences and to construct the theoretical and practical applications of a given approach.

The investment simulation

The investment simulation is a variation of the Balloon Analogue Risk Task (BART), designed by Lejuez *et al.* (2002), which has been shown to identify individuals who are prone to taking risks in a variety of social and non-social situations (Lejuez *et al.*, 2004; Aklin *et al.*, 2005). BART involves pumping up a virtual balloon as large as possible and stopping before the balloon pops. Subjects get points for each pump—and can stop at any time to collect them—but lose all the points for that round if the balloon pops. Subjects with high social anxiety tend to pump fewer times on average than subjects who have lower social anxiety (Maner *et al.*, 2007).

As part of a demonstration of content-related interactive technology, students (i.e. preservice teachers) in both classes participated in a group investment simulation built in NetLogo (Wilensky, 1999) in which the goal was to own the most cars on the last turn. Each student began with $100 and could choose to purchase cars at the price of $50 each at any time before the end of the game. Students chose how much of the remainder to invest at each turn and received 30% return on their investment at the beginning of the next turn. Personal client monitors on students' laptops allowed individuals to follow their own bank accounts and number of cars purchased. Before the first run of the game, students were allowed to interact with the interface until they felt comfortable. The instructor monitored students' actions on an upfront computer terminal and verified that students understood how to invest and buy cars by asking them to do so and following their responses.

After students understood how to play the game, they were told that after each turn the game would stop with a one in ten chance controlled by a random number generator. In other words, the average game should last ten turns, but no one, not even the instructor, knew exactly when the game would stop. The optimal strategy during this part of the game was to play a mixed strategy, equivalent to purchasing cars with probability approximately 0.3 each turn. In both classes, the first run with variable turn length lasted fewer than five turns. However, the second run lasted over 20 turns and data taken during this longer-duration run were those used in the analyses that follow. We chose to use this run because we felt it captured students' initial inclinations in the game, unfettered by exhaustive mathematical deliberation or the opinions of other students or the instructor about how the game should be played. The risk-related measure chosen for the investment game was the number of turns the student initially went without purchasing a car (turns until first purchase, TUFP).

Survey of risk preference

Students were given a questionnaire to assess their preferences for mathematical or scientific risk or for challenging tasks. Four questions were asked about preferences for risk-related behavior. Questions one and two were taken from a survey given by Ames and Archer (1988), used to assess students' general task preferences.

> On a 5-point scale (1 = not likely at all; 5 = very likely) indicate your preference for the following two types of projects:
>
> __ A. A project where you can learn a lot of new things but will also have some difficulty and make many mistakes.
>
> __ B. A project that would have a minimum of struggle or confusion and you would probably do very well.

Ames and Archer (1988) found that this question was very strongly correlated with students' perceptions of mastery goals in the classroom, willingness to try different learning strategies and positive classroom attitudes. Similar to Ames and Archer, preservice teacher responses to the two items were highly correlated ($r = -0.61$, $p < 0.001$), so item scores were combined (as in Ames & Archer). Therefore higher scores represented a preference for more challenging work.

Question 3 was used to assess students' preference for open-ended science activities.

> Most often, I prefer science activities with…
>
> A. Open-ended outcomes that require innovative thinking and could easily amount to nothing or go far afield of the key scientific ideas.
>
> B. Single correct answers, which require the ability to follow directions, and which demonstrate key ideas in science.

Question 4 was used to assess students' preference for open-ended mathematics.

> Most often, I prefer mathematics problems that…
>
> A. Have one correct answer that is not difficult to find.

B. Don't have one correct answer, require creative thinking, and may not ever be solved satisfactorily.

Students were given the survey one week after the investment simulation, but had prior opportunities to address the later two questions through reflective assignments.

Evaluation of participation in class discussions

To evaluate participation in class discussions, near the end of the semester the instructor and teaching assistant were asked to evaluate students' participation in discussions during the course by independently assigning scores of 1, 2 or 3 to all students, where '1' represented 'only speaking when spoken to,' '3' represented 'active involvement in all open discussions' and '2' represented a position in between. Students were then assigned to two groups based on the combination of the two scores. Groups represented those with 'low' participation (with scores of [1, 1] or [1, 2]) and those with 'high' participation (with scores of [2, 3] or [3, 3]). No students received [1, 3] or [2, 2]. Sixty-three percent of students fell into the low participation group, whereas 37% had high participation scores, divided roughly evenly between the two classes.

Long-term stability of risk preferences is a question we are unable to address here, but nonetheless a very important question with respect to teacher development. The social risk literature would suggest that social risk preferences are stable at least over the recent history of behavior (Weber *et al*., 2002). The present participation results extend over the course of the semester. Reliability is a question of equal importance for all of the measures used here, but statistical reliability does not imply that 'social risk' is a theoretically meaningful construct for developing teachers. The construct proposed here is individual consistency of social risk-related preferences and behavior. The measure of reliability in this context, then, is the relationship between apparent preferences and decisions in multiple contexts. A significant relationship there is de facto evidence of reliability with respect to the primary concern of risk pervasiveness among preservice teachers.

Results

The primary hypothesis is that social risk preferences and behavior will be conserved between constructivist activities in math and science, risky tasks in general, participation in discussions and risky behavior in a socially competitive game. The analyses, therefore, focus on the relations between these variables. Means and standard deviations are presented in Table 1 along with the pair-wise correlations between the measured variables. Overall, there was a strong relationship between socially risky preferences and behavior among the preservice teachers in the study. The only metric that didn't show this relationship was preference for open-ended science activities. All the other risk variables in the study showed a positive correlation with respect to risk. Preference for generally challenging projects (as measured by the Ames & Archer [1988] question) was positively correlated with a preference for

Table 1. Means, standard deviations, number and intercorrelations among each of the variables

Variable	Mean	SD	N	TUFP	Participation	MathP	ScienceP	RiskP
TUFP	5.18	5.4	33	–	0.38*	0.35*	–0.22	0.37*
Participation	0.37	0.98	35		–	0.42*	–0.14	0.46**
MathP	0.71	0.46	34			–	–0.22	0.55***
ScienceP	0.51	0.51	34				–	–0.29
RiskP	–0.11	2.05	34					–

Note. TUFP = turns until first purchase; Participation (0 = passive, 1 = active); MathP = answer to math preference question 4 (0 = A or 'one correct answer,' 1 = B or 'don't have one correct answer'); ScienceP = answer to science preference question 3 (0 = B or 'single correct answer,' 1 = A or 'open-ended outcomes'); RiskP = difference taken between Questions 1 and 2 (taken from Ames & Archer, 1988).
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

challenging open-ended mathematics problems, active classroom participation and risky behavior in the competitive social investment game. As well, these were all also positively correlated with one another. Consistent with the prior studies, the results suggest that active participation in classes (i.e. speaking in front of an audience; see Levin *et al.*, 1960) and risky competitive game play (see Maner *et al.*, 2007) were both strong indicators of students' underlying constructivist preferences, which themselves appear to be markedly similar to other constructs that are sensitive to social anxiety (Neuberg & Newsom, 1993; Nair & Ramnarayan, 2000).

To investigate causal attributions, variables were placed independently in a non-parametric one-way analysis of variance (the Kruskal-Wallis test), with turns until first purchase and participation in class discussions as the dependent variables (see Table 2). This reveals the strong relationship between active classroom participation and math preference for problems that 'don't have one correct answer'. Students who prefer more open-ended mathematics were 45% more likely to participate in discussions than students who preferred math problems with 'one correct answer'. The relationship between math preference and risk in the investment game is weaker than that found in the correlation in Table 1, but the result is highly suggestive given the sample size. Science preferences were not found to be a good predictor of either investment game behavior or active class participation (see below). Risk preferences are analyzed here as a two-category factor by taking the sign of the difference between Questions 1 and 2 (part A and B). The results indicate that risk preference in the Ames and Archer (1988) question is a significant predictor of both behavior in the investment game and participation in discussions; individuals with a higher risk preference take approximately three turns longer on average to purchase their first car and are 38% more likely to actively participate in discussions. Gender was not a good predictor of behavior in either the investment game or the classroom participation. A t-test was also used to evaluate gender with respect to science preference, math preference and general risk preferences; all relationships were not statistically significant (science: $t(32) = -1.72$, $p > 0.05$; math: $t(32) = 0.51$, $p > 0.05$; general preferences: $t(32) = -1.02$, $p > 0.05$).

Table 2. Results of casual attributions between preferences and behavior

Variable	TUFP	P^a	Participation	P^a
MathP		0.062		0.015[b]
- 'one correct answer'	4.12 (23)		0.25 (24)	
- 'don't have one correct answer'	8.33 (9)		0.70 (10)	
ScienceP		0.321		0.436
- 'single correct answer'	6.5 (16)		0.44 (18)	
- 'open-ended outcomes'	4.12 (16)		0.31 (16)	
RiskP		0.047[b]		0.038[b]
- < 0	3.43 (17)		0.23 (17)	
- > 0	6.75 (13)		0.61 (13)	
Gender		0.558		0.464
- male	5.78 (18)		0.32 (19)	
- female	4.47 (15)		0.44 (16)	

Note. Column entries are Mean (*N*) except for *P* values; TUFP = turns before first purchase; MathP = math preference; ScienceP = science preference; RiskP = risk preference (< 0 if B > A; > 0 if A > B).

[a] *P*s estimated using Kruskal-Wallis test.

[b] Statistically significant.

The results are somewhat surprising, for three reasons. First, science preferences seem to lie in a category that is independent of risk in other areas. This perhaps doesn't offer any new insight into the perennial question of whether preservice teachers in science and mathematics should be treated differently, but it does suggest that the behavioral consequences of preservice teachers' relationships with constructivist approaches to science and mathematics may be quite different. In the present study, preferring closed math problems with single solutions is far more likely to be associated with risk avoidance in general, passive classroom behavior and non-risky behavior in a competitive social game. One possible explanation for this relationship is that science is more typically perceived as a constructivist endeavor—involving 'experiments'—whereas mathematics is usually construed as a more rigid body of truth where constructivist approaches are more difficult to achieve (Schoenfeld, 1989; Boaler, 1997).

A second surprising finding is that gender does not significantly correlate with any of the risk variables. Differences in gender have been purported to indicate willingness to take risks in other contexts (e.g. Slovic, 1966; Spigner *et al.*, 1993; Boverie *et al.*, 1995; Weber *et al.*, 2002). However, in Weber *et al.*'s (2002) large study (560 subjects) on the multidimensionality of risk, social risk taking was the only component that failed to show a gender effect. The absence of gender differences in risk has also been observed in other educational contexts (Clifford, 1988), and this further supports the idea that social risk is a particular kind of risk. The results here are consistent with the hypothesis that constructivist preferences in mathematics are correlated with a willingness to take social risks, but not necessarily other kinds of risks (see Weber *et al.*, 2002).

The third reason for surprise, is that, with respect to the main premise of this article, the results suggest a strong relationship between active classroom participation, preference for open-ended tasks in general and a willingness to engage in constructivist mathematics. The presence of a relationship with the competitive investment game seems to suggest that the behavioral consequences of constructivist preferences and social risk avoidance may be more pervasive than we presently suspect. While we may have suspected that some students' consistent lack of participation in a class is due to boredom or fatigue and that some teachers' preferences for avoiding open-ended problems might be a mechanism they feel will help them maintain classroom control, it is not at all clear then how we would explain the relationship that is observed here. Beyond the 'constructivism is socially risky' argument presented here, I find no theoretical evidence to suggest a relationship between these diverse behaviors and preferences. To reiterate the empirical evidence, constructivist mathematics is highly correlated with risk preferences in general (Table 1), and both of these risk preferences are predictive of high levels of class participation (Table 2)—shown to be associated with social risk taking (Pavio & Lambert, 1959; Levin *et al.*, 1960; Pavio, 1964)—and with a risk-taking game—also shown to correlate with social risk taking (Maner *et al.*, 2007). Preferences for constructivist mathematics appear to be related to low levels of social anxiety and a willingness to take social risks.

The systemic nature of this relationship is summarized in Figure 1. Social risk-related behaviors appear to be strongly aligned with constructivist preferences; individuals with limited preference for constructivist activities (in mathematics) are

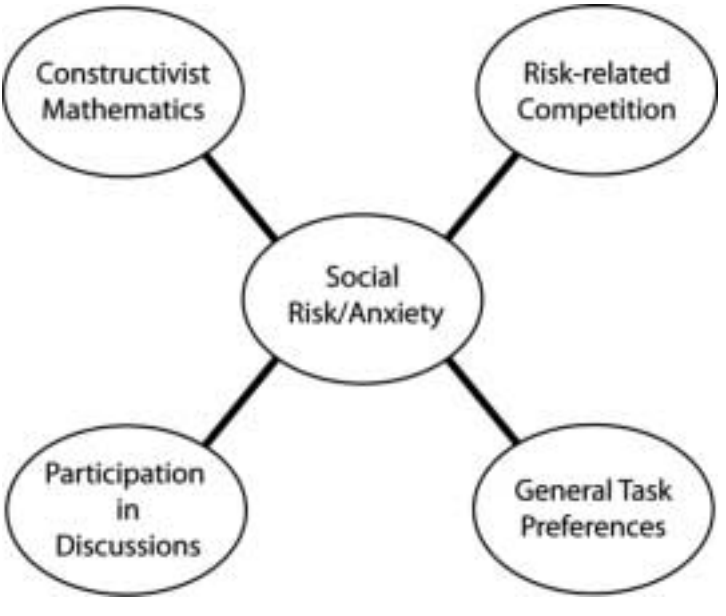

Figure 1. The systemic nature of social risk in teacher development. Risk perception related to constructivist mathematics is tightly linked to participation in discussions, preference for risk in general tasks and willingness to take risks in competitive interactions with other students

also least likely to participate in discussions in a classroom that are specifically about constructivist approaches to education.

Because of the nature of the investment game, these results also provide us with a theoretical explanation which may help guide future grounded theory. That is, in the investment game there are really two kinds of risk. One kind of risk is associated with 'playing to win' and involves being the last person to purchase cars, so that one's money is invested for the longest amount of time. The other kind of risk is a much more conservative risk and involves 'playing not to lose'—a form of risk we are inclined to associate with high social anxiety—which in this case is consistent with purchasing cars very early after the game begins. While these individuals may occasionally win, probabilistically speaking, what they guarantee themselves most frequently is that they will have more than zero cars when the game ends. This idea of 'playing to win' juxtaposed against 'playing not to lose' also has meaning with respect to mathematics preferences, because mathematics is notorious for anxiety associated with not knowing the answer (see Ashcraft, 2002 for a recent review). Confining oneself to easy math problems with a single correct answer is very much like 'playing not to lose'. Seeking out open problems, on the other hand, is more commensurate with 'playing to win'.

Supporting teachers' willingness to take risks

In terms of threats to competence (Ryan *et al.*, 2001), teachers' largest threats are likely to be active participation in discussions (i.e. openly sharing one's ideas and opinions) and engaging in potentially confusing tasks where the appropriate content knowledge is not well defined ahead of time. The main theoretical argument presented here suggests that willingness to engage these threats to competence and self-assessment (Trope, 1986; Sedikides & Strube, 1995) may be tightly linked with risky behaviors in other situations, and in particular with willingness to engage in open-ended mathematics. If constructivism in practice involves putting teachers and students in positions where their competence is threatened, then our real question as teacher educators is the following: How do we identify appropriate support structures for constructivist ideologies in light of the fact that teachers and students who most need this support are also those most likely to hide their needs for that support?

If the theoretical premise presented here is correct, then there are a number of related questions that need to be addressed by future research in our efforts to support teacher development. While the data presented here support aspects of this premise, the study presented here is designed to provoke more research into individual differences between teachers with respect to social risk and constructivist preferences and behavior. In particular, the critical feature of this future research will be that it addresses individual differences in preservice teachers' perceived risk in different environments, and follows their development as a consequence of their perception, under differing circumstances. In this respect, forces that influence the relationship presented in Figure 1 are of critical importance. The theory that arises as a result of this work will then allow us to develop the necessary approaches for

supporting teachers who, because of the pervasive nature of social risk avoidance, are least likely to show any signs that they need that support.

Some of the questions that need to be addressed are the following. What are the socio-cultural aspects of perceived risk? Classrooms are social environments and much of perceived risk may be defined as social risk, which may depend on economic or cultural factors and may also be related to anonymity (Davis, 2003). Understanding the socio-cultural aspects of social risk is therefore vital to a grounded theory of perceived risk among teachers. We should also ask questions about how perceived risk is influenced by aspects of the learning environment. Does moving socially risk-averse preservice teachers into groups of more socially risky individuals help them to engage constructivism in the same way that it may lead individuals to polarize in other beliefs (see Isenberg, 1986)? Do teachers and students associate risk with specific kinds of activities, for example is mathematics applied to science perceived as less risky than pure math? Does having 'pro' constructivist students present early, followed by instructor praise, enhance positive modeling as it can in other types of gambles (see Kearney & Drabman, 2005)? These kinds of questions go hand in hand with social questions, but also deal specifically with the kinds of methodologies that teachers bring to classrooms. It is clearly not appropriate to try to eliminate risk from classrooms, for example if risks are implied by open discussion, presentations or turning in assignments. However, if we can understand how situations increase perceived risk, then perhaps we can also understand how to alleviate those risks through appropriate support mechanisms. For example, if 'doing mathematics' represents a perceived risk, might we not frame mathematics in the context of model-eliciting activities (e.g. Lesh & Lehrer, 2003) or in the context of a group simulation (Wilensky & Stroup, 1999)? These situations may increase perceived risk, or they may reduce it by distributing threats to competence. However, the teacher's perceived risk must also be addressed in these situations, and this is one of the strengths of a grounded theoretical approach.

Other questions with respect to teacher development address how perceptions change with teacher experience and what aspects of teacher experience influence those changes. Are there particular kinds of teacher education experiences that increase or decrease perceived social risk among future teachers? Numerous excellent studies have addressed how experiences during teacher training influence teacher decisions (e.g. Luft *et al.*, 2003), but none have dealt specifically with the pervasiveness of individual differences in the frame of social risk perception. As stated above, without this frame our research based on voluntary participation is very likely to be biased in favor of what we, as teacher educators, hope to be accomplishing. That is, because students who prefer inquiry-guided activities and related constructivist practices are more likely to be vocal about their beliefs by participating in discussions, our inferences based on this feedback are necessarily biased in support of the effectiveness of our programs. Students who choose to speak are telling us what we want to hear.

The specific tasks presented in the data above offer some insights as well. The observation that game behavior, participation and preference are all related suggests that classrooms that too strongly approach constructivist mathematics with open-ended

questions that create confusion (i.e. disequilibrium) and challenge students without extensive support mechanisms may not be perceived as productive for many of the students who do not share the same risk tolerance as the teacher. Naturally, the inverse is also likely to be true. Overly risk-averse teachers may fail to challenge many of their students, again leading to less than favorable outcomes. Moreover, students in 'high-risk' groups (e.g. Attention Deficit Hyperactivity Disorder associated with novelty seeking, Ebstein *et al.*, 1996) may have the most to benefit from more challenging environments, though they often seem to receive the opposite. All of these issues are critical to our understanding of teacher and student development and are likely to have a significant impact on teachers' decisions.

New teachers certainly have good reasons to avoid risky educational situations. The characterization of constructivism described by Lave *et al.* (1988) and Reiman (1999) is likely to create classroom situations that challenge teachers' abilities to control outcomes. Resorting to familiar non-constructivist approaches may be a form of survival behavior, which allows teachers to create a more controlled environment. Research on individual differences with regards to preferences and behaviors associated with constructivism can help us understand both why certain teachers use the methods they use as well as understand why some teachers respond in one way to social stressors while others respond differently. It also helps us to understand that high-stakes student testing combined with state and federal sanctions creates an environment for teachers and students that is more closely aligned with threats to competence and threats of negative evaluation that inhibit constructivist behaviors, as described by Ames and Archer (1988). In this way, attending to differences in social risk provides us not only with the observation that teachers have different preferences and behavior with respect to constructivism, but it also provides us with insight into why these differences exist and under what conditions we should expect to observe them.

Conclusions

The theoretical argument presented here is that social risk taking is a critical feature of teacher development and that teachers' behaviors associated with perceived risk are pervasive. The pervasiveness of these behaviors, along with their association with constructivist preferences, naturally influence the developing teacher through subtle and overt decisions they make in different contexts, which tend to insulate them from the kinds of training that might help them develop skills for productive implementations of constructivist practices. Evidence for the pervasiveness of social risk-related behaviors is presented showing that risky classroom investment behavior, active participation and preference for risky tasks and constructivist-type mathematics are tightly linked. Science preferences do not show a similar relationship and I suggest this may be due to a more dominant experimental paradigm in science than in mathematics.

Understanding support structures for teacher development in relation to perceived risk requires more research based on individual differences and based on teacher

development as a possible feedback mechanism—preference for low-risk situations may prevent some teachers from developing skills associated with constructivism in practice. Some possible avenues for this research are presented, including studies of anonymity, group simulations, socio-cultural research and research on teachers' risk perceptions through time.

A natural goal of this research is that teachers in training can both be aided in their development towards more confident teaching styles that engage uncertainty and that teachers can be better informed about perceived risk among their future students. As recently stated by Perry and Ball (2004, p. 12) in this journal, 'prospective teachers need to be educated about ways that are not their own preferences and strengths, because it is extremely likely that those ways will be expressing other learners' preferences'. The variety of social risk preferences definitely forms part of those 'ways', and the reality is that we, as teacher educators, don't yet understand those ways very well.

References

Aklin, W. M., Lejuez, C. W., Zvolensky, M. J., Kahler, C. W. & Gwadz, M. (2005) Evaluation of behavioral measures of risk taking propensity with inner city adolescents, *Behavioral Research and Therapy,* 43, 215–228.

Ames, C., Ames, R. & Felker, D. W. (1977) Effects of competitive reward structures and valence of outcome on children's achievement attributions, *Journal of Educational Psychology,* 69, 1–8.

Ames, C. & Archer, J. (1988) Achievement goals in the classroom: students' learning strategies and motivation processes, *Journal of Educational Psychology,* 80, 260–267.

Ashcraft, M. H. (2002) Math anxiety: personal, educational, and cognitive consequences, *Current Directions in Psychological Science,* 11, 181–185.

Atkinson, J. W. (1957) Motivational determinants of risk-taking behavior, *Psychological Review,* 64, 359–372.

Baldwin, M. W. & Kay, A. C. (2003) Adult attachment and the inhibition of rejection, *Journal of Social and Clinical Psychology,* 22, 275–293.

Baldwin, M. W. & Main, K. J. (2001) Social anxiety and the cued activation of relational knowledge, *Personality and Social Psychology Bulletin,* 27, 1637–1646.

Boaler, J. (1997) *Experiencing school mathematics: teaching styles, sex, and setting* (Buckingham, Open University Press).

Boverie, P. E., Scheuffele, D. J. & Raymond, E. L. (1995) Multimethodological approach to examining risk-taking, *Current Psychology,* 13, 289–302.

Brophy, J. E. (1998) *Motivating students to learn* (Columbus, OH, McGraw-Hill).

Brown, J. D. (1990) Evaluating one's abilities: shortcuts and stumbling blocks on the road to self-knowledge, *Journal of Experimental Social Psychology,* 26, 149–167.

Clifford, M. M. (1988) Failure tolerance and academic risk-taking in ten- to twelve-year-old students, *British Journal of Educational Psychology,* 58, 15–27.

Clifford, M. M., Chou, F. C., Mao, K., Lan, W. Y. & Kuo, S. (1990) Academic risk taking, development, and external constraint, *Journal of Experimental Education,* 59, 45–64.

Covington, M. V. (1992) *Making the grade* (Cambridge, Cambridge University Press).

Davis, K. (2002) 'Change is hard': what science teachers are telling us about reform and teacher learning of innovative practices, *Science Education,* 87, 3–30.

Davis, S. (2003) Observations in classrooms using a network of handheld devices, *Journal of Computer Assisted Learning,* 19, 298–307.

Dweck, C. S. (1986) Motivational processes affecting learning, *American Psychologist,* 41, 1040–1048.

Ebstein, R. P., Novick, O., Umansky, R. *et al.* (1996) Dopamine D4 receptor (D4DR) exon III polymorphism associated with the human personality trait of Novelty Seeking, *Nature Genetics,* 12, 78–80.

Elliott, E. S. & Dweck, C. S. (1988) Goals: an approach to motivation and achievement, *Journal of Personality and Social Psychology,* 54, 5–12.

Fenigstein, A., Scheier, M. F. & Buss, A. H. (1975) Public and private self-consciousness: assessment and theory, *Journal of Consulting and Clinical Psychology,* 43, 522–527.

Hubbard, N. (2001) Three contexts for exploring teacher research: lessons about trust, power and risk, in: G. Burnaford, J. Fischer & D. Hobson (Eds) *Teachers doing research: the power of action through inquiry* (Mahwah, NJ, Lawrence Erlbaum Associates), 295–306.

Isenberg, D. J. (1986) Group polarization: a critical review and meta-analysis, *Journal of Personality and Social Psychology,* 50, 1141–1151.

Jackson, D. N., Hourany, L. & Vidmar, N. J. (1972) A four-dimensional interpretation of risk taking, *Journal of Personality,* 40, 483–501.

Kearney, C. A. & Drabman, R. S. (2005) Risk-taking/gambling-like behavior in preschool children, *Journal of Gambling Studies,* 8, 287–297.

Lave, J., Smith, S. & Butler, M. (1988) Problem solving as everyday practice, in: R. I. Charles & E. A. Silver (Eds) *The teaching and assessing of mathematical problem solving* (Reston, VA, National Council of Teachers of Mathematics), 61–81.

Leary, M. R. & Kowalski, R. M. (1995) *Social anxiety* (New York, The Guilford Press).

Lejuez, C. W., Read, J. P., Kahler, C. W. *et al.* (2002) Evaluation of a behavioral measure of risk taking: the balloon analogue risk task (BART), *Journal of Experimental Psychology: Applied,* 8, 75–84.

Lejuez, C. W., Simmons, B., Aklin, W. M., Daughters, S. B. & Dvir, S. (2004) Risk-taking propensity and risky sexual behavior of individuals in residential substance use treatment, *Addictive Behaviours,* 29, 1643–1647.

Lesh, R. & Lehrer, R. (2003) Models and modeling perspectives on the development of students and teachers, *Mathematical Thinking and Learning,* 5, 109–129.

Levin, H., Baldwin, A. L., Gallwey, M. & Paivio, A. (1960) Audience stress, personality, and speech, *Journal of Abnormal and Social Psychology,* 61, 469–473.

Luft, J. A., Roehrig, G. H. & Patterson, N. C. (2003) Contrasting landscapes: a comparison of the impact of different induction programs on beginning secondary science teachers' practices, beliefs, and experiences, *Teaching and Teacher Education,* 40, 77–97.

Maner, J. K., Richey, J. A., Cromer, K. *et al.* (2007) Dispositional anxiety and risk-avoidant decision making, *Personality and Individual Differences,* 42, 665–675.

Maner, J. K. & Schmidt, N. B. (2006) The role of risk avoidance in anxiety, *Behavior Therapy,* 37, 181–189.

Nair, K. U. & Ramnarayan, S. (2000) Individual differences in need for cognition and complex problem solving, *Journal of Research in Personality,* 34, 305–328.

National Science Teachers Association (2003) *Standards for science teacher preparation* (Washington, DC, National Science Teachers Association).

Neuberg, S. L. & Newsom, J. T. (1993) Personal need for structure: individual differences in the desire for simple structure, *Journal of Personality and Social Psychology,* 65, 113–131.

Nicholls, J. G., Patashnick, M. & Nolen, S. B. (1985) Adolescents' theories of education, *Journal of Educational Psychology,* 77, 683–692.

Norum, K. E., Grabinger, R. S. & Duffield, J. A. (1999) Healing the universe is an inside job: teachers' views on integrating technology, *Journal of Technology and Teacher Education,* 7, 187–203.

Osberg, T. M. (1987) The convergent and discriminant validity of the need for cognition scale, *Journal of Personality Assessment,* 51(3), 441–450.

Pavio, A. (1964) Childrearing antecedents of audience sensitivity, *Child Development,* 35(2), 397–416.

Pavio, A. & Lambert, W. E. (1959) Measures and correlates of audience anxiety ('stage fright'), *Journal of Personality,* 27, 1–17.

Perry, C. & Ball, I. (2004) Teacher subject specialisms and their relationships to learning styles, psychological types and multiple intelligences: implications for course development, *Teacher Development,* 8, 9–28.

Pintrich, P. R. & Schunk, D. H. (2002) *Motivation in education: theory, research, and applications* (Upper Saddle River, NJ, Merrill Prentice Hall).

Reiman, A. J. (1999) The evolution of social roletaking and guided reflection framework in teacher education: recent theory and quantitative synthesis of research, *Teaching and Teacher Education,* 15, 597–612.

Resnick, L. B. (1987) *Education and learning to think* (Washington, DC, National Academy Press).

Rogers, P. L. (2000) Barriers to adopting emerging technologies in education, *Journal of Educational Computing Research,* 22, 455–472.

Ryan, A. M., Pintrick, P. R. & Midgley, C. (2001) Avoiding seeking help in the classroom: who and why?, *Educational Psychology Review,* 13, 93–114.

Schlenker, B. R. & Leary, M. R. (1982) Social anxiety and self-presentation: a conceptualization and model, *Psychological Bulletin,* 92, 641–669.

Schoenfeld, A. H. (1989) Explorations of students' mathematical beliefs and behavior, *Journal of Research in Mathematics Education,* 21, 338–355.

Sedikides, C. & Strube, M. J. (1995) The multiply motivated self, *Personality and Social Psychology Bulletin,* 21, 1330–1335.

Slovic, P. (1964) Assessment of risk taking behavior, *Psychological Bulletin,* 61, 220–233.

Slovic, P. (1966) Risk-taking in children: age and sex differences, *Child Development,* 37, 169–176.

Spigner, C., Hawkins, W. & Lorens, W. (1993) Gender differences in perception of risk associated with alcohol and drug use among college students, *Women and Health,* 20, 87–97.

Trope, Y. (1986) Self-assessment and self-enhancement in achievement motivation, in: R. M. Sorrentino & E. T. Higgins (Eds) *Handbook of motivation and cognition: foundations of social behavior.* Vol. 1 (New York, Guilford), 350–378.

Weber, E. U., Blais, A. & Betz, N. E. (2002) A domain-specific risk-attitude scale: measuring risk perceptions and risk behaviors, *Journal of Behavioral Decision Making,* 15, 1–28.

Wilensky, U. (1999) *NetLogo* (Evanston, IL, Center for Connected Learning and Computer-Based Modeling. Northwestern University). Available online at: http://ccl.northwestern.edu/netlogo (accessed on 15 April 2005).

Wilensky, U. & Stroup, W. (1999) Learning through participatory simulations: network-based design for systems learning in classrooms, *Proceedings of the Computer Supported Collaborative Learning Conference,* Stanford University, CA.

Windschitl, M. (2002) Framing constructivism in practice as the negotiation of dilemmas: an analysis of the conceptual, pedagogical, cultural, and political challenges facing teachers, *Review of Educational Research,* 72(2), 131–175.