DOCUMENT RESUME

ED 332 250 CS 507 459

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TITLE Student Responses to Computers: A Longitudinal Study.
PUB DATE May 91
NOTE 20p.; Paper presented at the Annual Meeting of the International Communication Association (41st, Chicago, IL, May 23-27, 1991).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Computer Assisted Instruction; Computer Literacy; *Computers; *Educational Media; Elementary Secondary Education; Instructional Effectiveness; Longitudinal Studies; Media Research; Novelty (Stimulus Dimension); Public Schools; Student Attitudes
IDENTIFIERS *Computer Anxiety; *Educational Media Role; Tennessee

ABSTRACT

Using R. E. Clark's concept of media attributions, a study examined the evolution of fourth through tenth grade students' perceptions about computers on three dependent variables--preference, perceived learning, and perceived difficulty, over the course of 3 years. Subjects were 339 public school students in Tennessee who completed a self-administered questionnaire. Findings demonstrated clear evidence of novelty effects. Students' judgments regarding preferences for computers declined significantly as did their perceptions of learning from the technology during the 3 years. Perceived difficulty of using computers, which was expected to decline, remained stable. In addition, both gender and age proved to be significantly related to all three dependent variables. Older students were consistently more skeptical about the technology than were younger students, and boys were consistently more positive than girls. These relationships showed no evidence of change over the course of 3 years. The results support critiques of the methodological limitations of the dominant approach to the study of computer effects in learning environment. Reports of short-term experimental applications of the technology have led to misleading generalizations about the computer's instructional potential. (Thirty-three references are included.) (PRA)

Student Responses to Computers:
A Longitudinal Study

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Top Paper presented to the International Communication Association, Communication and Technology Division, May 1990, Chicago, IL.

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The results of this study support critiques of the methodological limitations of the dominant approach to the study of computer effects in learning environments. That is, reports of short-term experimental applications of the technology have led to misleading generalizations about the computer's instructional potential. Using Clark's concept of media attributions, this study examines the evolution of students' (fourth through tenth grade) perceptions about computers on three dependent variables -- preference, perceived learning, and perceived difficulty, over the course of three years. The findings demonstrate clear evidence of novelty effects. Students' judgments regarding preferences for computers declined significantly as did their perceptions of learning from the technology during the three years. Perceived difficulty of using computers, which was expected to decline, remained stable. In addition, both gender and age proved to be significantly related to all three dependent variables. Older students were consistently more skeptical about the technology than were younger students, and boys were consistently more positive than girls. These relationships showed no evidence of change over the course of three years.

Student Responses to Computers: A Longitudinal Study

Critics and reviewers of research on computers and learning have identified important limitations characteristic of many studies. These criticisms have focused, to a large extent, on the inadequacies of the traditional experimental approach, in particular, the use of the media comparison model, to enhance knowledge about the instructional effectiveness of computers (Clark, 1984; 1985; 1990; Clark & Salomon, 1985; Kulik, Kulik, & Cohen, 1980; Papert, 1987; Salomon & Gardner, 1986), as well as the glaring absence of longitudinal research efforts emphasizing the long-term impact of computers, as opposed to short-term novelty effects (Krendl & Lieberman, 1986; Lieberman, 1985; Salomon, 1984).

The central concern in these critiques is grounded in what Salomon (1984; Salomon & Gardner, 1986) has characterized as the naivety or simplemindedness of research which purports to draw valid and generalizable conclusions about the instructional effectiveness of "the computer" based on short-term, experimental applications of the technology. Typically these studies are vague about the details of the computer application being used -- characteristics and content of the software, degree of student control, role of the teacher, description of the learning environment, and so on. In these studies researchers often discuss computer technology as if it were one monolithic system that could readily be transferred from one setting and one learning environment to another and could reasonably be expected to obtain the same results.

Of course, challenges of this underlying assumption are frequently cited in critiques of the rapidly accumulating body of studies. Salomon has explained the situation as follows:

> Too many factors interact to produce any uniform effects. There are various modes of computer use, ranging from computer-based instruction to LOGO programming, and from data crunching to mindlessly playing games; there are various kinds of users, various contexts in which the

> use takes place, and other variables of importance that interact. As there is no capital letter "Computer," no two combinations of these are likely to yield identical effects (1984, p. 8).

In addition, Clark (1984; 1985; Clark & Salomon, 1985) has suggested that the results gleaned from research on computers and learning are highly suspect because they may well be attributable to a variety of uncontrolled effects, including novelty effects and differences in instructional method or instructional content, rather than to the delivery medium, the computer. In particular, discussions of the novelty effect have noted that high levels of motivation and attention are often associated with new activities. The critics argue that it is the motivation and attention, inflated by the novelty of the computer application, that account for enhanced learning outcomes and positive attitudes that result, not the delivery system itself as researchers often conclude. The implication of this criticism is that the positive outcomes -- learning from the new medium, having more positive attitudes about learning -- will tend to decline as the technology becomes more familiar and its novelty wears off. However, the constraints of the short-term experimental applications prohibit any effort to test for the existence or power of novelty effects. The only evidence that speaks to the issue of the role of novelty effects appears in meta-analyses comparing the relative strength of learning effects in longer versus shorter term computer applications (Kulik, Bangert, & Williams, 1983; Kulik & Kulik, 1987). These studies conclude that short-term applications typically report more positive learning effects than do studies of long duration.

The general conclusion of the critiques is that research on computers and learning is weak in many critical areas -- it lacks scientific rigor, conceptual development, appropriate and adequate research methods. Rather than learning from and building on research addressing the effects of previous new technologies, such as television, research on computers and learning imitates and replicates the limitations and naivety of such work (Clark, 1984; Salomon & Gardner, 1986).

One of the suggestions emerging from the various critiques of research on computers is to shift attention away from the examination of effects of the medium exclusively and to begin to address individuals' approaches to, attributions about, and perceptions of the technology (Clark, 1984; 1985; Clark & Salomon, 1985; Salomon & Gardner, 1986). The purpose of the present study is to follow this suggestion using longitudinal data from a large, representative sample to study the evolution of responses to computers over an extended period of time. This approach should provide the researcher with evidence to assess the magnitude and substance of any sort of novelty effects related to computers, as well as understand how the role of computers -- users' perceptions of and attributions about them -- have changed over time as the technology has become more firmly established in our culture and, in particular, in our schools.

The particular dimensions of interest in the study of individuals' responses to computers are based on Clark's discussion of media attributes (Clark, 1983; Clark & Salomon, 1985). According to Clark, examination of media attributes is necessary to understand learning outcomes resulting from media applications. He has identified three dimensions -- preference, difficulty, and perceived learning -- as being fundamental to understanding individuals' media attributions.

Formulating hypotheses for understanding individuals' perceptions of and attributions about computers over time required a review of two areas of inquiry -- studies of media novelty effects and research on computer attitudes. Both literatures were relevant in shaping our expectations about how computer attributions might evolve over time. These hypotheses focus on respondents' assessments of computers in relation to the three dimensions of interest -- preference, difficulty, and perceived learning. In each case we identified a general trend we expected to find among the sample as a whole. In addition, we hypothesized changes we anticipated based on previous research examining the role of gender and grade level in determining students' responses to the technology. Each set of hypotheses below includes predictions for the general trend and then specifically for the influence of gender and grade level.

Hypotheses related to computer preference

Two approaches related to the assessment of preference for or enjoyment of a medium appear in the literature. One is an indirect approach that equates this concept with direct time expenditures (Himmelweit, Oppenheim, & Vince, 1958; Schramm, Lyle, & Parker, 1961; Vitalari, Venkatesh, & Gronhaug, 1985). That is, researchers test for novelty effects by measuring how much time is spent on an activity and how time expenditures on other related activities change as a result. The other approach is to ask respondents directly to assess their level of enjoyment for the activity (Henke & Donohue, 1986). Regardless of the conceptualization used for preference, the conclusion from these studies is that, in general, level of enjoyment or preference for a media activity tends to decline as its novelty wears off over time.

Thus, in the case of computers, we expected individuals' attributions about how much they enjoy using computers to decline significantly over time. We also expected gender to play a significant role with girls' assessments of computer enjoyment being significantly lower than boys' over time (Abler & Sedlacek, 1987; Collis & Ollila, 1986; Griffin, Gillis, & Brown, 1986; Johnston, 1987; Koohang, 1989; Moore, 1985. In addition, based on previous work on the relationship between grade level and computer attitudes, we predicted that younger students' enjoyment of computers would be significantly higher than older students' enjoyment over time (Smith, 1987). That is, we anticipated a negative relationship between grade level and computer enjoyment.

Hypotheses related to perceived difficulty of using computers

We expected perceived difficulty of computers to decline over time as students gained experience and confidence with the technology. In general, researchers have found that students' level of confidence with the technology has increased as a result of practice and experience (Arndt, Clevenger, & Meiskey, 1985; Dalton & Hannafin, 1984; 1985; Griffin, Gillis, & Brown, 1986; Koohang, 1989; Moore, 1985; O'Toole & Wagner, 1985). We anticipated that gender would also play a significant role with girls' reports of difficulty being higher than boys' (Abler & Sedlacek, 1987; Collis & Ollila, 1986; Koohang, 1989). Grade level was also expected to influence perceptions of difficulty. We anticipated that younger students would perceive the technology as less difficult than older students because of their generally more positive attitudes (Collis & Ollila, 1986; Smith, 1987). Thus, we hypothesize a positive relationship between grade level and perceived difficulty.

Hypotheses related to perceived learning from computers

We expected perceived learning to decline over time as students gained experience with computers and the generally positive influence of novelty effects declined (Becker, 1985). Based on the gender differences research cited earlier, we also anticipated that girls' perceptions of learning would be significantly lower than boys' (Abler & Sedlacek, 1987; Collis & Ollila, 1986; Griffin, Gillis, & Brown, 1986; Johnston, 1987; Koohang, 1989; Moore, 1985). The role of grade level was also expected to be significant in that elementary students' perceptions of learning from computers would be higher than both middle and high school students' (Krendl, 1986; Smith, 1987).

Method

A panel of 339 respondents randomly selected from all fourth through tenth grade classes in the public school system in a small city (population=35,000) in Tennessee participated in the study. The participants (53.4% female and 46.6% male) completed a self-administered questionnaire at the same time each year for three sequential years reporting on their media use habits and their assessments of various media activities.

Half (50.8%) of the sample reported having used some type of computer (including video game systems) outside of school at the beginning of the study. By the end of the three-year period, 65.2% of the students were using computers outside of school. School use, though already well established at the outset, further increased during the course of the study from 90% of the students having used the technology in at least one class the first year to 97% by the end of the third year.

Respondents reported that teachers were the most frequent source of help with using a computer at all three points in time, probably because most computer use took place in a school setting. Parents ranked second in helping, with friends coming in third and siblings last in all three surveys.

Some specific types of computer use changed during the three-year period of time, while others remained stable. For example, video game playing decreased from a high of 72.5% (of the students who had used computers) who reported having played such games in the first year to a low of 30.8% (of those using computers) by the third year. In contrast, using the computer for word processing increased during this period of time from 32.6% in the first wave to 53.7% by the final wave. More stability was reflected by such activities as playing word games (42.9% in 1984 and 38.1% in 1986).

The following analyses look specifically at students' responses to computers on the three dimensions (preference, difficulty, and learning) defining individuals' media attributions. We collected data on changes in students' perceptions of the medium as their familiarity with computers increased and their uses of the technology changed during the course of the study. The nature of these media attributions and their evolution over the three years of the study are examined through a series of analyses examining the role of time, gender and grade level in determining the respondents' attributions about the medium over the three years.

The dependent measures examined in the following analyses are based on students' responses to a series of paired comparison judgments about traditional literacy activities (reading and writing) and electronic media activities (using a computer and watching television). These judgments were based on students' comparisons of the activities in terms of the three dimensions identified by Clark as fundamental to understanding one's attributions and beliefs about media activities -- which one they would prefer in relation to the others, which one they would learn more from, and which they would find more difficult. Each activity was compared with all others, resulting in a series of questions as follows:

Which would you rather do ...

read a book or write
write or watch television
watch television or use a computer
use a computer or read a book
read a book or watch television
write or use a computer

Which would be more difficult for you ...

same as above

Which would you learn more from ...

same as above

This approach of comparing activities was adopted because activities do not exist in isolation; each one is only a part of a complex mix of opportunities available to the individual. The ability of each activity to fulfill one's needs and desires is assessed relative to other readily available alternatives.

Three indices -- one each for preference, difficulty, and learning -- indicating how many times each respondent chose the computer over other activities were constructed. These indices served as the dependent variables in the following analyses.

Results

We used MANOVA repeated measures procedures for longitudinal data (Schaie & Hertzog, 1981) to assess the role of gender and grade level over time in determining respondents' assessments of the computer. Gender and grade level were specified as the between-subject factors and time as the within-subjects factor for subjects' reported levels of preference, perceived difficulty, and perceived learning. These analyses address the specific hypotheses examining the role of gender and grade level as they relate to computer attributions.

Computer preference hypotheses

Student assessments of computer preference over time confirmed the first hypothesis. Scores generally declined over time for the sample as a whole: time 1, M=2.01; time 2, M=1.72; time 3, M=1.43. The main effect for time was significant for computer enjoyment: F (2,332) = 46.87, $p < .001$. As students became more familiar with the technology, assessments of their enjoyment steadily declined.

Gender and grade level also yielded significant results in relation to computer preference. As predicted, girls' scores reflected the same overall pattern as boys'; that is, a steady and monotonic decrease over time was apparent. However, despite the similarity in the pattern of the results, girls' assessments of computer enjoyment were significantly lower at each point in time than were boys'. For girls means were as follows: time 1, M = 1.69; time 2, M = 1.43; time 3, M = 1.06. Comparable means for boys were: time 1, M = 2.11; time 2, M = 1.91; time 3, M = 1.69. The main effect for gender was significant: F (1,333) = 51.27, $p < .001$. Thus, the second part of the first hypothesis regarding gender differences in assessments of computer enjoyment was confirmed.

For grade level, the pattern was once again consistent and as predicted. Though their scores declined over time, younger students tended to rate the computer as more enjoyable at each point in time than did older students. Means by grade level (presented with elementary students first) are as follows: time 1, M = 2.31, 1.91, 1.49; time 2, M = 1.95, 1.65, 1.58; time 3, M = 1.76, 1.30, 1.07. MANOVA results yielded a significant main effect for grade level: F (2,333) = 14.79, $p < .001$. No interaction effects among the independent variables resulted in the analysis.

Computer difficulty hypotheses

We predicted that perceived difficulty with computers would decline over time. This hypothesis was not supported by the analysis. Mean assessments of difficulty for the whole sample remained relatively stable over time: time 1, M = 2.29; time 2, M = 2.39; time 3, M = 2.38. The test for the main effect of time was not significant: $F(2,332) = 2.11$, $p = .12$. Students' perceptions of the difficulty of using computers did not decrease with familiarity and experience as anticipated.

Results for the test of gender effects reflect the pattern established earlier with computer preference. That is, the shape of the relationship is similar for boys and girls, with girls being significantly different at each point in time. In this case, girls found computers more difficult than boys each year, with very little change over the three years of the study. For girls, means were as follows: time 1, M = 2.45; time 2, M = 2.58; time 3, M = 2.50; for boys: time 1, M = 2.20; time 2, M = 2.29; time 3, M = 2.20. The test for the main effect of gender yielded significant results: $F(1,333) = 25.76$, $p < .001$. Once again, then, girls' responses differed significantly from boys', with girls perceiving computers to be consistenly more difficult to use.

The test of the relationship between grade level and perceived difficulty of computers supported our hypothesis. Elementary students rated the computer as significantly less difficult each year than did middle school and high school students. Means (with elementary students listed first) were as follows: time 1, M = 2.02, 2.44, 2.51; time 2, M = 2.35, 2.37, 2.60; time 3, M = 2.29, 2.44, 2.33. The main effect of grade level yielded significant results, $F(1,333) = 7.56$, $p < .001$. Thus, despite the stability of the difficulty ratings over time, the positive relationship between grade level and perceived difficulty of using computers proved to be significant. A significant interaction between grade level and time also emerged from the analysis, $F(4,666) = 4.05$, $p < .01$. What appears to happen over time is that the differences in perceived difficulty of using computers tend to converge. That is, differences in ratings between younger and older students are more dispersed at time 1 than at time 3, though elementary students continue to rate the computer as less difficult at each point in time.

Computer learning hypotheses

Next we examined tests of the hypotheses related to student assessments of learning from computers. The general hypothesis was confirmed. Ratings of learning from computers for the sample as a whole declined over time: time 1, M = 2.16; time 2, M = 1.97; time 3, M = 1.82. The for the main effect of time yielded significant results: F (2,332) = 13.79, $p < .001$. Each additional year of experience with the technology resulted in lower student assessments of their perceived learning from computers.

The pattern of the relationship between gender and perceived learning from computers presents a similar pattern of results to those reported for previous hypotheses. That is, boys and girls tended to respond to computers similarly over time, assessments declined over time for both groups, but girls' assessments of perceived learning were significantly lower than boys' at each point in time. Means for girls were as follows: time 1, M = 2.09; time 2, M = 1.87; time 3, M = 1.75. The comparable ratings for boys' mean assessments of perceived learning were: time 1, M = 2.17; time 2, M = 1.98; time 3, M = 1.81. The main effect for gender was significant, F (1,333) = 3.97, $p < .05$. These results confirmed our expectations regarding the role of gender in relation to perceived learning.

Analysis of the results for grade level also confirmed our expectations. Assessments of perceived learning from computers demonstrated a negative relationship with grade level over time. Means (beginning with elementary scores) were as follows: time 1, M = 2.36, 2.05, 1.97; time 2, M = 2.15, 1.89, 1.73; time 3, M = 1.97, 1.76, 1.61. The main effect for grade level was significant: F (2,333) = 7.97, $p < .001$. As demonstrated in the tests for computer preference and difficulty, younger students were more optimistic and positive about the computer. Here this is demonstrated by their more generous assessments of the computer's effectiveness as an instructional tool than were older students. They reported higher levels of perceived learning at each point in time than either middle school or high school students. Interactions among the independent variables did not emerge.

Discussion

The purpose of this study was to examine the nature of individuals' responses to computer technology over an extended period of time, a time during which computers were rapidly disseminating in schools and homes. The orientation adopted focuses on the concept of media attributions as identified by Clark (1983; 1984; 1985; Clark & Salomon, 1985). The study responds to criticisms levelled against research on computers and learning suggesting that the findings are severely limited, invalid, and not generalizable as a result of methodological constraints. Reliance on short-term experimental applications of computers using a media comparison approach does not rule out alternative explanations, specifically the possible role of novelty effects, in accounting for the generally positive results emanating from computer applications.

This study attempted to overcome these limitations by using a longitudinal panel design, an approach that permits the researcher to examine and identify the role of novelty effects as the technology becomes established and familiar to users. The results of the study yield support for some previous findings and important qualifications for others. The specific areas of interest here focus on the evolution of individuals' perceptions of and attributions about computers on the dimensions of preference, perceived difficulty and learning. As expected, responses assessing preference for or enjoyment of the technology generally tend to decline over time. In addition, both gender and grade level play significant roles in determining where these assessments are initially and how much or how little they decline during the course of three years. Girls enjoy the technology significantly less than boys at each point in time; younger students enjoy computers much more than older students at each point in time.

The results for perceived difficulty did not confirm our expectations. Individuals' perceptions of computer difficulty did not decline as anticipated. Rather they remained quite stable over the three-year period. However, once again, gender and grade level proved to be important determinants of the relative level of perceived difficulty. Girls reported that computers were significantly more difficult than boys at all three measurement points. Older students found computers more difficult to use than did younger students all three years. These results are somewhat surprising. We expected students to become more comfortable with the technology as they gained experience with it. This did not happen. Computers are viewed as being just as difficult to use at the end of the study as they had been when there were first beginning to be used in schools despite three years of rapid dissemination when nearly everyone in the school was using them in classes and home use had increased dramatically. Uses of the technology changed during the three years; that is, more word processing was being done, for example, and fewer games were being played by the end of the study. However, regardless of patterns and types of use, the level of perceived difficulty remained absolutely unchanged.

Finally, we examined results for perceived learning from computers during the three-year period of time. As expected, perceptions of the technology's instructional effectiveness in general declined significantly over time. Gender and grade level were again significant predictors of perceptions. Girls assessed computers as less effective instructional tools than boys. Older students were more skeptical about the computer's teaching ability than younger students. This is an intriguing finding given the early criticisms of the drill-and-practice orientation of most computer software for in-school applications. During the course of the study new and innovative software became available for both in-school and out-of-school use, and teachers began to expand their uses of the technology in the classroom. Despite the introduction of more sophisticated, challenging, and visually stimulating software and teachers' expanded efforts to integrate the technology in to the curriculum, students' perceptions of learning from the technology declined over time, though less for younger students and less for boys.

In terms of future research, these results suggest that there is strong evidence of novelty effects, particularly in the area of affective responses to the technology and assessments of its instructional effectiveness. Liking and enjoying computers tends to decline with familiarity, as do perceptions of its teaching ability. Thus, studies concluding that students like computers, prefer the computer as an instructor, and think they learn more from computers than from traditional instructional methods following short-term applications are probably misleading. The findings presented herein provide evidence that the critics are right -- there are problems with the generalizability and validity of earlier studies as a result of methodological constraints. It appears that novelty effects do exist. Therefore, their presence and influence on findings can no longer be ignored in research on computers and learning.

It is also clear from these results that gender and age are critical factors in understanding students' responses to the technology. Gender was identified by Chen (1985) as a consistent factor affecting computer attitudes and use in the early research on the technology. This study suggests that his conclusion remains valid. The results presented here also suggest that age is an additional factor that consistently shapes individuals' perceptions of and attributions about computers.

The role of gender and age should be examined in future research on computers. As the technology gains a stronger foothold on our educational institutions and becomes a standard instructional tool in the classroom, as well as a fundamental component of cultural literacy, it is critical that we understand students' responses to this medium. We know very little about this topic as yet, and we know less about how to deal with the associated fears and apprehensions that are experienced more by some students than by others. Meanwhile, the number of computers in our schools continues to expand, and teachers are becoming more creative in their efforts to integrate the technology into the curriculum. The fact that older students are less enamored and more skeptical about computers and that girls are consistently more negative about the technology has profound implications for the instructional potential of the medium. A research agenda for the future should include more and better research addressing issues related to the long-term impact of the technology. Rigorous research on this issue would be useful to policy makers, educators, and parents. In addition, we need studies of the potential of systematic and thorough training programs to reduce negative affect toward computers among certain groups of students. What will probably provide no further benefit to the field are the standard small-scale experiments reporting on the short-term effects of computer implementation.

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