The Role of Technology in Increasing Student Interest in Genetics: Field Trip versus Online Interaction

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Abstract

With the aim of increasing interest in genetics, we used a Web-based module about simple-inheritance and adapted it for an Israeli context. We increased the relevancy of the module through an anchoring (real) story of fundraising for cystic-fibrosis (CF) patients. We also added interactions with CF patients using two types of interactions: (1) a field-trip to a CF hospital unit; (2)on-line interaction with a patient.

The goal was to explore the learning with the module and determine how the hospital-visit and the online-interaction with a patient contributed to the students' interest and understanding of genetics.

One 10th grade class visited the hospital and another one communicated with a patient. By using pre/post Knowledge-Integration tests, a feedback questionnaire, observations in class and the students' recorded work in the web-based module, we found that the adapted-module, even without the field-trip and the online-interaction contributed to students' interest in genetics. Project features such as involving students in making decisions were crucial in getting students engaged and promoting their interest in genetics. There was no difference in knowledge acquisition, but there was a significant difference between the groups' engagement.

Keywords: on-line interaction, design principles, Web-based Inquiry, relevancy.

Introduction

In this study, we adapted a web-based learning module on simple inheritance that was developed in the United States to the Israeli context aiming to increase the relevancy of the module and enhance meaningful learning of genetics by Israeli students. The work reported here takes advantage of a capability of the Web-based Inquiry Science Environment (WISE) – the authoring environment, which allows one to revise, adapt and refine existing modules. While learning with WISE modules, students learn scientific content in relevant contexts, and develop a variety of thinking skills such as asking questions, identifying and critiquing evidence, making arguments, making hypotheses and so forth. Interactive visualizations in WISE modules allow the students to explore complex phenomena and processes and integrate knowledge from various resources (Linn, Lee, Tinker, Husic, & Chiu, 2006). In WISE, students can work individually, as well as in small groups. For teachers, WISE allows modifications, additions and on-going revisions to improve learning (Slotta & Linn, 2009).

The module begins and ends with a framework story of a boy who is sick with cystic fibrosis (CF). The students explore his family history to arrive at the conclusion that CF is an inherited trait. This context allows for further investigation of other inherited traits and learning about genetic mechanisms. Despite the engaging context, we believed that a "real life" context could make a greater contribution to students' learning. We assumed that other opportunities for social interactions to advance learning will further contribute to the students' engagement and learning.

In addition to better contextualizing the module to the Israeli context, we added two components to the original module: The first component, experienced by one class, was a visit to a CF unit in a children's hospital, and the other component was authentic communication through an asynchronous forum (online interaction), which allowed students to talk with a young CF patient over a period of a few days. Generally, we were interested in patterns of learning with the adapted WISE module, and more specifically, in the value of the two additions that aimed at improving the relevance of the module.

Relating science to personally relevant contexts is a well known instructional strategy for designing learning environments that can make science accessible (Kali, Fortus, & Ronen-Fuhrmann, 2008). In fact, the design of both the original module and the adaptations introduced into the module for the Israeli audience described, were based on this design principle.

Methodology

The participants were 10th graders from a school in Tel Aviv that serves a heterogeneous population of low to high socioeconomic status. Typically, simple inheritance is taught in Israel in 9th grade, but in some schools it is taught in the 10th grade. In a pilot study we developed the adapted module, changed the framework story of the module and the associated learning tasks. The adaptation was based on design guidelines for educational technologies found in the Design Principles Data Base (Kali, 2006; Kali & Linn, 2007).

The research questions

In the main study, the research questions that we pursued were:
(1) What were the learning characteristics of the students who learned simple inheritance using the adapted Simple Inheritance module?
(2) How did the two enhancements (the hospital visit and the online interaction with a patient) contribute to: (a) the students' interest in genetics? (b) the understanding of scientific ideas in genetics?

The main study included two stages: (a) enactment of the revised Simple Inheritance module with one class of 28 students to answer research question 1, and (b) enactment of the two additional versions of the module (basic + hospital visit and basic + online interaction), with two classes of about 30 students each to answer research question 2.

Data collection

Data collection included:
(a) A science-knowledge integration test, administered one week after students completed their learning with the module. The knowledge integration test that was designed to measure students' explanations was developed by the original developers in the WISE project in the US. To this test, we added another complex question that required students to apply their knowledge to a typical situation in Israel.
(b) A feedback questionnaire that included two parts: six Likert type questions with four possible answers, and two open-ended reflection questions,

(c) The answers of the students to the written tasks in the module,
(d) Observation data collected throughout the enactments of the adapted Simple Inheritance module.

The knowledge integration framework was used to develop a rubric with a 0-5 point scale to assess student responses (on the science-knowledge integration test) in order to identify the number of incorrect, partial, and complete connections that students make (Liu et al., 2008).

Differences between students' outcomes in the two conditions (field-trip and online interaction with a patient) were calculated using a T-test procedure. As we could not make a normal distribution assumption, we compared between students' attitudes toward learning with the field-trip vs. the online interaction by employing Mann-Whitney U test. In order to analyze the students' responses to the open ended questions in the module, we looked at students' claims and their justifications. For example, for a family tree task, in which the students were requested to predict which family members will carry the CF gene, we used the rubric presented in Table 1. In this task the students had to present a claim with respect to heredity of CF. This claim was supposed to use the evidence, which was their own drawing of the family tree based on given textual data. In their justification, they had to tie the claim and evidence.

Table 1. Scoring rubric for the family tree task (max=4)

Score	0	1	2
Claim	Inaccurate claim (CF is not a genetic disease)	Accurate claim (CF is inherited)	
Evidence	Uses the family tree diagram incorrectly	Referring to correct details in the family tree diagram	
Reasoning	No attempt to explain the relationship between claim and evidence	Insufficient explanation	Provides accurate reasoning that ties the evidence to the claim

Outcomes

Interest and engagement

Regarding our first research question, we found that the vast majority of the students expressed interest and enjoyment regarding the WISE Simple Inheritance module referring to their comfort in using technology. In our observations, we found extensive evidence for increased interest in genetics among the students. We observed the students enthusiastically negotiating and debating while performing this task. The variety of students' answers indicated they understood the sensitivity involved.

We observed not only within group discussions about the socio-scientific issues, but we also saw many between group discussions. Evidence from students' work in the module and the observation data indicated deep engagement on the part of students and thoughtful group discussions that were the result of enhancing relevancy and including controversies in teaching the Simple Inheritance module.

The contribution of the field-trip and the online interaction

To answer the second and third research questions, we describe and compare the contribution of the two enhancements (online interaction with a patient and the visit to the hospital) to students' interest and understanding of scientific ideas in genetics. The analysis of the open-ended

responses to the question "In what way/s has the online interaction with David (the CF patient) contributed to your learning of genetics in the Simple Inheritance module?" allowed highlighting the contribution of this addition to students' learning (research question 2). A few topics emerged in the students' responses that elucidate this contribution: the ability to ask questions, improved learning, learning new things, understanding the patient challenges.

The responses to the same question that addressed the field-trip provided stronger evidence for the field-trip supporting meaningful learning and complementarity, meaningful learning, relevancy.

While the students who were engaged in the online interaction addressed mainly affective contributions, the students who visited the hospital were more clearly articulated. Moreover, they better connected the out-of-school experience to learning with the module. An analysis of the contribution of the two additions to student learning, as reflected in the sophistication of their responses is presented in Table 2.

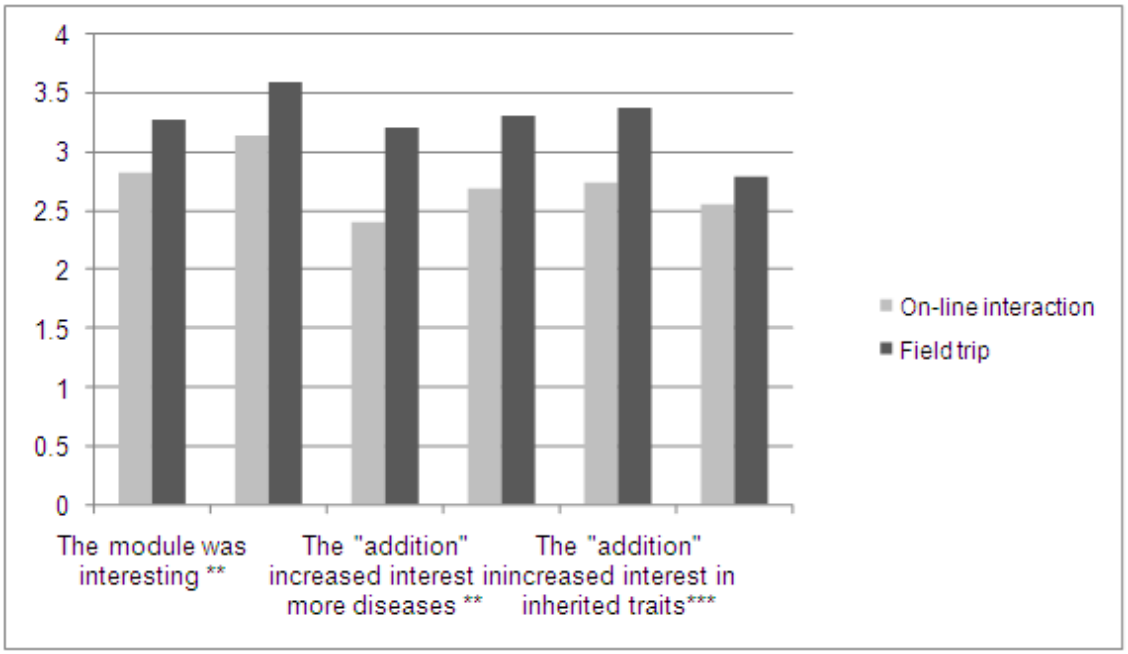
Table 2. Analysis of student answers regarding the contribution of the online interaction and the field-trip to their learning

Answer orientation (positive vs. negative) and justification		Example	Frequency (%) Online interaction [N=22]	Frequency (%) Field-trip [N=28]
Negative	**Not justified**	N/A	4	
Negative	**One justification**	Talking with David did not help me understand genetics better, it only helped understanding his everyday functioning (online interaction) No, talking to David did not help me understand, while seeing his family tree helped better (online interaction)	19	**0**
Limited contribution	**At least one justification**	Not much, since David did not add anything new. He mainly talked about how the disease affects his life. What he did add was that he explained how a carrier or a sick person calculates the odds of a sick offspring, so David will not have kids with a carrier (online interaction) Not so much, because the visit took place after we completed most of the module, but it did help me connect what we already learned (field-trip)	14	**4**
Positive	**Generic or one justification**	Yes, David helped me understand the disease characteristics Yes, because learning in school with the teacher – the routine, is less effective than real interacting with patients (field-trip)	53	**69**
Positive	**A claim and detailed justification**	Talking with David in the forum helped because he explained about CF, and answered the question that interested me such as… (online interaction) Yes, the field-trip helped learning the subject. In the hospital, they showed a presentation that gives clear explanation of the disease. For example, we learned that in order to increase their life expectancy the patients need high calorie diet, they need to consume enzymes to catalyze the fat, practice out, do physiotherapy and inhalations… we were physically much close to the whole thing, and it made us want to learn more about the disease, its symptoms, cure and so forth (field-trip)	10	**27**

Table 2 indicates that the hospital visit was better perceived as a contribution to the students' learning than the online interaction.

Knowledge acquisition was assessed by (a) the knowledge integration test developed by the WISE group at Berkeley, (b) an additional open-ended item, and (c) analysis of the responses to questions that students answered using "notes" that are part of the module. The differences between the online interaction and the field-trip groups were not significant.

Student attitudes toward learning with the module with each of the additional components was analyzed by employing Mann-Whitney's U test. The results are presented in Figure 1; the term "addition" in the figure refers the online interaction or the field-trip.



*p≤.05; **p≤.01; ***p≤.001

Figure 1. The students' attitudes toward learning with the online interaction and the hospital field-trip

In most items, field-trip students expressed attitudes that were significantly more positive toward the module than the online interaction students.

A brief summary of our findings shows that: (a) the adapted module, even without the additions, created interest and motivation among students to learn about genetics, (b) the field-trip addition was more productive than the online interaction addition in enhancing student interest and self-viewed learning, and (c) no differences were found in students' knowledge acquisition as measured by the test and the module tasks when learning with the modules with each of the two additions.

Discussion

The design of the adapted module, even without the additions of the field-trip and the online interaction with a patient, was successful in getting students interested in understanding the science behind CF. Features in the project, such as incorporating the real story of a CF patient, involving students in making decisions were crucial in getting students engaged and promoting their interest in understanding genetics.

During the field-trip, students had an opportunity to interact not only with a CF patient, but also with a social worker, a nurse, a physiotherapist and a doctor, and to experience real tests and exercises that CF patients need to go through. The online interaction on the other hand, was limited to the interaction with a CF patient. We assume that the diversified interactions in the field-trip enhancement were highly important in providing students with a holistic understanding of simple inheritance and CF, and thus, brought to increased authenticity.

During the field-trip, students were able to communicate with all the people described above in real life. Such social interactions are advocated in the informal science education literature (Ash, 2004; Schauble, et al., 2002). Asynchronous discussions have the advantage of enabling students to carefully articulate their thoughts, and to reflect before replying. This is definitely an added value in many curricular settings (Hoadley & Linn, 2000). However, based on the same findings indicated in the *diversified interactions* design elements, it seems that in the particular setting of the current study, when one of the goals is to engage students emotionally, the disadvantages of asynchronous discussions, which lack the dynamics, the body language, and the liveliness of a face-to-face discussion, are more dominant. An improved design in a technology-enhanced solution, could take advantage of synchronous meetings with people in the field, preferably with video.

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