Goal Orientation and Changes of Carelessness over Consecutive Trials in Science Inquiry

A. HERSHKOVITZ
R.S.J.D. BAKER
J. GOBERT
AND
M. WIXON
Worcester Polytechnic Institute, USA

_____

In this paper, we studied the relationship between goal orientation within a science inquiry learning environment for middle school students, and the manifestation of carelessness over consecutive trials. Carelessness is defined as not demonstrating a skill despite knowing it; we measured carelessness using a machine learned model. Findings suggest that students with performance goals demonstrate an increase in carelessness sooner in the set of trials than do students with learning goals, and that students with lack of goals are consistent with their carelessness over trials.

Key Words and Phrases: carelessness, goal orientation, science inquiry, cluster analysis, automated detectors

_____

1. INTRODUCTION

In recent years, there is increasing evidence that the goals students have during learning play a key role in their learning outcomes. These goals might impact learning by creating different forms of disengagement. One disengaged behavior is carelessness, i.e., when a student fails to answer an item correctly despite possessing the required skills (Clements, 1982). Previous research has indicated that students possessing mastery or performance goal orientation have (on average) double the probability of carelessness as students characterized by low scores for these goal orientations (Hershkovitz et al., 2011). In this research, carelessness was automatically detected using a log-based machine-learned model. This measurement can be quickly applied to data from new students and situations. Within this study, we examine how carelessness is manifested over consecutive trials by students with different goal orientations.

2. METHODOLOGY

The learning environment. We used the Science Assistants learning environment (www.scienceassistments.org) and a microworld for phase change to study carelessness in demonstrating three science inquiry skills – namely, control for variable strategy (CVS), testing articulated hypotheses, and planning using the table tool. The microworld engages students in authentic science while supporting inquiry via widgets. The students completed three learning activities involving these three skills. The learning environment detects whether students demonstrate inquiry skills using validated machine-learned models of these behaviors.

Participants, Data. 130 public middle school 8th graders (Central Massachusetts), 12-14 years old. Students' fine-grained actions were logged, then analyzed at the "clip" level (a consecutive set of a student's actions during experimentation). Goal orientation was assessed with the PALS (Patterns of Adaptive Learning Scales) survey (Midgley et al.,

_____

1997).

Carelessness Detector. We developed the carelessness detector in RapidMiner 5.0 using REPTree, a regression tree classifier. Carelessness, first predicted at the clip-level, was averaged at the student-level. The resulting regression tree (a 6-fold cross-validation correlation of r=0.63) includes 13 variables, has a size of 35, and a total depth of 13.

Cluster Analysis. Exploratory cluster analysis was conducted to group students by their PALS scores in order to examine whether certain sub-groups of students with specific characteristic patterns on the PALS survey also differ on carelessness manifestation over trials. We used Two-step Cluster Analysis (in SPSS 17.0) with the PALS scores (Z-standardized) and a log-likelihood distance measure. We chose k=3 as it led to more interesting separations between aspects of the PALS. The clusters corresponded to: 1) *mastery goal orientation* (N=35), 2) *performance goal orientation* (N=66), and 3) *lack of goal orientation* (N=20).

3. RESULTS

The mean value of carelessness for the population was 0.08 (SD=0.12; N=130). Overall, carelessness increased over all trials (as students have more practice opportunities for the same skill), and its means for activities 1-3 were 0.04 (SD=0.08; N=126), 0.07 (SD=0.13; N=127), and 0.11 (SD=0.19; N=112), respectively. According to a paired-sample t-test, the increase in carelessness from activity 1 to 2 is significant, $t(122)=2.7$, $p<0.01$, as was the increase from activity 2 to 3, $t(109)=2.2$, $p<0.05$. Next, we analyzed how carelessness manifests over trials in the different clusters. These results are summarized in Figure 1. For the students in the **Learning Goals cluster**, mean carelessness does not significantly increase from activity 1 to 2, $t(32)=1.3$, $p=0.2$, nor from activity 2 to 3, $t(27)=1.5$, $p=0.15$; however, it is significantly higher in activity 3 compared to activity 1, $t(28)=3.1$, $p<0.01$. In the **Performance Goals cluster**, the mean carelessness significantly increases between activities 1 to 2, $t(61)=2.6$, $p<0.05$, but does not significantly increase between activities 2 to 3, $t(56)=1.5$, $p=0.14$. These results suggest that the increase in carelessness for students with learning goals is slower but more dramatic than for students with performance goals. As for **Lack of Goals cluster**, no significant differences were found in mean carelessness for either pair of activities (all t-tests had $p>0.63$).
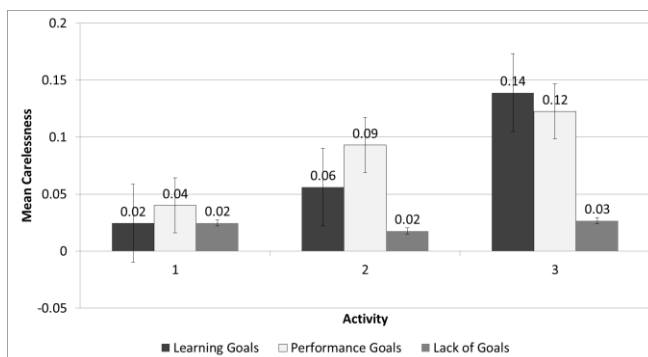

Fig. 1. Mean Carelessness over consecutive trials by PALS-based clusters

REFERENCES

CLEMENTS, M.A. 1982. Careless errors made by sixth-grade children on written mathematical tasks. *Journal for Research in Mathematics Education*, 13, 136-144.

HERSHKOVITZ, A., BAKER, R.S.J.d., GOBERT, J., WIXON, M. AND SAO PEDRO, M. 2011. Carelessness and goal orientation in science microworld. Poster presented at *AIED'2011*, Auckland, New Zealand.

MIDGLEY, C., MAEHR, M., HICKS, L., ROESER, R., URDAN, T., ANDERMAN, E., & KAPLAN, A., ARUN-KUMAR, R., MIDDLETON, M. (1997). *Patterns of adaptive learning survey (PALS)*. Ann Arbor, MI: University of Michigan.