

# Exploring Student Persistence in STEM Programs: A Motivational Model

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## Background

### The present study addressed:

- The underrepresentation of females in STEM disciplines.
  - Gender differences in performance and persistence among junior college students in science programs.
  - The effects of student motivation and affect on achievement and attrition as informed by research on self-determination, self-efficacy, and achievement goals.
  - Based on the extant research literature, a number of direct relationships were predicted and evaluated using structural equation modeling.
- ### Hypotheses:
- Autonomy support to positively predict intrinsic motivation and positive affect but negatively predict negative affect.
  - Self-efficacy to positively predict intrinsic motivation and positive affect, negatively predict negative affect, and positively predict achievement.
  - Mastery goals to positively predict intrinsic motivation and positive affect whereas performance goals to positively predict negative affect and achievement.
  - Persistence to be positively predicted by positive affect and intrinsic motivation, and negatively predicted by negative affect.
  - Achievement to positively predict academic persistence.

## Method

**Participants:** 1,309 first-year junior college students (46% male) enrolled at one of four public colleges in the greater Montreal area. The mean age was 17.33 years (range 15 to 19) with 74.7% of students enrolled in a science program as per an intensive recruitment focus on science majors. All study participants had nonetheless completed optional, advanced science courses in grades 10 and 11 and obtained a high school average of 70% or above in their mathematics and science classes, and therefore had the potential for admission into a science program.

**Procedure:** All participants completed a questionnaire during the first two weeks of college that included various demographic, social, motivational, and affective self-report measures concerning their high-school experiences. All self-report

## Method (cont.)

measures were obtained directly from published research or minimally adapted for junior college students, with institutional data obtained from participating colleges following study completion. Participants were compensated through random prize draws totaling \$600 per institution.

**Measures:** All questionnaire items were rated on a 5-point Likert scale (1 = *strongly disagree/very rarely or not at all*; 5 = *strongly agree/very often*).

- Autonomy Support:** four items from the Perceptions of Science Classes Survey (PSCS; Kardash & Wallace, 2001;  $\alpha = .67$ ).
- Self-efficacy:** six items adapted from the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1991;  $\alpha = .77$ ).
- Achievement Goal Orientation:** two four-item scales from the Patterns of Adaptive Learning Survey (PALS; Midgley et al., 1997) measuring two goal orientations (mastery orientation,  $\alpha = .70$ ; performance orientation,  $\alpha = .74$ ).
- Intrinsic Motivation:** two items from the Academic Motivation Scale (AMS; Vallerand et al., 1992;  $\alpha = .75$ ).
- Affect:** two four-item scales evaluating how often participants experienced positive emotions (joyful, happy, pleased, enjoyment;  $\alpha = .86$ ) and negative emotions (frustrated, worried/anxious, depressed, unhappy;  $\alpha = .77$ ; see Emmons, 1992) in high school math and/or science classes.
- Achievement & Persistence:** High school science course grades were obtained from government records. A total science achievement score for high school was computed by taking the mean of students' grade 10 and 11 science grades. Persistence in STEM education was operationalized dichotomously as students' enrolment in a science program ( $N = 978$ ) vs. non-science program ( $N = 331$ ) in junior college.

## Analysis

Structural equation modeling was conducted using EQS software to examine the extent to which the proposed model accounted for male and female students' decisions to enroll in science in junior college. The model was first evaluated for the total sample and then assessed separately for males and females students to examine structural differences due to gender. The robust maximum likelihood (RML) method of estimation was used for missing data (Byrne, 2001). Directional paths between latent variables were modeled as per the study hypotheses based on existing motivation research, with non-significant paths retained to provide a more conservative analysis of the analytical model.

Fig. 1. Structural Equation Model: Females

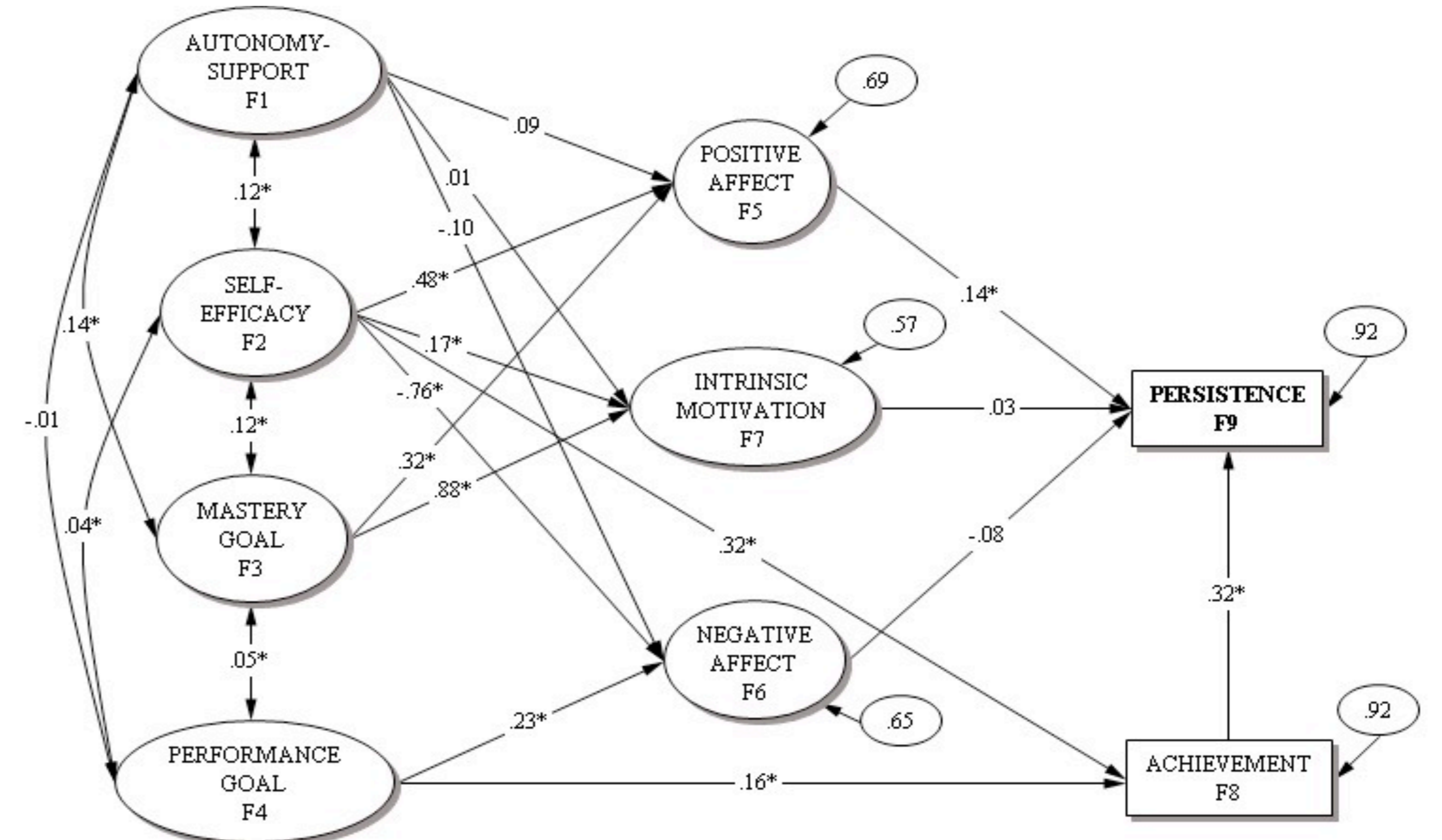
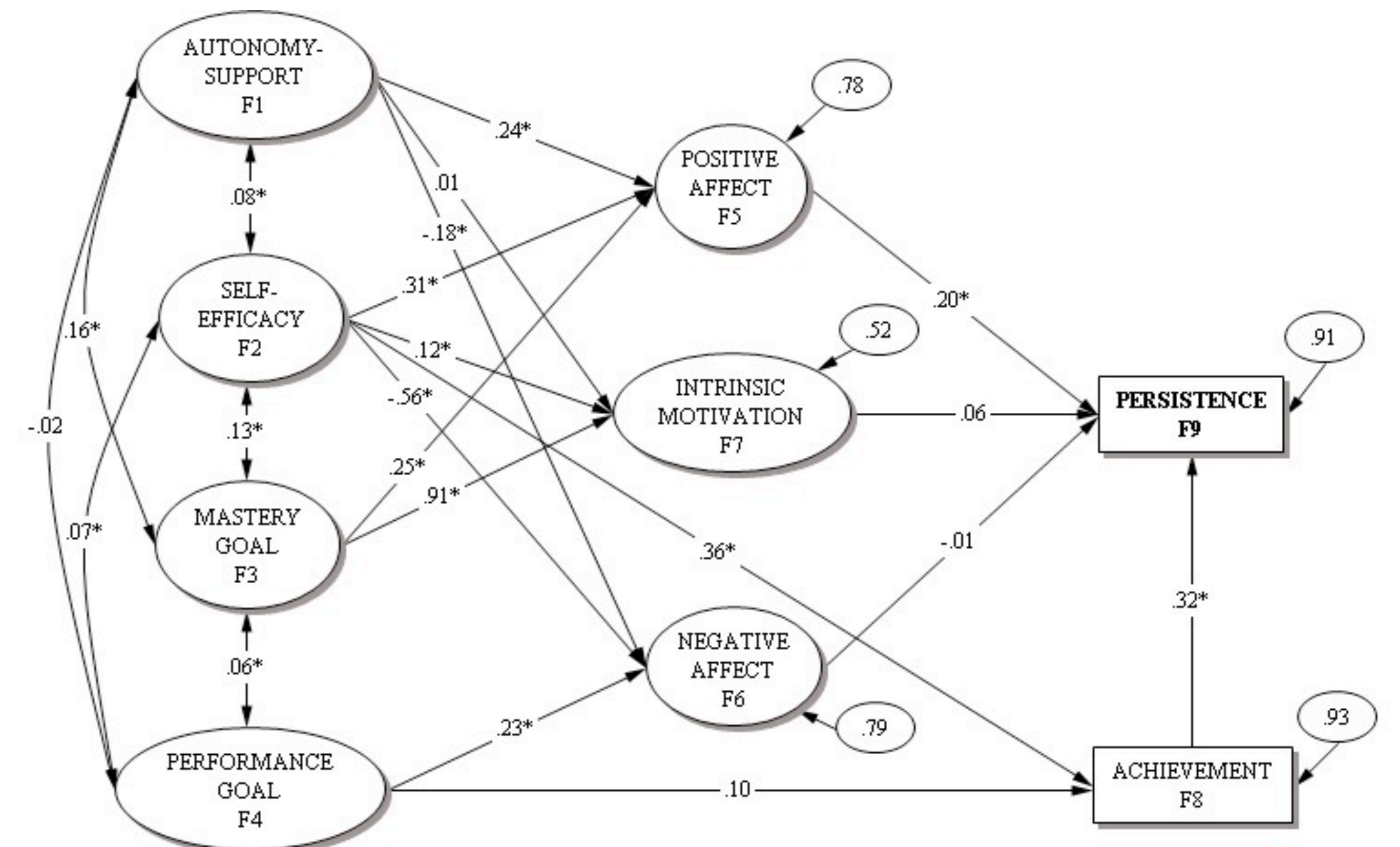


Fig. 2. Structural Equation Model: Males



## Results

- The overall fit of this model was satisfactory:  $c2(101) = 467.52$ ,  $p < .001$ ,  $c2/df = 4.63$ ,  $CFI = .940$ ,  $NNFI = .918$ ,  $RMSEA = .053$ .
- For *females*, the model fit was satisfactory (see Figure 1):  $c2(104) = 347.20$ ,  $p < .001$ ,  $c2/df = 3.34$ ,  $CFI = .930$ ,  $NNFI = .907$ ,  $RMSEA = .058$ . For *males*, the model fit was also satisfactory (see Figure 2):  $c2(104) = 256.43$ ,  $p < .001$ ,  $c2/df = 2.47$ ,  $CFI = .942$ ,  $NNFI = .923$ ,  $RMSEA = .049$ .
- A test for invariance (Byrne, 2001) involving a series of equality constraints to evaluate equivalent strengths of the structural relationships for males vs. females showed only the effect of self-efficacy on negative affect to be significantly moderated by gender.
- As indicated by a CFI of .934, NNFI of .917,  $c2(219) = 588.09$ ,  $p < .0001$ , and  $c2/df = 2.68$ , and a significant constraint between self-efficacy and negative affect, this path was found to be significantly stronger for females ( $\beta = -.76$ ) than for males ( $\beta = -.56$ ).

## Discussion

- Results revealed students' achievement goals, self-efficacy, and perceived autonomy support to impact intrinsic motivation, emotions, and achievement that, in turn, predicted persistence in the science domain into junior college.
- For men, affect mediated the relationship between autonomy and persistence, meaning that men needed to feel autonomous in the classroom in order to have a positive affective experience and in turn to persist.
- Women, on the other hand, seemed to derive their affective experience not from teaching practices or classroom context but instead from internal characteristics such as their sense of competence and their personal achievement goals.
- Self-efficacy more strongly predicted lower levels of negative affect in females than for males, highlighting the need for future intervention research addressing maladaptive, and often unfounded, perceptions of competence concerning STEM disciplines in female students (see Goetz et al., 2013).