DOCUMENT RESUME

ED 420 509 SE 061 522

AUTHOR Henderson, David G.; Fisher, Darrell L.; Fraser, Barry J.
TITLE Learning Environment, Student Attitudes and Effects of Students' Sex and Other Science Study in Environmental Science Classes.
PUB DATE 1998-04-11
NOTE 14p.; Paper presented at the Annual Meeting of the American Educational Research Association (San Diego, CA, April 13-17, 1998).
PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Classroom Environment; Course Selection (Students); Educational Strategies; *Environmental Education; Foreign Countries; High Schools; *Interest Inventories; Learning Theories; Science Education; *Sex Differences; *Student Attitudes
IDENTIFIERS Australia

ABSTRACT

This study reports the first use of classroom learning environment questionnaires involving students in senior high school environmental science classes. The three objectives of the study were to measure students' perceptions of aspects of their learning environment in environmental science classrooms by means of the Environmental Science Learning Environment Inventory (ESLEI), to investigate associations between students' perceptions of their classroom learning environment and students' attitudinal outcomes, and to investigate differences in student perceptions based on the students' gender and whether they were studying another science course. Results indicate that of the five aspects of environmental science students' learning environments measured in this study, student cohesion, involvement, and task orientation were found to be the most strongly associated with positive attitudinal outcomes. Contains 35 references. (DDR)

LEARNING ENVIRONMENT, STUDENT ATTITUDES AND EFFECTS OF STUDENTS' SEX AND OTHER SCIENCE STUDY IN ENVIRONMENTAL SCIENCE CLASSES

David G. Henderson,
Darrell L. Fisher & Barry J. Fraser,
Curtin University of Technology
GPO Box U1987
Perth Western Australia 6845

email:

dhenderson@space.net.au

Paper presented at the Annual Meeting of American Educational Research Association, San Diego, April, 1998

OBJECTIVES

This study reports the first use of classroom learning environment questionnaires involving students in senior high school Environmental Science classes. The study had three objectives. The first objective was to measure students' perceptions of aspects of their learning environment in senior Environmental Science classrooms by means of the *Environmental Science Learning Environment Inventory* (ESLEI). The second objective was to investigate associations between students' perceptions of their classroom learning environment and students' attitudinal outcomes. The third objective was to investigate differences in student perceptions based on the students' sex and whether or not they were currently studying another science course.

BACKGROUND

International research efforts involving the conceptualization, assessment, and investigation of perceptions of aspects of the classroom environment have firmly established classroom environment as a thriving field of study (Fraser, 1998; Fraser & Walberg, 1991). For example, recent classroom environment research has focused on constructivist classroom environments (Taylor, Dawson, & Fraser, 1995), computer-assisted instruction classrooms (Teh & Fraser, 1994), and teacher interpersonal behavior in the classroom (Wubbels, Creton, Levy, & Hooymayers, 1993; Kent & Fisher, 1997).

Foundations for classroom environment research were laid more than 60 years ago, when the work of Lewin and Murray assumed particular significance. Lewin (1936) introduced the formula $B = f(P,E)$ to describe human behavior *(B)* as a function of two interdependent influences, the Person *(P)* and the Environment *(E)*. Murray (1938) developed this theory to describe the concept of the personal needs of an individual (including goals and drives) and the environmental press (including stimulus, treatment, and process variables). Murray's needs-press theory led to the development of various measures of personality, but environmental measures rarely were considered in early studies.

In the past three decades, much attention has been given to the development and use of instruments to assess the qualities of the science classroom learning environment from the perspective of the student (Fraser, 1986, 1994; Fraser & Walberg, 1991), and the association between learning environment variables and student outcomes has provided a particular rationale and focus for the use of learning environment instruments. In a meta-analysis which examined 823 classes in 8 subject areas and representing the perceptions of 17,805 students in 4 nations, Haertel, Walberg, & Haertel (1981) found enhanced student achievement in classes which students felt had greater Cohesiveness, Satisfaction, and Goal Direction and less Disorganization and Friction. Other literature reviews since then have supported the existence of associations between classroom environment variables and student outcomes (Fraser, 1998).

Until about 20 years ago, research involving science students' outcomes focussed primarily on educational objectives in the cognitive domain but, in more recent times, attention has been paid to outcomes in the affective domain; the study of student

attitudes has formed a primary component of this research (Weinburgh, 1995). Shulman and Tamir (1972) suggested that affective outcomes of education are at least as important as cognitive outcomes and acknowledgement of the importance of affective outcomes is reflected in their increasing emphasis in curricula (Gardner & Gauld, 1990; Hough & Piper, 1982; Mathews, 1974).

Walberg's theory of educational productivity (Walberg, 1981, 1984) holds that there are nine factors which contribute to variance in students' cognitive and affective outcomes: student ability, age and motivation; the quality and quantity of instruction; and the psychological climate of the home, the classroom social group, the peer group outside the classroom, and the mass media (especially television viewing). Testing of the model using data collected as part of national studies has confirmed its validity in showing that student achievement and attitudes are influenced jointly by a number of factors rather than by one dominant factor (Walberg, 1986; Walberg, Fraser, & Welch, 1986). Classroom and school environment factors were found to be particularly important influences on student outcomes, even when a number of other factors were controlled. These findings are consistent with the theoretical model of Getzels and Thelen (1960), which describes the school class as a social system and suggests that group behavior can be predicted from personality needs, role expectations, and classroom environment.

Although past studies have examined associations between student attitudinal outcomes and student perceptions of the learning environment in science classes (Fraser, 1998), this study is distinctive in that it is the first to involve students specifically in Environmental Science classrooms.

Previous studies have reported sex-related differences in science students' perceptions of the learning environment (Fraser, Giddings, & McRobbie, 1995; Henderson, Fisher, & Fraser, 1995; Lawrenz, 1987) and in students' attitudes to science (Catsambis, 1995; Friedler & Tamir, 1990; Keeves & Kotte, 1995). Therefore, in keeping with these lines of research, sex-related differences in students' perceptions of their learning environment and in their attitudinal outcomes were explored in this study.

Amongst the variety of subjects available to senior high school students in Tasmanian schools and colleges, there are several science subjects. Students may choose to study one or more science subjects, or none at all. In Environmental Science classes in Tasmania, it is common to find that 50% or more of the students are studying no other science subjects, a much higher proportion than in Biology, Chemistry, or Physics classes. As these students comprise such a major proportion of Environmental Science classes, they were treated as a subgroup in this study and their learning environment perceptions and attitudinal outcomes were compared with students studying one or more other science subjects.

DATA SOURCE

The sample was composed of Environmental Science students in two of the seven senior secondary colleges (grades 11 and 12) in Tasmania, Australia and three of the independent schools which offer senior secondary courses. A total of 100 students in seven classes were involved, representing about one-third of the total population of Environmental Science students in Tasmania in 1996.

METHOD

Students' perceptions of their learning environment were measured using the 35-item *Environmental Science Learning Environment Inventory* (ESLEI), an instrument containing scales derived from the *Science Laboratory Environment Inventory* (SLEI) (Fraser, McRobbie, & Giddings, 1993) and the instrument *What is Happening in This Class* (Fraser, Fisher, & McRobbie, 1996). Each of the 35 items in the ESLEI is assigned to one of five scales: Student Cohesion, Integration, Involvement, Material Environment, and Task Orientation, and each scale has seven items. Table 1 provides descriptive information for each scale of the ESLEI.

Table 1
Descriptive information for each scale of the ESLEI

Scale Name	Description
Student Cohesion	Extent to which students know, help and are supportive of one another.
Integration	Extent to which the laboratory activities are integrated with non-laboratory and theory classes
Material Environment	Extent to which the laboratory equipment and materials are adequate
Involvement	Extent to which students have attentive interest, share ideas, do additional work and participate in class activities
Task Orientation	Extent to which it is important to complete activities planned and to stay on the subject matter

The senior secondary Environmental Science course offered in Tasmania (Tasmanian Secondary Assessment Board, 1996) places strong emphasis on students gaining an awareness of individual values as they concern the environment, and teachers are encouraged to use class discussions to promote an understanding of values amongst students. With this in mind, a ten-item *Attitude to Class Discussions* scale was devised to gauge students' opinions of such discussions. Student attitudes also were assessed with a seven-item *Attitude to This Class* scale based on selected items from the *Test of Science-Related Attitudes* [TOSRA] (Fraser, 1981).

Using the scales of the ESLEI as independent variables, associations were computed with two outcome variables: attitude to the class and attitude to class discussions. Both

simple and multiple correlation analyses were employed, using the individual student as the unit of analysis.

Sex-related differences in students' perceptions of their learning environments were explored using a one-way multivariate analysis of variance (MANOVA) with the set of ESLEI scales as dependent variables. A second MANOVA was then used where the independent variable was whether or not a student was studying another science subject. In both cases. when Wilks' lambda criterion was found to be statistically significant ($p<0.05$), the corresponding one-way univariate analysis of variance (ANOVA) was examined for each of the ESLEI scales individually.

RELIABILITY AND VALIDITY OF THE INSTRUMENTS

Environmental Science Learning Environment Inventory (ESLEI)

When using a classroom environment instrument, it is usual to validate the instrument by the use of Cronbach's (1951) alpha coefficient as an index of internal consistency (the extent to which items in the same scale measure the same dimension). Table 2 presents alpha coefficients for the ESLEI using the individual student as the unit of analysis. Coefficients range from 0.69 to 0.77, exceeding the threshold of 0.60 given by Nunnally (1967) as being acceptable reliability for research purposes.

Another feature considered important in a classroom environment instrument is the discriminant validity of each scale of the instrument, or, the extent to which a scale measures a dimension different from that measured by any other scale. The mean interscale correlations reported in Table 2 confirm the discriminant validity of the ESLEI, indicating that each scale measures distinct (although somewhat overlapping) aspects of the classroom environment.

Table 2
Internal consistency (Cronbach alpha coefficient) and discriminant validity (mean correlation with other scales) for the ESLEI

Scale	Alpha Reliability	Mean Correlation with other scales
Student Cohesion	0.77	0.38
Integration	0.75	0.30
Material Environment	0.69	0.44
Involvement	0.71	0.32
Task Orientation	0.75	0.40

The sample consisted of 100 Environmental Science students in 7 classes.

The Attitude Questionnaires

This study used two attitude questionnaires entitled Attitude To This Class and Attitude To Class Discussions. Using the individual student as the unit of analysis, the alpha reliability coefficient was found to be 0.78 for the seven-item Attitude To This Class and 0.79 for the ten-item Attitude To Class Discussions, indicating that both instruments have acceptable internal consistency.

ASSOCIATIONS BETWEEN STUDENTS' PERCEPTIONS OF THEIR LEARNING ENVIRONMENT AND STUDENT OUTCOMES

In order to investigate associations between students' perceptions of learning environment and students' attitudinal outcomes, the data were analyzed using both simple and multiple correlation analyses. Table 3 reports the simple correlation (r), which describes the bivariate association between an outcome and an ESLEI scale, and the standardized regression weight (β), which characterizes the association between an outcome and a particular environment scale when all other ESLEI scales were controlled.

Table 3
Associations Between ESLEI Scales and Students' Attitudinal Outcomes in Terms of Simple Correlations (r) and Standardised Regression Coefficients (ß)

Scale	Strength of Environment-Outcome Association			
	Attitude to Class		Attitude to Class Discussions	
	r	β	r	β
Student Cohesion	0.34**	0.21	0.35**	0.17
Integration	0.09	-0.05	0.02	-0.12
Involvement	0.33**	0.16	0.38**	0.28*
Material Environment	0.17	0.05	0.12	0.01
Task Orientation	0.20*	0.05	0.20*	0.06
Multiple Correlation, R	0.37**		0.42**	

*$p < 0.05$ **$p < 0.01$ n=100

The multiple correlation (R) data reported in Table 3 indicate statistically significant ($p<0.01$) associations between students' perceptions on the set of learning environment scales and attitudinal outcomes. Simple correlation (r) figures indicate that three scales of the ESLEI, namely, Student Cohesion, Involvement, and Task Orientation, were

significantly related to student attitudinal outcomes. The beta weights show that one of these associations, that between Involvement and Attitude to Class Discussions, retained its significance in a more conservative multivariate test with all other ESLEI scales controlled.

EFFECTS OF STUDENTS' SEX ON PERCEPTIONS OF THE LEARNING ENVIRONMENT AND ON ATTITUDINAL OUTCOMES

Sex-related differences were explored for the ESLEI using a one-way multivariate analysis of variance (MANOVA) with the set of ESLEI scales as dependent variables and with sex as the independent variable. When Wilks' lambda criterion was found to be statistically significant ($p<0.05$), the corresponding univariate analysis of variance (ANOVA) was examined for each of the ESLEI scales individually.

Table 4 presents the scale means and standard deviations for male and female students' responses to the ESLEI. Sex differences in scale means also are shown in Table 4; a negative sign indicates that the scale mean for females was higher than the scale mean for males. The data presented in Table 4 indicate statistically significant sex-related differences in students' perceptions of their learning environment, with females perceiving greater levels of Student Cohesion, Integration, Task Orientation, and Involvement, and a more favorable Material Environment. These findings are in line with several previous studies which have revealed that females generally hold more favorable perceptions of their classroom environments than do males in the same classes (e.g., Fisher, Fraser, & Rickards, 1997; Fraser, Giddings, & McRobbie, 1995; Henderson, Fisher, & Fraser, 1995).

Table 4
Sex Differences in Students' Responses to the ESLEI

Scale	Scale Mean			Standard Deviation	
	Male	Female	Difference	Male	Female
Student Cohesion	3.53	3.93	-0.38**	0.64	0.56
Integration	3.59	3.85	-0.26*	0.64	0.53
Involvement	3.77	4.04	-0.27**	0.46	0.46
Material Environment	3.82	4.35	-0.53**	0.57	0.42
Task Orientation	3.57	3.83	-0.26*	0.63	0.44

*$p < 0.05$ **$p < 0.01$ n=100

In order to explore sex differences in students' attitudinal outcomes, another one-way multivariate analysis of variance (MANOVA) was performed with the two attitudinal outcome measures as dependent variables and with sex as the independent variable. Mean scores and standard deviations calculated for each outcome are presented in Table 5.

Table 5
Sex Differences in Students' Attitudinal Outcomes

Outcome	Mean			Standard Deviation	
	Male	Female	Difference	Male	Female
Attitude To This Class	3.71	3.72	-0.01	0.58	0.47
Attitude To Class Discussions	3.85	3.90	-0.05	0.52	0.56

n=100

Table 5 indicates that no significant sex differences were found in Environmental Science students' attitudinal outcomes. These results contrast strongly with the significant sex differences found in students' perceptions of their learning environment. However, previous studies have indicated that such sex-related differences are less pronounced in biology than in other science subjects such as chemistry and physics (Husén, Fägerlind, & Liljefors, 1974; Keeves & Kotte, 1995; Lawrenz, 1987; Murphy, 1991; Tamir, 1987; Young & Fraser, 1994) and the Environmental Science course taught in Tasmania is more closely aligned in content and delivery with Biology than with Chemistry or Physics.

A COMPARISON OF SCIENCE AND NON-SCIENCE STUDENTS' PERCEPTIONS OF LEARNING ENVIRONMENTS AND ATTITUDINAL OUTCOMES

When responding to the Environmental Science Learning Environment Inventory (ESLEI), students were asked to indicate which, if any, other science subjects they were curently studying in addition to Environmental Science. In order to compare science and non-science students' perceptions of their learning environment in Environmental Science classes, a one-way multivariate analysis of variance (MANOVA) was performed with the set of ESLEI scales as dependent variables and with involvement/non-involvement in other science courses as the independent variable.

Table 6 provides scale means and standard deviations for each scale of the ESLEI for science and non-science students, and indicates the magnitude of the difference between scale means. It is clear indicates that students currently studying another science subject perceive significantly higher levels of Student Cohesion and a more favorable Material Environment than do students not currently studying another science subject.

Table 6
Differences in Science and Non-Science Students' Responses to the ESLEI

Scale	Scale Mean			Standard Deviation	
	Science	Non-Science	Difference	Science	Non-Science
Student Cohesion	3.88	3.63	0.25*	0.51	0.68
Integration	3.84	3.66	0.18	0.46	0.66
Involvement	3.93	3.90	0.03	0.36	0.55
Material Environment	4.24	4.01	0.23*	0.44	0.61
Task Orientation	3.74	3.69	0.05	0.51	0.57

*$p < 0.05$ n=100

A one-way multivariate analysis of variance (MANOVA) with the two attitudinal outcomes as dependent variables enabled comparison of science and non-science students' attitudinal outcomes. The results of this analysis, depicted in Table 7, indicate that Environmental Science students currently studying another science subject hold significantly more positive attitudes to their class and to class discussions than do non-science students in the same classroom.

Table 7
Differences in Science and Non-science Students' Attitudinal Outcomes

Outcome	Mean			Standard Deviation	
	Science	Non-science	Difference	Science	Non-science
Attitude To This Class	3.87	3.61	0.26*	0.42	0.56
Attitude To Class Discussions	4.11	3.72	0.39**	0.46	0.55

*$p < 0.05$ **$p < 0.01$ n=100

CONCLUSION

This study has confirmed the reliability and validity of the Environmental Science Learning Environment Inventory and the reliability of the two attitudinal instruments when used specifically with senior high school Environmental Science students.

Of the five aspects of Environmental Science students' learning environments measured in this study, Student Cohesion, Involvement, and Task Orientation were found to be most strongly associated with positive attitudinal outcomes.

Results of previous studies were replicated in that female students were found to perceive a more positive learning environment than did males. The magnitude of these differences is not large (between a half and one standard deviation) but the differences consistently show that females perceive their learning environment more positively than do males. Despite these differences in student perceptions, significant sex differences were not apparent in attitudinal outcome measures.

The sex-related differences reported indicate that male and female students perceive aspects of their learning environment in different ways. This has important implications for teachers wishing to change aspects of the classroom environment in order to optimise student outcomes because particular changes might be advantageous to male students but not to female students, or vice versa.

Students studying another science subject were found to perceive some aspects of their Environmental Science classroom environment in a significantly more positive way than students not studying another science subject, and to have more positive attitudes. It is possible that students currently studying another science subject feel more confident about their abilities in Environmental Science because some of the scientific concepts which they encounter are already familiar to them and this is reflected in their positive attitudes to their learning environment. These findings are of significance to teachers of Environmental Science in that they identify a subgroup of students within a class who would benefit from classroom activities and teacher-student interactions designed to promote more positive perceptions and attitudes.

Whilst a number of previous studies have examined science students' perceptions of their learning environments, this study is distinctive in that it is the first to involve students specifically in Environmental Science classes. A particular value of this kind of study is that it identifies differing perceptions and outcomes amongst subgroups of students, providing teachers with important information that could help them to improve the quality of the teaching and learning process. Furthermore, results indicate that some aspects of the learning environment in Environmental Science classrooms are associated with students' attitudinal outcomes and suggest that favorable student attitudes could be promoted in classes where the students perceive more cohesion amongst students, a greater degree of student involvement in classroom activities, and a higher level of task orientation. Whilst an improvement in students' attitudinal outcomes is desirable for its own sake, it is possible that more positive student attitudes will be reflected in higher achievement outcomes (Freedman, 1997; Schibeci & Riley, 1986), particularly if achievement is measured by student classwork rather than by end-of-year examinations and tests (Germann, 1988).

REFERENCES

Catsambis, S. (1995). Sex, race, ethnicity and science education in middle grades. *Journal of Research in Science Teaching, 32,* 243-257.

Cronbach, L.J. (1951). Coefficient alpha and the internal struture of tests. *Psychometrica, 16,* 297-334.

Fisher, D.L., Fraser, B.J., & Rickards, T. (1997, April). *Gender and cultural differences in teacher-student interpersonal behavior.* Paper presented at the annual meeting of the American Educational Research Association, Chicago, Il.

Fraser, B.J. (1981). *Test of science-related attitudes.* Melbourne: Australian Council for Educational Research.

Fraser, B.J. (1986). *Classroom environment.* London: Croom Helm.

Fraser, B.J. (1994). Research on classroom and school climate. In D. Gabel (Ed.), *Handbook of research on science teaching and learning* (pp. 493-541). New York: Macmillan.

Fraser, B.J. (1998). Science learning environments: Assessment, effects and determinants. In B.J. Fraser & K.G. Tobin (Eds.), *The international handbook of science education* (pp. 527-564). Dordrecht, The Netherlands: Kluwer.

Fraser, B.J., Fisher, D.L., & McRobbie, C.J. (1996, April). *Development, validation and use of personal and class forms of a new classroom instrument.* Paper presented at the annual meeting of the American Educational Research Association, New York City.

Fraser, B.J., Giddings, G.J., & McRobbie, C.R. (1995). Evolution and validation of a personal form of an instrument for assessing science laboratory classroom environments. *Journal of Research in Science Teaching, 32,* 399-422.

Fraser, B.J., McRobbie, C.R., & Giddings, G.J. (1993). Development and cross-national validation of a laboratory classroom environment instrument for senior high school science. *Science Education, 77,* 1-24.

Fraser, B.J., & Walberg, H.J. (Eds.). (1991). *Educational environments: Evaluation, antecedents and consequences.* Oxford, England: Pergamon Press.

Freedman, M.P. (1997). Relationship among laboratory instruction, attitude toward science and achievement in science knowledge. *Journal of Research in Science Teaching, 34,* 343-357.

Friedler, Y., & Tamir, P. (1990). Sex differences in science education in Israel: An analysis of 15 years of research. *Research in Science and Technological Education, 8,* 21-34.

Gardner, P., & Gauld, C. (1990). Labwork and students' attitudes. In E. Hegarty-Hazel (Ed.), *The student laboratory and the science curriculum* (pp. 132-156). London, England. Routledge.

Germann, P.J. (1988). Development of the attitude toward science in school assessment and its use to investigate the relationship between science achievement and attitude toward science in school. *Journal of Research in Science Teaching, 25,* 689-703.

Getzels, J.W., & Thelen, H.A. (1960). The classroom as a unique social system. In N. B. Henry (Ed.), *The dynamics of instructional groups: Sociopsychological aspects of teaching and learning* (Fifty-ninth yearbook of the National Society for the Study of Education, Part 2). Chicago: University of Chicago Press.

Haertel, G.D., Walberg, H.J., & Haertel, E.H. (1981). Socio-psychological environments and learning: A quantitative synthesis. *British Educational Research Journal, 7,* 27-36.

Henderson, D., Fisher, D.L., & Fraser, B.J. (1995, April). *Gender differences in biology students' perceptions of actual and preferred learning environments.* Paper presented at the annual meeting of the National Association for Research in Science Teaching, San Francisco, CA.

Hough, L.W., & Piper, M.K. (1982). The relationship between attitudes toward science and science achievement. *Journal of Research in Science Teaching, 19,* 33-38.

Husén, T., Fägerlind, I. & Liljefors, R. (1974). Sex differences in science achievement and attitudes: A Swedish analysis by grade level. *Comparative Education Review, 18,* 292-302.

Keeves, J.P., & Kotte, D. (1995). Patterns of science achievement: International comparisons. In Parker, L.H., Rennie, L.J., & Fraser, B.J. (Eds.), *Gender, science and mathematics: Shortening the shadow* (pp. 77-94). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Lawrenz, F. (1987). Sex effects for student perception of the classroom psychosocial environment. *Journal of Research in Science Teaching, 24,* 689-697.

Mathews, J.C. (1974). The assessment of attitudes. In H.G. Macintosh (Ed.), *Techniques and problems of assessment* (pp. 172-185). London, England: Arnold.

Murphy, P. (1991). Gender differences in pupils' reactions to practical work. In B.E. Woolnough (Ed.), *Practical science: The role and reality of practical work in school science* (pp. 112-122). Milton Keynes, England: Open University Press.

Nunnally, J. (1967). *Psychometric theory.* New York: McGraw Hill.

Schibeci, R.A., & Riley, J.P. (1986). Influence of students' backgrounds and perceptions on science attitudes and achievements. *Journal of Research in Science Teaching, 23,* 177-187.

Shulman, L.S., & Tamir, P. (1972). Research on teaching in the natural sciences. In R.M.W. Travers (Ed.), *Second handbook of research on teaching* (pp. 1098-1148). Chicago, IL: Rand McNally.

Tamir, P. (1987). Some factors which affect science achievement of high school seniors in Israel. *Research in Science and Technological Education, 5,,* 69-92.

Tasmanian Secondary Assessment Board (1996). *12EV846C Environmental science: A 'C' syllabus for the Tasmanian Certificate of Education.* Hobart, Tasmania: Tasmanian Secondary Assessment Board.

Walberg, H.J. (1981). A psychological theory of educational productivity. In F. Farley and N. Gordon (Eds.), *Psychology and education: The state of the union* (pp. 81-108). Berkeley, CA: McCutchan.

Walberg, H.J. (1984). Improving the productivity of America's schools. *Educational Leadership, 41,* 19-27.

Walberg, H.J. (1986). Syntheses of research on teaching. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd. ed; pp. 214-229). Washington, DC: American Educational Research Association.

Walberg, H.J., Fraser, B.J., & Welch, W.W. (1986). A test of a model of educational productivity among senior high school students. *Journal of Educational Research, 79,* 133-139.

Weinburgh, M. (1995). Sex differences in student attitudes toward science: A meta-analysis of the literature from 1970 to 1991. *Journal of Research in Science Teaching, 32,* 387-398.

Young, D.J., & Fraser, B.J. (1994). Gender differences in science achievement: Do school effects make a difference? *Journal of Research in Science Teaching, 31,* 847-871.

14

SE061522

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

REPRODUCTION RELEASE

(Specific Document)

Science classes

I. DOCUMENT IDENTIFICATION:

Title: Learning environment, student attitudes and effects of students' sex and other science study in Environmen

Author(s): David G. Henderson, Darrell L. Fisher and Barry J. Fraser

Corporate Source: Curtin University of Technology, Perth, Western Australia

Publication Date: 11 April 1998

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following three options and sign at the bottom of the page.

The sample sticker shown below will be affixed to all Level 1 documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

1

Level 1

☑

Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g., electronic) *and* paper copy.

The sample sticker shown below will be affixed to all Level 2A documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE, AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY, HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2A

Level 2A

☐

Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only

The sample sticker shown below will be affixed to all Level 2B documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2B

Level 2B

☐

Check here for Level 2B release, permitting reproduction and dissemination in microfiche only

Documents will be processed as indicated provided reproduction quality permits.
If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.

I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries.

Sign here, → please

Signature: David Henderson

Printed Name/Position/Title: Dr. David G. Henderson

Organization/Address: Science and Maths Ed. Centre
Curtin University
GPO Box U1987
Perth, W.A., 6845, AUSTRALIA

Telephone: +61 8 9266 7896

FAX: +61 8 9266 2503

E-Mail Address: dhenderson@space.net.au

Date: 11.4.98

(over)

III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC, or, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

Publisher/Distributor:
Address:
Price:

IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant this reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

Name:
Address:

V. WHERE TO SEND THIS FORM:

Send this form to the following ERIC Clearinghouse:

THE UNIVERSITY OF MARYLAND
ERIC CLEARINGHOUSE ON ASSESSMENT AND EVALUATION
1129 SHRIVER LAB, CAMPUS DRIVE
COLLEGE PARK, MD 20742-5701
Attn: Acquisitions

However, if solicited by the ERIC Facility, or if making an unsolicited contribution to ERIC, return this form (and the document being contributed) to:

ERIC Processing and Reference Facility
1100 West Street, 2nd Floor
Laurel, Maryland 20707-3598

Telephone: 301-497-4080
Toll Free: 800-799-3742
FAX: 301-953-0263
e-mail: ericfac@inet.ed.gov
WWW: http://ericfac.piccard.csc.com