Supporting Student Choice and Collaborative Decision-Making During Science Inquiry Investigations

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Abstract: This study investigates the impact of providing students with opportunities for collaborative choice-making during inquiry learning with *Investigating Seasons*, an online curriculum module. Two versions of *Seasons* (*no-choice* and *choice*) was implemented with ten classes of high school students (N = 207). Study findings indicate that students in the *choice* condition demonstrated greater gains in their conceptual understanding of seasons as well as a higher increase in normative written explanations compared to the *no-choice* students.

Introduction and Rationale

Despite research documenting the tremendous benefits of introducing more authentic forms of inquiry into the classroom (e.g., White & Frederiksen, 1998), most science teachers do not have the adequate classroom time or resources to involve their students in independent inquiry investigations and are forced to turn instead to the use of linear step-by-step “cookbook labs” that bear little resemblance to authentic inquiry practices.

The *Seasons* unit aims to strike a balance between rigorously structured “cookbook” inquiry (lacking in rich learning outcomes but easier to implement) and inquiry that is more authentic and open-ended (highly challenging to implement but with potentially more powerful learning outcomes) by incorporating student choice. Allowing students to choose and decide upon their own inquiry paths “accommodates and values the diversity” of learners; “by allowing for multiple entry points and multiple paths, all students ultimately come into proximity to core learning goals, with richer and deeper learning experiences” (Murata, 2012, p. 20). In addition, in making their choices, student pairs are given the opportunity to collaboratively discuss and compare their developing ideas together.

This study explores the effect of providing choice during inquiry and considers research questions such as: How does providing students with the option to choose their own path of inquiry investigations affect their learning and conceptual understanding of seasons? Does instruction that scaffolds students’ choice-making result in improved learning outcomes for students? If so, why is providing choice effective for learning?

Theoretical Framework

This research work adopts a constructivist perspective towards learning, in which the pre-existing ideas that learners have are viewed as productive starting points for instruction to leverage towards more scientifically valid and integrated understandings of challenging science ideas and concepts (Smith, diSessa, & Roschelle, 1993). For example, while changing distance between the Earth and the Sun is the primary misconception about seasons cited in the research literature, it is not the only strongly held misconception. A survey that this author administered to 9th grade earth science students (N = 102) revealed that nearly just as many students cite Earth’s orientation towards or away from the Sun as the primary cause of seasons (N = 30; 29%) as those who mention the changing Sun-Earth distance (N = 32; 31%), suggesting that inquiry instruction on the seasons should be flexible and adaptable enough to acknowledge and address the variety of starting prior ideas across all students.

Methods

Investigating Seasons, a ten-hour WISE (Web-based Inquiry Science Environment) curriculum module, incorporates interactive dynamic visualizations and instructional scaffolding to support students in conducting experiments, collecting data, and integrating their diverse ideas for explaining seasonal temperature changes. The unit contains five inquiry investigations covering key concepts central to understanding the phenomenon of seasonal temperature changes.

For this study, two versions of *Seasons* (*no-choice* and *choice*) was used with ten classes of ninth-grade earth science students (N = 207) at a socially and economically diverse high school in California. Students worked through the unit in pairs. The *no-choice* version of *Seasons* presented students with the five inquiry investigations in a preset order. The *choice* version of the curriculum, in contrast, allowed student pairs to decide upon and choose their next investigation together. In particular, students in the *choice* condition were encouraged to discuss their ideas with one another in order to come to an agreement as to which of the five investigations to complete next (see Figure 1).

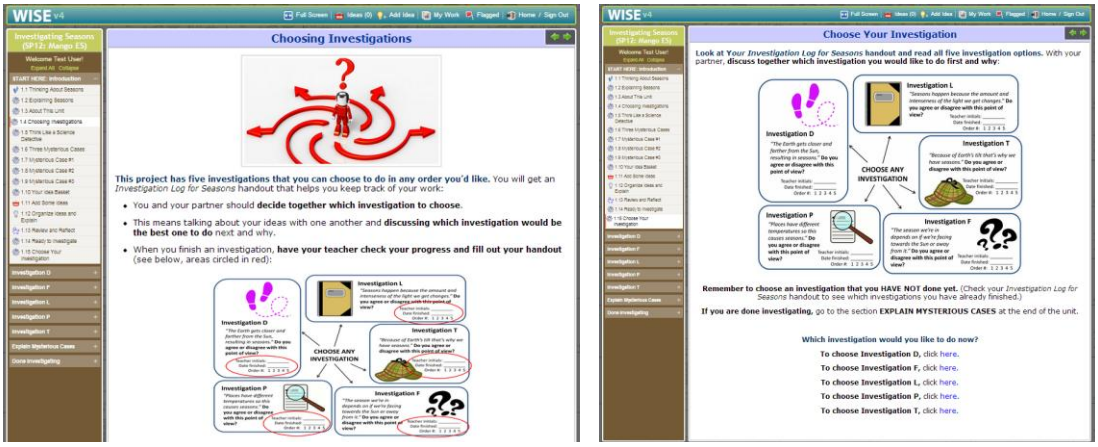

Figure 1. Student pairs were encouraged to discuss and decide together which investigation to choose next.

Results

Students were administered individual pre- and post-unit tests. Explanations were scored on a scale from 0-4 using a knowledge integration (KI) rubric which rewards the number of valid scientific connections present in the explanation (Linn, Lee, Tinker, Husic, & Chiu, 2006). Analysis of pre- and post-test explanations revealed higher levels of knowledge integration for students in the *choice* condition. Students in the *choice* condition made moderate, significant pre- to post-test gains (M = 1.49, SD = 0.79 (pre); M = 1.91, SD = 0.92 (post); $t(109) = 3.70$, $p < 0.001$, $d = 0.49$) while students in the *no-choice* condition demonstrated small pre- to post-test gains (M = 1.46, SD = 0.70 (pre); M = 1.69, SD = 0.83 (post); $t(76) = 1.84$, $p = 0.07$, $d = 0.30$). Furthermore, students in the *choice* condition demonstrated a greater percentage in both increase of normative explanations (from 24% to 41%) and decrease of non-normative explanations (63% to 50%) compared to their study counterparts; for the *no-choice* students, the percentage of both normative explanations (from 29% to 32%) and non-normative explanations (63% to 58%) remained roughly the same pre- and post-unit. One possible explanation for these findings is that since *choice* students were encouraged to discuss their ideas together before deciding on their next investigation, they may have more actively engaged in comparing and reflecting upon their developing ideas about seasons. Further in-depth analyses using other collected data sources (e.g., videotaped data of student pairs working together) may help to further inform and contextualize these findings.

Significance of Study

Research indicates that the benefits of successfully engaging students in more authentic and open-ended forms of inquiry are numerous. Providing students with the opportunity to make choices during their own inquiry learning can help to support diverse and unique paths of learning for different students while also encouraging the collaborative exchange of ideas between students during choice-making. Hopefully the findings from this study will in turn spark rich and productive discussions among session participants about how to design science instruction that can effectively promote student choice and collaborative discussion during inquiry and learning.

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Acknowledgments

This work was supported in part by a National Science Foundation Graduate Research Fellowship. In addition, I would like to thank Marcia Linn, the members of the Linn Research Group, Barbara White, and the Concord Consortium for their assistance and contributions to this research.