Gender Differences in Self-Regulated Learning Strategy Use in an Intelligent Tutoring System

David A. Organista, Daryn A. Dever, and Roger Azevedo

[Dorganista@knights.ucf.edu](mailto:Dorganista@knights.ucf.edu), [ddever@knights.ucf.edu](mailto:ddever@knights.ucf.edu), Roger.Azevedo@ucf.edu

**Abstract (word count = 204 words):** Intelligent tutoring systems (ITSs)have been used to scaffold students’ self-regulated learning (SRL) in various subjects. In this study, MetaTutor, an ITS, implements pedagogical agents (PAs) to guide college students’ SRL while learning about the human circulatory system. Data from 120 undergraduate students was collected. Participants were randomly assigned to one of two conditions: The Control condition where participants did not receive support from pedagogical agents and could only self-initiate SRL strategies and the prompt and feedback condition where participants were able to self-initiate SRL strategies but were also prompted by the PA to engage in strategies and provided feedback on their use of the strategy. We used a 2 x 2 factorial design (Gender: males and females, and Scaffolding: no scaffolding vs adaptive scaffolding) to compare male and female students across the two conditions to measure learning outcomes and strategy use to determine if SRL scaffolding should adapt to gender for possible improvements in learning outcomes. While analyses did not find significant differences in learning outcomes, results found that females had greater frequency of note-taking, spend more time note-taking, and self-initiated more on their note-taking compared to males. Differences in strategy use like note-taking may reflect differences in gender behavior and not reflect differences in learning outcomes.

**Extended Summary:** Self-regulated learning (SRL) is learning guided by leaners’ understanding and management of their own cognition, affect, metacognition, and motivation [1]. SRL tools can be conceptualized within a hierarchy, organized into 35 micro-level processes grouped under 5 macro-levels [2]. Strategy use, a macro-level process, includes micro-level processes of summarization and note-taking where the quality of learners’ deployment of these processes provides insight into successful learning [3].

In this study, learners’ goal was to learn about the human circulatory system using an intelligent tutoring system (ITS), MetaTutor [3] which integrates instructional pedagogical agents (PAs) to support learners’ SRL strategy use. Studies have shown learners with PA adaptive scaffolding had higher learning outcomes and used a wider range SRL strategies [3,4] suggesting that adaptive scaffolding is crucial for students’ SRL.

SRL tools have been shown to be used differently between genders (male/female), aligned with past research showing gender differences in problem solving approaches [5]. Studies on gender differences have shown that females have been more receptive to seeking and accepting help from PAs even when having mastered similar number of topics [6,7].

Despite these gender differences, there is a gap examining differences in learning outcomes and SRL strategy use while learning with PAs. This paper examines gender differences while learning with MetaTutor, asking: Should SRL support be gender dependent? More specifically, (1) Are there differences between males’ and females’ learning gains, accounting for PA support? (2) Are there differences between males’ and females’ SRL strategy use, accounting for PA support? (3) To what extent do males and females rely on PAs to prompt their SRL strategy usage?

**Method, Materials, and Coding and Scoring.** Undergraduate students (N=120; M\_age=20.4; SD\_age=3.17; Range: 18-41; 56% female) were randomly assigned to one of two conditions, the Control (N=60) and the PA Prompt and Feedback (PF; N=60). Within the Control condition, participants did not receive PA support and could only self-initiate SRL strategies. Within the PF condition, participants were able to self-initiate SRL strategies, but were also prompted by the PA to engage in strategies based on a set of production rules [3] and were provided feedback.

Log-file data captured when learners engaged in different types of SRL strategies. Within this paper, we focus on micro-level processes nested within macro-process including note-taking, summarizing, re-reading, and coordinating informational sources. Gender was determined using self-reports. Learning gains were calculated using pre- and post-test scores on human circulatory system concepts [8].

**Results.** *Are there differences between males’ and females’ learning gains, accounting for PA support?* A two-way ANOVA was run using both gender and condition as between-subjects variables and learning gain as the dependent variable. There was a significant main effect between conditions (*t*(111.52)=9.94, *p* < .01). There was no main effect of gender or an interaction effect (*p*>.05).

*Are there differences between males’ and females’ SRL strategy use, accounting for PA support?* A two-way ANOVA revealed a significant difference in the frequency of note-taking (*F*(3,116)=5.25, *p*<.01; *t*=-2.16, *p*<.05) between genders where females had significantly greater note-taking frequencies (*M*=14.7, *SD*=16.0) than males (*M*=6.19, *SD*=8.74; *t*=-2.16, *p*<.05). Another two-way ANOVA revealed a significant main effect on the total time spent taking notes where females (*M*=804.79s, *SD*=1077.8s) had a greater note-taking duration than males (*M*=256.4s, *SD*=488.8s; *t*=-2.88, *p*<.01).

*To what extent do males and females rely on PAs to prompt their SRL strategy usage*? Two t-tests found males’ (*M*=5.77, *SD*=8.73) and females’ (*M*=14.4, *SD*=16.1) self-initiated SRL note-taking strategy frequencies differed (*t*(97.6)=3.70, *p*<.01).

**Discussion**

While there are no significant differences in learning outcomes between genders, there are differences in strategy use. Results found that females had greater frequency, spend more time, and self-initiated more on their note-taking compared to males. Ideally, if there are significant differences in SRL tool use based on gender, ITSs should adapt to those differences. However, differences in strategy use like note-taking may reflect a behavioral difference and not one on learning outcomes. Questions like, “Do males need more feedback from PAs since they are relying on their scaffolding?” arise. The focus should be on how scaffolding could adapt to gender for possible learning outcome improvements. According to Azevedo et al [3], the methods used to capture and measure learning should reflect the dynamic, cyclical, and non-linear learning model for system features to adapt to the individual student. To justify such adaptations, future research should focus on identifying which differences in tool use reflect behavioral differences between the genders and which reflect true learning gains.

**References**

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