DOCUMENT RESUME

ED 383 286 IR 017 141

AUTHOR Black, John B.; And Others
TITLE Student Understanding and Learning from an Interpretation Construction Design.
PUB DATE 95
NOTE 7p.; In: Proceedings of the 1995 Annual National Convention of the Association for Educational Communications and Technology (AECT), (17th, Anaheim, CA, 1995); see IR 017 139.
PUB TYPE Reports - Descriptive (141) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Cognitive Development; Computer Networks; Cooperative Programs; *Educational Environment; Higher Education; High Schools; *Instructional Design; Knowledge Level; *Multimedia Materials; *Study Facilities; *Workstations
IDENTIFIERS *Columbia University NY Teachers College; Dalton School NY; Study Support Environments

ABSTRACT

This study is a key concept in making design more fruitful in education. It is proposed that what students are doing when they construct knowledge is studying. For several years, Teachers College, Columbia University and the Dalton School (an independent school in New York City), have been collaborating on the Dalton Technology Project. The goal of the project is to use networked multimedia workstations to provide Study Support Environments (SSEs). The core of study is the hermeneutic activity of constructing interpretations. From this perspective, the basis for cognition is interpretation based on background contextual information. In this paper, a framework for SSE design and its application to a specific SSE created as a part of the Dalton Technology Plan is described; and an evaluation that demonstrates its effectiveness is discussed. (Contains 11 references.) (Author/AEF)

Title:

Student Understanding and Learning from an Interpretation Construction Design

Authors:

John B. Black, Janet Schiff, Robert O. McClintock, David van Esselstyn
Teachers College, Columbia University
and
Malcolm Thompson
The Dalton School

Study is a key concept in making design more fruitful in education. We propose that what students are doing when they construct knowledge is studying. For several years, Teachers College, Columbia University and the Dalton School (an independent school in New York City), have been collaborating on the Dalton Technology Project. The goal of the project is to use networked multimedia workstations to provide Study Support Environments (SSEs). Creating SSEs allows us to create "a place for study in a world of instruction" (McClintock, 1971). The core of study is the hermeneutic activity of constructing interpretations. From this perspective, the basis for cognition is interpretation based on background knowledge and beliefs (Heidegger, 1962; Winograd and Flores, 1986). Thus, the key consideration in designing a SSE is fostering the construction of interpretations based on observations and background contextual information. In this paper, we describe a framework for SSE design and describe its application to a specific SSE created as part of the Dalton Technology Plan. After describing the SSE we report an evaluation that demonstrates its effectiveness.

Interpretation Construction (ICON) Design Model

Much of the effort in the Dalton Technology Project has gone into developing particular study systems for different subject areas, but we have also been working to specify what the appropriate design principles would be for this approach. As reported earlier (Black and McClintock, 1995; Black, McClintock and Hill , 1994) this constructivist design approach seems to be captured by the following seven principles comprising the Interpretation Construction (ICON) design model:

1. **Observation:** Students make observations of authentic artifacts anchored in authentic situations

2. **Interpretation Construction:** Students construct interpretations of observations and construct arguments for the validity of their nterpretations

3. **Contextualization:** Students access background and contextual materials of various sorts to aid interpretation and argumentation

4. **Cognitive Apprenticeship:** Students serve as apprentices to teachers to master observation, interpretation and contextualization

5. **Collaboration:** Students collaborate in observation, interpretation and contextualization

6. **Multiple Interpretations:** Students gain cognitive flexibility by being exposed to multiple interpretations

7. **Multiple Manifestations:** Students gain transferability by seeing multiple manifestations of the same interpretations

Some of these constructive design principles are adaptations from proposals by others. For example, the Cognitive Apprenticeship principle comes from Collins, Brown and Newman (1988), the Multiple Interpretations one from Spiro, Feltovich, Jacobson and Coulson (1992), and the Collaboration one from Johnson, Johnson, Holubec and Roy (1984). The Observation principle is a combination of recommendations by Brown, Collins and Duiguid (1989) and the Cognition and Technology Group at Vanderbilt (1990), but our focus on authentic artifacts is unique. Further, our emphasis on Interpretation Construction, Contextualization, and Multiple Manifestations is distinctive.

An Example SSE

To illustrate the application of this design framework, we describe an SSE program created for the Dalton Technology Plan. Specifically, we describe how these constructive design principles apply to the *Galileo* program used in 11th and 12th grade science (particularly for students not scientifically oriented) at the Dalton School.

In the *Galileo* program, students study astronomy and science in general by using observations of telescopic plates and a computer simulation of the sky to construct and test interpretations of astronomical phenomena. Students examine and make measurements on photographic plates from observatory telescopes and computer simulations of the sky (**Observation**), then relate these analyses to reference materials (**Contextualization**) containing what is know about astronomical objects (i.e., stars, planets, etc.). The teacher initially talks through how he would analyze and interpret examples of such astronomical data (**Cognitive Apprenticeship**) then the students form groups to work on some data (**Collaboration**), while the teacher coaches and advises them as they proceed. The students develop their own hypotheses and test them against the astronomical data (**Interpretation Construction**). Students defend their hypotheses using their analyses and reference materials both within and between the groups, and such argumentation together with background readings exposes them to various ways to interpret the data (**Multiple Interpretations**). As they proceed through the course, the students see how basic principles of astronomy, physics and chemistry can be used to make sense of different sets of astronomical data (**Multiple Manifestations**).

An Evaluation of Generic Skill Learning with the SSE

Since we believe that interpretation is central to cognition and learning, we evaluated whether the *Galileo* program would increase students' interpretation skills. Specifically, we tested whether the students who had been through this program could make observations and interpretations in a completely new area better than students who had not been through the programs. For these studies, we chose an area unlikely to be familiar to precollege students -- namely, cognitive psychology.

In this evaluation study, the 11th and 12th grade students who had been through the *Galileo* program were compared to a comparable group on how well they could interpret and link three related cognitive psychology studies and their underlying principles. The students were given booklets containing descriptions of basic observations made in these three psychology studies together with various informational resources including relevant and irrelevant background material. The students were given three hours to perform the task and write a final report. These reports served as a measure of the students abilities to recognize particular patterns in the data, argue or explain the causes and effects of these patterns, as well as represent the data to support or refute their interpretations.

Method

Participants

The experimental group consisted of 46 11th and 12th grade students at the Dalton School who were at the end of the *Galileo* course. The control group was 33 Dalton 10th and 11th grade students who planned to take the *Galileo* course during the following year.

Materials

The participants were provided with copies of data from three cognitive psychology studies. The participants were told that in all three of the studies they were reading about, the researchers select six students and have them memorize a list of 12 Subject-Verb-Object sentences (propositions). However, the studies differ in the following ways:

Study One. One full day after remembering the list, participant memory is tested with items on computer screen. the propositions appear in the same form as they were memorized. The computer records how long it take each participant to respond with an affirmative answer.

Study Two. A different set of six students are asked to recall the propositions they memorized a day before; however, this time, they are tested with the passive voice version of the sentences instead of the active voice version they memorized. Once again, the computer records how long it takes each participant to respond with an affirmative answer.

Study Three. Yet another set of six students are asked to recall the propositions they memorized earlier; however, in this study, participants are tested with paraphrases of the sentences memorized and asked to respond "yes" if the test sentence as essentially the same meaning as the memorized sentence.

Upon reading these three studies and the background materials provided, Dalton students were asked to interpret the data using background materials provided as well as other outside sources. The background readings included both relevant information about information processing systems as well as propositional network theory. Irrelevant information from philosophy was also included as a distractor.

Procedure

Administering the Materials and Collecting Student Reports.

The study was conducted in one 3-hour session. First, the experimenter passed out the assignment booklets and the teacher read the instructions on the first page of the assignment booklet. After the instructions, the students proceeded to work on the assignment in their groups. While doing the assignment the students were free to use any of the resources in the Dalton School building (computers, libraries, etc.) including asking the experimenter clarification and information questions (the same experimenter and teacher conducted all sessions). At the end of the 3-hour period the students handed in their reports and all the work they had done in folders.

Analysis of Student Reports

The file folders from both the *Galileo* and pre-*Galileo* groups were evaluated along the following there dimensions: pattern recognition, explanation and argumentation, and data representation. These dimensions were weighted 2:3:1 based upon levels of difficulty. More specifically, groups could earn up to 20 points for pattern recognition, 30 points for explanation and argumentation, and 10 points for data representation. Extra credit points were awarded for plausible recommendations for follow-up studies on the cognitive psychology principles tested; however, a majority of the students did not address this aspect of the data.

Using our coding system, we were able to weigh answers in terms of difficulty as well as plausibility. the "optimal responses for pattern recognition, explanation and argumentation, and data representation are as follows:

Pattern Recognition

Study One. Students should recognize that the response time increases with the number of propositions per subject. For example, if lawyer has e propositions and doctor has 2 propositions then subjects will take longer to remember a proposition about the lawyer than the doctor. They are also expected to report the means. Partial credit is given for alternative patterns. *Maximum Points: 4.*

Study Two. Students should note that the positive relationship between number of propositions per subject and response time still holds. They should also recognize that study two takes longer than study one. Again, means should be reported and partial credit is given for alternative patterns. *Maximum Points: 7.*

Study Three. Students should recognize that the positive relationship between number of propositions per subject and response time still holds. They should also note that study three takes longer than study one and study two. Ideally, students should note that study three has a steeper climb (i.e., slope) than the other two studies. Means should be reported and partial credit is given for alternative patterns. *Maximum Points: 9.*

Explanation and Argumentation

Study One. In this study, the optimal respones would relate the information processing and/or propositional network theories to the pattern recognized. Partial credit was given for responses favoring individual differences. Testing hypotheses was also credited. Maximum Points: 6.

Study Two. Students were supposed to relate the increase in mean response time to the stage of transforming a proposition from passive to active voice. They should have also noted that it takes time to match the transformed proposition to the database. Again, students were given points for appropriately using information processing theory or propositional network theory to support their hypotheses. Partial credit was given for responses favoring individual differences. Regardless of final outcome, hypothesis testing was also given partial credit. Maximum Points: 12.

Study Three. Students were given credit for discussing how the overall increase in mean response time is due to an increase in search time, which is caused when a synonym for the original proposition is put in the recall test. They also should have noted that the increased time is due to the time required to match the synonym against the database. Students were given credit for using relevant background readings. Partial credit was given for responses favoring individual differences. Students were also given partial credit for reporting their hypothesis test and results. Maximum Points: 12.

Data Representation

Groups were given credit for creating spreadsheets that reported means and/or ratios, bar graphs that appropriately represented the data, propositional network diagrams, and alternative ways of representing the data to support explanations of trends. Ideally students would have been creating graphs that reflected the differences between studies. By plotting these trends, students would have recognized that the intercepts of study one and study three are the same but their slopes are different. Additionally, the intercept of study one and study two are different but their slopes are the same. Representations of these trends were likely to have improved both pattern recognition and argumentation scores. *Maximum Points: 10.*

Results

Table 1 presents the results of the data analyses. As the first column in Table 1 shows, in total the *Galileo* group scored 33% higher than the pre-*Galileo* group (26.1 vs. 19.6 – out of 60 possible), and this is statistically a very significant difference, $t(77)=4.56$, $p<.001$.

Table 1
Quantitative Analysis of Reports Written by Students in the *Galileo* Group and the Control Group

	Total	Pattern Recognition	Explanation & Argumentation	Data Representation
***Galileo* Group**	26.1	9.8	14.2	2.1
Control Group	19.6	7.7	11.8	0.1

This significantly superior performance of the *Galileo* group also occurred in all three of the component scores: namely, in Pattern Recognition (9.8 vs. 7.7 -- out of a possible 20), $t(77)= 2.40$, $p<.01$; in Explanation and Argumentation (14.2 vs 11.8 -- out of a possible 30), $t(77)=1.69$, $p<.05$; and particularly in Data Representation where the pre-Galileo control group effectively got 0 (specifically, 0.1) whereas the *Galileo* group got 21% of the possible (2.1 out of 10 possible), $t(77)=6.14$, $p<.001$.

Conclusions

We have proposed an approach to constructivist design (ICON) that makes interpretation construction of authentic artifacts in the context of rich background materials the central focus. We have shown how this approach can be applied to design a Study Support Environment for teaching science and scientific reasoning to students not scientifically oriented We have also shown that in addition to learning specific content, students using these programs acquire generalizable interpretation and argumentation skills. Thus, our constructivist design framework is useful both for guiding design and for producing valuable learning results.

References

Black, J.B. and McClintock, R. (1995) An interpretation construction approach to constructivist design. In B. Wilson (Ed.) . *Constructivist learning environments*. Englewood Cliffs, NJ: Educational Technology Publications.

Black, J.B., McClintock, R.O. and Hill, C.S. (1994) Assessing student understanding and learning in constructivist study environments. In M. Simonson, H. Maushak and K. Abu-Omar (Eds.) *16th Annual Proceedings of the Selected Research and Development Presentations at the 1994 National Convention of the AECT*. Washington, DC: Association for Educational Communications and Technology.

Brown, J.S., Collins, A. and Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, **18**, 32-42.

Cognition and Technology Group at Vanderbilt (1990). Anchored instruction and its relation to situated cognition. *Educational Researcher*, **20**, 2-10.

Collins, A.,, Brown, J.S., and Newman, S.E. (1988). Cognitive apprenticeship: teaching the craft of reading, writing and mathematics. In L.B. Resnick (Ed.) *Cognition and instruction: Issues and agendas*. Hillsdale, NJ: LEA.

Heidegger, M. (1962) *Being and time* (translated by J. Macquarrie and E. Robinson). New York: Harper and Row.

Johnson, D., Johnson, R., Holubec,E. and Roy,P. (1984). *Circles of learning*. Alexandria, VA: ASCD.

McClintock, R. (1971) Toward a place for study in a world of instruction. *Teachers College Record*, 72, 405-416.

Palmer, R.E. (1969) *Hermeneutics*. Evanston, IL Northwestern University Press.

Spiro, R.J., Feltovich, P.J., Jacobson, M.J. and Coulson, R.L. (1992) Cognitive flexibility, constructivism and hypertext: Random access instruction for advanced knowledge acquisition in ill-structured domains.In T.M. Duffy and D.H. Jonassen (Eds.) *Constructivism and the technology of instruction: A conversation*. Hillsdale, NJ: LEA.

Winograd, T. and Flores, F. (1986) *Understanding computers and cognition: A new foundation for design*. Norwood, NJ: Ablex.

Address for all authors:
Box 62
Teachers College, Columbia University
525 West 120th Street
New York, NY 10027

7