The Effect of Curricular Elements on Student Interest in Science

Abstract: Enhancing student interest in science is a critical goal for science education. However, little is known about what makes science interesting to the students. This study examined the effect of three curricular elements (topic, activity, and learning goal) on student interest in science. The results suggest significant effect of activity types, among which the "hands-on" and technology-based ones tend to elicit higher interest.

Introduction

Scholars have pointed out in recent years that students are becoming uninterested or losing interest in school learning, particularly in areas of math and science. This is alarming because research has shown that interest leads to effective learning processes, and has strong positive impact on various learning outcomes (Renninger, Hidi, & Krapp, 1992). Thus, a critical goal of education should be to enhance students' interest in science.

What might explain our schools' ineffectiveness in maintaining student interest is the lack of knowledge regarding what makes science interesting (or not). Much of prior research has focused on examining the features of perceptual stimuli (Berlyne, 1960) and texts (Hidi & Baird, 1986) that influence people's interestingness judgments. Studies that are more relevant to science interest have only begun to identify the science topics or instructional activities (Jenkin & Nelson, 2005; Palmer, 2009) of high or low interest to young students. We believe these approaches are insufficient given the complexity of real classrooms. What we need is to examine variables that possibly influence student interest together, instead of in isolation, as students' interest is most likely the outcome of their simultaneous interactions with all of these variables.

We report here some of the quantitative findings from a study of the independent and interactive effects of curricular elements on student interest in science in the school context. Specifically, three elements were examined — content topic, activity, and learning goal. They are chosen because they are present in most (if not all) learning scenarios, and they can be easily manipulated by educators.

Methods

Five hundred thirty three middle school students from a suburban district near a major Midwest city participated in this study. We chose to focus on middle school grades because they have been suggested to be the age when academic interest begins to decline. Thus it is critical to understand what makes science interesting to these students, and consequently how to keep them interested. The demographic make-up (gender, minority status) of the participants is quite diverse, which is representative of student population in the particular school district.

The data and results reported here are based on a questionnaire completed by all participants. The questionnaire presented students with 100 instructional episodes (IEs) — instructional periods devoted specific content or skill. Each IE is designed such that it represents a unique combination of curricular elements — a topic, an activity type, and a learning goal category. Four topics chosen from the biology domain, five activity types, and seven learning goal categories were embedded in the IEs. For example, the IE "Look at real data on polar bears to see if global warming is hurting the ecosystem at the north pole" represents the topic "ecosystems", the activity type "design/conduct investigation without scientific instruments or interactive technology", and the learning goal "societal impact". One fourth of the IEs (n=25) are under the same topic, and IEs under every topic share the same activity-goal structure (i.e., item 3 under the topic "ecosystems" represents the same activity type and learning goal category as item 3 under the topic "cells"). The IEs, though hypothetical, were designed to resemble the actual IEs that take place in participants' science classes. Students were asked to rate how interesting they thought each IE was using a 1-6 scale (6 being the most interesting).

Results

Factor analysis was conducted to explore the structure of the questionnaire data. Hierarchical linear modeling (HLM) models were run to further examine the effect of the curricular elements (and their categories). HLM is appropriate in this case because the ratings of the questionnaire items are nested within individual students. In other words, the variance between the item ratings was due to not only item differences but also individual differences.

Factor Analysis

The questionnaire data were transformed two ways to understand the embedded structure. First, for each student, the ratings of items of the same activity-goal combination (i.e., across topics) were averaged to generate an "item-average" score. A comparison of the "item-average" scores shows a great degree of variation, suggesting that the variance between the item ratings could be attributed to the activity types and/or learning goal categories. Second, the ratings of items under the same topic (i.e., across activity-goal combinations) were averaged to generate a "topic-average" score. The comparison of these scores, however, did not show much variation, with the only notable difference being that the average rating of items under the topic "human body systems" was slightly higher than that of other topics ("cells", "Ecosystems", and "Diversity of living things").

As much of the variance existed for the "item-average" scores, a principal axis factor analysis was done on these scores. Three factors were extracted (scree plot and factor loadings are not shown here due to limited space), and the activity types and learning goal categories of the items loaded on each factor are listed in Table 1. The results suggest that the variance explained by the activity-goal combinations is attributable to activity only, not learning goal. Furthermore, it seems that students did not perceive the differences between the original five activity types; rather, they grouped them into three new categories — purely cognitive, technology-based, and hands-on. Students' interest varied primarily depending on the activity type represented in each IE.

Table 1: Factor analysis results interpretation for "item-average" scores.

	Factor 1	Factor 2	Factor 3
Activity types	Brainstorm/Discuss; Receive information passively	Design/Conduct investigation *with* technology	Design/Conduct investigation *without* technology; Create product(s)
Learning goal categories	All categories; No pattern	All categories; No pattern	All categories; No pattern
Interpretation	"Purely cognitive" activities (PureCog)	"Technology-based activities (Tech)	"Hands-on" activities (HandsOn)

Hierarchical Linear Modeling (HLM)

HLM models including the "human body system" (Human) topic and the "Tech" and "HandsOn" activity types as level 1 predictors were run. The significant coefficients for these variables (Table 2) confirm that students on average perceived IEs dealing with human to be slightly more interesting, and suggest that the average interest in IEs involving hands-on and technology-based activities is higher than purely cognitive activities. Compared to the variance component to the model without any predictors, these variables explained approximately 14% of the level 1 variance (the majority of which was due to the activity type predictors), which is significant.

Table 2: HLM model output.

Fixed effect		Coefficient *(*p<0.05)*	SE
For interest intercept	Intercept	3.64*	0.04
For Human slope	Intercept	0.17*	0.03
For HandsOn slope	Intercept	0.50*	0.03
For Tech slope	Intercept	0.68*	0.03
Random effect		SD	Variance component
Intercept		0.84	0.71
Level 1		1.31	1.71

Discussion

The results confirmed that the curricular elements examined in the study indeed contribute substantially to students' interest in science IEs. It is interesting that among the three elements, only activity exerted significant effect, whereas topic and learning goal had little or no effect. With much of the current emphasis on content choices and the embedment of learning goals or driving questions in curriculum, this finding raises the need to focus more on what activities to include in a curriculum, and how students perceive such activities.

The finding that students tend to be more interested in IEs that are hands-on or involve technology is not surprising, but it contrasts with our observation of participants' actual science classes (details presented elsewhere) where few IEs fell into these categories. Therefore, one way to enhance student interest (and hence performance) in science is to restructure the classes to incorporate more opportunities of such nature.

References

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