

Students Speak: An Analysis of Student Feedback on the Virtual High School Experience

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Abstract

This paper analyzes student feedback on the Virtual High School (VHS) experience. Surveys were delivered via the Internet to 373 students who had enrolled in one or more VHS NetCourses in the spring semester of 1998. We developed two statistical models to evaluate student satisfaction with VHS based on the survey responses. The survey return rate was 80.7% and our final data set consisted of 229 complete surveys. We used the following question as a satisfaction indicator: “While we realize your VHS experience is only a small part of your high school experience, do you think it is one that will benefit you as you move on?” 189 students (82.5%) responded that the VHS experience was beneficial to them and 40 responded that it was not. We used our models to determine which of the other survey questions and statements (representing different aspects of the VHS program) predicted a positive or negative response to the satisfaction indicator. We found that significant predictors included the following: quality of the course content, presence of discussion as a regular part of the course, frequency of teacher communication, presence of useful resource materials, availability of the site coordinator (a local administrator) for student assistance, and student’s gender, among others. In addition to a discussion of these statistical findings, we present an informal discussion and summary of student comments.

“I really enjoyed my first semester class (Introduction to Stellar Astronomy) because the teacher was extremely dedicated, we did experiments and observations of the sky and I met classmates who were determined to make this class great. Astronomy has helped me enrich my general knowledge and change my perspective on the Universe.”

“VHS has been a very interesting experience, however, it is crucial that communication between the students and the instructor happen on a regular basis. One of my main problems with working with this is lack of communication. A student cannot go on in their studies if they have a question that is never answered. I will be taking VHS again next year I hope that by then all communication barriers that occur between students and teachers are fixed.”

1 Introduction:

1.1 Virtual High School (VHS)

The Virtual High School (VHS) is a five-year, \$7.4 million project funded in 1996 by the U.S. Department of Education Challenge Grants for Technology in Education. The grant was awarded to the Hudson (MA) Public Schools¹ (the fiscal agent), the Concord Consortium², and other collaborators, including dozens of high schools across the country. The primary goal of the Virtual High School is to greatly expand participating high schools' curricular offerings by delivering quality NetCourses to students via the Internet. VHS is built on a simple cooperative model. In exchange for contributing a small amount of teaching time to the VHS cooperative, a high school adds an entire catalog of innovative new courses to its existing offerings. Each participating high school provides computers and Internet connectivity to its local VHS students. In addition, each school contributes part of one teacher's time to develop and deliver a NetCourse, and part of one administrator's time to manage and support the local VHS teacher and students. The VHS grant provides participants with training, software, and technical and administrative support. Each school can enroll up to 20 students per semester in VHS courses for each course it contributes to the VHS catalog. To ensure the quality of VHS courses, all VHS teachers must complete The Teachers Learning Conference (TLC), a graduate-level NetCourse designed to give participants exposure to the best educational strategies and technologies for NetCourse teaching.

VHS NetCourses are chosen to augment rather than replace schools' traditional core offerings. The selection ranges from advanced academic courses to technical and specialized electives. Sample NetCourse titles include *Music Appreciation and Composition*, *Business in the 21st Century*, *Introduction to*

¹<http://www.hudson.k12.ma.us/>

²<http://www.concord.org>

Microbiology, Poetics and Poetry for Publication, and Advanced Placement Statistics. VHS students usually take one or two NetCourses a year in addition to a normal load of courses at their local high schools. A student can access his or her NetCourse at any time from any computer with an adequate Internet connection and graphical browser. VHS NetCourses are delivered in a scheduled, asynchronous format, meaning that the teacher and up to 20 students in each course interact as a group via text-based “threaded” discussions and shared course work, but participate in the course at any time each day and week according to their own schedules.

VHS is currently in its third year of the grant. VHS trained the first group of teachers in 1996-1997; this group of teachers offered 29 NetCourses to over 300 students in the 1997-1998 school year. In 1998-1999, VHS teachers offered 34 NetCourses to over 600 students. Student registration for the 1999-2000 school year began in April 1999, with a selection of 105 NetCourses for students from over 100 high schools around the country to choose from.

An overview of the VHS NetCourse environment is provided in the Appendix. For a more detailed description of the VHS cooperative model, see Tinker, 1998, “The Virtual High School: A Scalable Cooperative.”

1.2 Purpose of this Paper

One of the most important pieces of the VHS project is ongoing evaluation of all aspects of the program. The long-term goal of VHS is to create a successful model for developing and offering high-quality NetCourses that can be replicated by other groups.

VHS aims to create NetCourses that are interdisciplinary, collaborative, and student-centered in design. The asynchronous and technology-rich environment of the NetCourse enables students to collaborate with peers worldwide and to become familiar with informational and educational technologies, in addition to learning about the unique topics covered in each course. With these goals in mind, VHS faculty and staff are continually assessing and improving courses as well as project design and implementation.

This paper discusses one facet of VHS evaluation efforts: student feedback on the Virtual High School experience. Student surveys designed by the Concord Consortium and the VHS independent evaluator, SRI International, are administered electronically at the end of each semester to all students who complete a VHS NetCourse.

This paper will concentrate on an analysis and discussion of the findings from the spring semester 1998 VHS student surveys.

We have built two models to evaluate the performance level of VHS based on the student survey data. Specifically, we are interested in determining which factors can predict a student’s overall satisfaction with the VHS experience. We chose one question as our “overall satisfaction” indicator, and then tested the other questions in the survey for their significance as satisfaction predictors. The student’s satisfaction is vital and understanding what factors contribute to a satisfactory experience can lead to further development of VHS.

2 The Survey

The spring 1998 survey was comprised of forty-eight questions and statements distributed among eight categories:

1. Operation of VHS (6 questions),
2. Course Contents (6 statements),
3. Communications (9 statements),
4. MediaCenter (4 statements),
5. Site Coordinator (3 statements),
6. Technology (4 statements), and
7. Overall Assessment (12 questions and statements)
8. Information About You (4 questions).

Participants responded to each *question* by choosing one or more answers from a series of provided choices, or *Yes/No*. They responded to each *statement* by choosing one of the following: *Strongly Agree*, *Agree*, *Disagree*, or *Strongly Disagree*. Participants' choices were then converted as appropriate to either dummy variables, or 1/0 (with 1 being yes and 0 being no), or a 4-point scale with 1 being the most positive response and 4 being the most negative response. Biographical information including each student's grade level, future plans after graduation, total number of courses taken during the semester (including both VHS courses and regular courses), and gender is included in this study. Students were given an opportunity to enter suggestions for additional courses that they would like to see offered by VHS, as well as any comments that they had on the VHS program. These comments were not used in the statistical analysis of the surveys; however, an informal discussion of the comments is presented in this paper.

The survey was offered to 373 students who completed a VHS NetCourse in the spring 1998 semester. A student was considered to have completed a VHS course if he or she received a final semester grade of A+ through F from the VHS National Office. Approximately 52 students who dropped or withdrew from the program before the semester ended did not take the survey. This survey was not designed to determine why students dropped VHS courses. An exit survey has since been designed and is being delivered to all students who drop for future analysis.

The data were collected over the Internet, and 301 students (80.7%) responded to the survey. A total of 72 students were excluded from the study because they did not fill out the entire survey. The 229 complete surveys used in this analysis were split almost evenly in terms of gender; the data set consists of 111 female responses and 118 male responses.

We used student responses to question 12, **Satisfaction**, in the **Overall Assessment** category, as a way to determine students' overall satisfaction with VHS. Statement 12 asked the student, "While we realize your VHS experience is only a small part of your high school experience, do you think it is one that will benefit you as you move on?" Yes is coded as 1 and No is coded as 0. We used the rest of the survey information to build logistic models that would tell us which aspects of VHS predict a positive or negative response to question 12.

A list of the variable names used in the analysis is in the Appendix. A copy of the survey is attached.

3 The Study

3.1 Observations

Out of 229 respondents, 189 students (82.5%) thought that the VHS experience was beneficial to them and 40 students thought that it was not.

Generally speaking, if a student *strongly agrees* with any of the survey statements, he or she tends to agree that VHS is a beneficial experience. For example, here is a contingency table of the response to **Communications** statement C1 ("Within my VHS course, I frequently communicate with other students.") versus the response to our satisfaction indicator, question 12. (1 indicates that the student *strongly agrees* and 4 indicates that the student *strongly disagrees* that he or she communicated with other students frequently during the semester.)

		ComWStud			
		1	2	3	4
Was VHS beneficial?	No	0	6	23	11
	Yes	20	76	70	23

As this example demonstrates, there are no students who frequently communicated with their VHS classmates (as indicated in column 1) but who still responded negatively regarding their experience with the program. On the other hand, students who communicated little with other students (as indicated in column 4) were more likely to have a negative response to the program.

The contingency table between sex and response to our satisfaction indicator shows a fairly interesting picture:

		Sex	
		Female	Male
Was VHS beneficial?	No	11	29
	Yes	100	89

Eleven out of 111 female students (10%) feel negatively about the VHS program, whereas 29 out of 118 male students (24.5%) feel the same way. The odds ratio between the female students and the male students, based on this contingency table only, is 2.96 :1 in favor of a positive reaction towards the program.

3.2 Models

Two models were developed and analyzed for this study. Model One examines each individual survey question as a predictor of a positive or negative response to our satisfaction indicator, question G12, and uses a logistic regression model to find important/significant predictors out of them. In Model Two, we combine related individual questions, average the relevant scores, and apply a logistic model in order to find a sensible prediction model. Both models have strong points as well as shortcomings. In this section, a brief presentation of both models and the findings is given.

3.2.1 Model Number One

Model One found that the following thirteen variables are significant predictors of the satisfaction probability (predicting whether or not a student feels that his or her VHS NetCourse has been beneficial):

- **TimeofSec** When the VHS course was selected, i.e. at the beginning of the semester, during the summer, etc.
- **NotOffer** Compared to the normal school program, an advantage of VHS is that I can take a course that I want but is not offered at my school.
- **KnowPeople** Compared to the normal school program, an advantage of VHS is that I can get to know people from other schools and around the country.
- **VHSDif** Compared to the normal school program, an advantage of VHS is that VHS courses are a very different way to learn.
- **TechUse** Compared to the normal school program, an advantage of VHS is that I can use technology on a regular basis.
- **content** The content of this course is of high quality.
- **discuss** Discussion is a regular part of the course.
- **ComWteacher** The teacher communicates frequently with me, individually or as part of a group.
- **useful** The materials in the MediaCenter are useful.
- **WWWlinks** The teacher has provided students with active links to resources on the WWW or Internet.
- **CoordAva** The Site Coordinator was available on a regular basis for assistance.
- **IntCourse** I took a VHS course because it sounded interesting.

- **sex**

Variable	Estimated Coefficient $\hat{\beta}$	Standard Error $\widehat{SE}(\hat{\beta})$
Constant	11.19	2.03
TimeofSec1	0.049	0.718
TimeofSec2	-1.165	0.573
TimeofSec3	0.99	0.3
TimeofSec4	-0.119	0.147
NotOffer	0.57	0.319
KnowPeople	0.91	0.467
VHSDif	0.86	0.864
TechUse	0.59	0.587
content	-1.17	0.469
discuss	-0.76	0.43
ComWteacher	-0.96	0.37
MCuseful	-1.48	0.395
WWWlink	1.02	0.423
CoordAva	-1.28	0.392
IntCourse	0.79	0.313
sex	-0.43	0.333

Table of variables, their estimated coefficients and standard error.

We like this model because the statistically significant variables are representative of the entire survey: they come from all categories except **Technology**. The **Technology** questions do not have predictive power over the response variable. We attribute this to the observation that the **Technology** questions were inadequately designed to reveal technology factors that affect the students' overall experience. The survey designers may wish to revisit the Technology questions in future versions of the survey. However, we were pleased to find that most of the significant predictors coincide with those expected by VHS staff, based upon their anecdotal experiences.

Of all the variables, we were most surprised to see **TimeofSec** (when was the VHS course selected) included. We did not expect this to have an important influence on students' overall VHS experience. A VHS student can choose his or her VHS course/s in any of the following five periods:

- When the student selected his or her regular courses last school year;
- After the student selected his or her regular courses but before the end of last school year;
- During the summer vacation;
- During the first semester of this school year;

e) During the spring add/drop period.

After some simple calculations³, we can conclude that students who register for a VHS course during the summer vacation (group c), are more likely to have a positive experience with the course.

Another surprise is that **WWWlink** has a positive coefficient. This variable is coded in such a way that a value of 1 stands for the strongest agreement, and a value of 4 stands for the strongest disagreement. We would hope that as the value increases, the estimated probability of a satisfaction outcome would decrease. This is indeed the case with most of the variables⁴. As we expected, for example, if the student is not happy with the content of the VHS course, the student tends to dislike the course and give a lower overall satisfaction score. But the **WWWlink**⁵ variable has a positive coefficient, implying that the less the teacher has provided the student with WWW resources, the more likely it is that the student will find the VHS course to be a beneficial experience. It is hard to tell a good story about this deviance.

The contingency table of **WWWlinks** and **Satisfaction** suggests a relationship opposite to the one suggested by our model: the more the student is provided with WWW resources, the more likely he or she is to have a positive course experience. The contingency table is shown here:

		WWWlinks			
		1	2	3	4
Was VHS beneficial?	No	8	20	7	5
	Yes	80	77	23	8

3.2.2 Model Number Two

There are five sections in the survey in which the questions use a scale of 1 to 4 which can be averaged: **course contents**, **communications**, **mediacenter**, **site coordinator**, and **technology**. We think it makes sense to take the average cross section scores and use the scores as our predictors.

Our final fitting for this model has the following variables and coefficients: **contents**, **coordinator**, **TimeofSec**, **IntCourse** (the student took the course because it sounded interesting), and **LearnTech** (the student took the course because he or she wanted to learn more about technology and the Internet). Even though **sex** did not emerge as a statistically significant factor, we decided to leave this variable in our model.

³Please refer to the technical appendices.

⁴Variables **NotOffer**, **KnowPeople**, **VHSDif**, **TechUse**, **IntCourse**, are all coded as 0 and 1 with 1 being agree and 0 being disagree.

⁵The survey question asks the student whether the teacher has provided students with active links to resources on the World Wide Web or the Internet.

Variable	Estimated Coefficient $\hat{\beta}$	$StandardError\widehat{SE}(\hat{\beta})$
constant	10.12	1.684
contents	-2.60	0.542
coordinator	-1.17	0.394
TimeofSec1	0.142	0.606
TimeofSec2	-0.5	0.546
TimeofSec3	0.614	0.240
TimeofSec4	-0.095	0.139
IntCourse	0.863	0.268
LearnTech	0.718	0.300
sex	-0.03	0.274

For example, if a female (**sex**= -1) student selected the **VHS** course during the last school year (**TimeofSec1** = -1, **TimeofSec2** = -1, **TimeofSec3** = -1, **TimeofSec4** = -1), thought poorly of the course content (**contents** = 3), thought well of her interactions with the coordinator (**coordinator** = 2), took the course because she thought it sounded interesting (**IntCourse** = 1) and because she wanted to learn more about technology and the Internet (**LearnTech** = 1), the estimated probability $\hat{\pi}$ that she would think positively about the overall **VHS** program is:

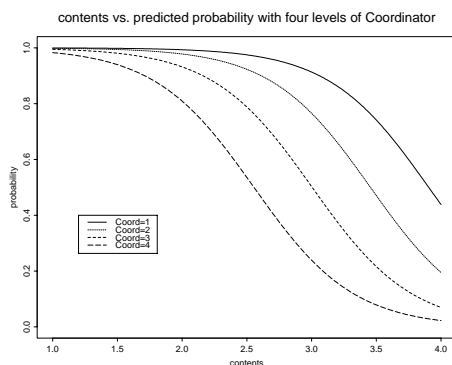
$$\begin{aligned}\hat{\pi} &= \frac{1}{1 + e^{-(10.12 - 2.6(3) - 1.17(2) - 0.14(-1) - 0.5(-1) + 0.61(-1) - 0.10(-1) + 0.86(1) + 0.72(1) - 0.03(-1))}} \\ &= 0.77\end{aligned}$$

By looking at the scales of the coefficients for these variables, we can tell that **contents** has a large -2.6 coefficient. This means that **contents** carries a heavy load in predicting the estimated probability. If the student in the above example - with everything else held constant - thought positively about the course contents (**contents** = 1), then the estimated probability jumps up to 0.998. On the other hand, if she thought very negatively about the content of the course (with **contents** = 4), then the corresponding probability becomes 0.195.

The next most influential variable is **coordinator**; it has a coefficient of -1.17. It does not cast as much influence on the model as **contents** does, but the weight it carries is sufficient enough to make a difference in predicting overall satisfaction. Other variables, though statistically significant, do not have as much influence.

In the following example, we graph **contents** versus the estimated probability of satisfaction with the course, on the scale of 1 to 4 (with 4 being the least satisfied). The four lines represent four levels of satisfaction with **coordinator** communications. The other variables (i.e. **TimeofSec**, **IntCourse**, etc) are held constant as in the example given above. This graph demonstrates the importance of **content** in this model. As one can see, if the student is very satisfied with **contents**, large differences in **coordinator** satisfaction do

not affect the predicted probability much. But as the satisfaction with course **contents** drops, **coordinator** satisfaction starts to play a more and more important role in affecting the predicted probability.



3.2.3 Comparison of the Two Models

We like both models. The first model is very specific. It tells us which aspects of the program we might focus on to improve overall student satisfaction with VHS. For example, we might choose to dedicate more time in the Teacher's Learning Conference to preparing teachers to facilitate discussions in their courses. We might also consider ways to better prepare them to communicate effectively with their students in the online environment, as these are both significant predictors of student satisfaction. In other words, we can be very specific when it comes to improving or understanding the VHS program.

There are also advantages of looking into the second model. By taking the average scores, we hope to eliminate some bias that is usually carried in the individual scores. Taking the average, however, can be dangerous because we can end up ignoring certain information (or loss of information). So we think that it is helpful to use both models to make sound judgments.

Two dominant variables appear in the second model, **contents** and **coordinator**. This is very useful information. In terms of promoting the VHS program, it is important to VHS faculty, staff, and evaluators that despite the unique online environment of the courses, it is the course content that determines whether or not a student will find the course beneficial. As for the importance of the local site coordinator in making the VHS experience a positive one, this is something that has been observed anecdotally by VHS administrators. The VHS staff can use this information to further illustrate and emphasize the need for extensive site coordinator training and involvement in all aspects of VHS.

3.3 Goodness of Fit

Both models fit reasonably well with the data. Hosmer-Lemeshow ⁶ tests are carried out to test the goodness of fit of both models. Overall, the first model fits slightly better than the second, with 96.2% fit versus 88.6% fit using method one, and 63.7% fit versus 53.2% fit using method two.

3.4 Interpretation and Findings

The primary goal of the Virtual High School is to deliver high-quality course content to schools that do not have the resources to deliver the same content locally. In addition, VHS teachers strive to use the technology-rich environment of their NetCourses to help VHS students acquire the skills they need to succeed in an increasingly technological world. Finally, VHS NetCourses are designed not only to deliver quality course content, but also to help students develop communication, collaboration, and creative problem solving skills, and to help them become independent lifelong learners who can communicate that learning to others. We were pleased to find in the first model that the significant indicators of student satisfaction very closely match all of these VHS goals.

For example, VHS faculty and staff strive to create NetCourses in which students will experience collaborative learning; in other words, VHS courses are not independent-study courses. Three of the significant variables in Model One (**KnowPeople**, an advantage of VHS is that the student can get to know people from around the country; **discuss**, discussion is a regular part of the course; and **ComWteacher**, the teacher communicated frequently with the student) indicate to us that communication and collaboration in a group environment is as important to the students as it is to the designers of the courses, and that this is something that should be heavily emphasized in the VHS teacher training course.

Model One also suggested that the following variables are important predictors of a student's satisfaction with the program: **VHSDif**, compared to the normal school program, an advantage of VHS is that VHS courses are a very different way to learn; and **TechUse**, compared to the normal school program, an advantage of VHS is that students can use technology on a regular basis.

That these variables are significant predictors indicates to us that the asynchronous, technology-rich environment of the VHS NetCourse plays an important role in recruiting VHS students and providing them with a satisfying experience in which they can become more confident and competent technology users and independent learners. As discussed earlier, we cannot be sure why **WWWlinks** (active WWW links were provided to the student) had a positive coefficient, but this certainly presents an interesting area for further investigation. One explanation could be that a NetCourse with materials created by the teacher inside the course is a better design than one that often sends stu-

⁶Two methods of testing are employed. Please refer to technical appendices for calculation and testing details.

dents out onto the Internet. The balance of internal and external resources for students could be an interesting aspect of course design to investigate further.

Model one tells us that students think an important advantage of VHS is that they can take courses that they want but are not offered at their local schools (**NotOffer**), and that when students choose their VHS courses because they sound interesting (**IntCourse**), they are more likely to find the VHS experience beneficial. Our interpretation of these findings is that VHS is fulfilling its primary goal of delivering specialized, quality course content to schools that do not have the means to offer these courses themselves, and that VHS should continue to focus its efforts on developing non-core courses that augment rather than replace schools' traditional curricular offerings.

Finally, Model One tells us that **MCuseful**, the usefulness of the course MediaCenter (the online library of course materials and resources), the quality of the course content (**content**), and the availability of a local site coordinator for student assistance (**CoordAva**), are all important predictors of a positive or negative experience for VHS students. The latter two variables also emerged in Model Two as major predictors of student satisfaction. This and all the findings summarized above have implications for the design of the TLC, the graduate-level NetCourse that all VHS teachers take in order to learn how to develop their own NetCourses. The findings in this study suggest that more attention be paid to pedagogical matters such as course content and course communications. The findings also underscore the importance of developing standards for quality NetCourses by which all VHS courses can be evaluated, a process that VHS has recently begun. The second significant predictor in Model Two, regarding the availability of the site coordinator (**coordinator**) implies that more attention be paid to the training and involvement of VHS site coordinators, who play a key role in making VHS run smoothly and successfully.

4 Student Comments

At the end of the survey, students were asked to offer their suggestions for future VHS courses, as well as any additional comments they had regarding VHS. In this section, we informally summarize the student responses to these open-ended questions, and relate these responses to the statistical findings of our study.

4.1 Suggestions for Additional Courses

Students were asked, "What additional courses would you like to see offered by VHS?" Our study found that those students who chose VHS courses because they sounded interesting were more likely to find the VHS experience beneficial. Students were also more likely to find VHS beneficial if they felt that one of the advantages of VHS was that students could take courses they wanted but that were not offered at their own high schools.

Therefore, it is useful to determine which courses are interesting to VHS students, as well as which courses might not be locally available to them. VH-

S administrators can use this information when they accept new schools and courses into the VHS cooperative in April each year. One of the advantages of the VHS program is its ability to offer students specialized, in-depth courses not usually available at the high school level. At the same time, VHS needs to be able to fill as many of its courses as possible in order for the cooperative model to run smoothly. VHS administrators thus need to strike a balance in selecting a wide range of specialized courses that will at the same time appeal to a substantial number of students from around the country. The feedback gathered from student surveys can be a valuable guide during the course selection process.

Approximately 120 students suggested courses they would like VHS to offer in the future. The three most popular disciplines were Computer Science (Technical), Science, and Social Science. Arts and Language Arts were next. Following are samples of student suggestions in each of the most requested discipline areas:

Computer Science/Technical (31)

Computer programming: C++, Java, Pascal, Smalltalk, Visual Basic

HTML, web page design, computer graphics

Animation and game programming

Networks

Unix

Science (30)

Chemistry

Ecology/environmental science

Health and nutrition

Zoology

Oceanography

Physiology

Medicine/alternative medicine

Biology

Holography

Engineering

Social Science (21)

U.S. and world history

Political science/government

Cultural studies/anthropology

Current events/geography

African American/American Indian history

Asian cultures

Military history

There clearly is a high demand for Computer Science courses in VHS. Computer-related courses offered by VHS in past semesters (Web Page Design, C++ Computer Programming) have typically been the first to fill, and have ended up with the longest waiting lists. A second section of C++ quickly filled as soon as it was added to the VHS offerings. A number of students commented in the survey that they would like VHS to expand its offering of computer programming courses so that more students could take these very popular courses. Student sentiment can probably be summed up best by this student's request, "I would like to see a line of all different programming classes with all different types of computer languages."

There were 30 requests for science courses; however, unlike the computer-related suggestions which focused primarily on programming and web page design, the science suggestions ranged among fifteen or so different subject areas, with everything from physics to archaeology represented. Chemistry and environmental science courses received the most requests, with five and four requests respectively.

Social Science courses were next with 21 requests. These suggestions centered mostly on the study of different countries and cultures; U.S. and world history; government and political science; and current events.

Arts courses received 19 suggestions, including art history, film studies, music, graphic design, and photography. Literature, foreign language, business, and psychology courses each received about six to ten requests each. Math courses received only three requests. These numbers correspond fairly well with observations that have been made regarding VHS student registration. With the exception of AP Statistics, math courses have been difficult to fill. Foreign language courses and certain literature courses have also been difficult to fill. This may be due to a high availability of such courses at participating high schools, or to the fact that many VHS high schools only give elective credit for VHS courses. VHS students may be less likely to take literature and math NetCourses if they cannot receive core credit for them.

One thing that is striking is the prevalence of recommendations for specialized courses on subjects not typically seen at the high school level (examples

include *Screenwriting*, *Media Studies*, *History of the Ireland/England conflict*, and *Forensic Science*, among others). This resonates with the finding from our study that a major appeal of VHS for students is that it provides them the opportunity to take courses they do not normally have access to in high school.

4.2 Open-Ended Student Feedback

At the very end of the survey, VHS students were asked to “Please make additional comments below.” They were allowed to enter comments of any kind in an empty text field. Approximately one-third of the students volunteered comments.

While there were a large number of comments, the content of the comments was remarkably consistent. Student comments have been grouped into three broad categories: positive comments, negative comments, and suggestions for improvement. Many students offered mixed feedback with both positive and negative remarks.

Following is a list of positive comments offered by students:

Positive Comments

VHS allowed me access to a great teacher and a great course.

In addition to learning about the course content, I learned a lot about using computers and the Internet.

I was able to take a course not offered at my school.

I like the flexibility and self-pacing of VHS courses; I learn better when I can work on my own time.

I like the informal nature of VHS courses - students can read and freely comment on others’ work and have more open discussions than in a traditional classroom.

I developed more discipline in my ability to study and manage my time.

I liked meeting and learning about teenagers from other states.

This course was a great preparation for college.

This course enabled me to learn more about myself.

VHS has helped my community and my school.

I liked being part of something new.

The negative comments centered around three major themes: “not what I expected,” communications, and technical problems. The content of these three categories is summarized in list form below.

“not what I expected”

The course did not match the description in the catalog.

The course was harder or easier than expected.

The course took much more time than I expected.

I was not prepared for how much discussion would be required.

The course was not suited for the Internet.

The course was too traditional and "textbook;" the material was boring.

This type of course does not fit my learning style.

Many students commented that VHS courses require students to be highly self-motivated and to be able to work independently, and that a lot of students cannot handle the responsibility that this entails. Some students said that they were not prepared for this level of individual responsibility. Others said that the quality of the course suffered because their classmates could not manage their time and thus did not participate in group work or class discussions. Many students suggested that site coordinators use a more careful selection process to ensure that they recruit students who are able to manage their time and work independently. Others were frustrated that their classmates did not take VHS seriously, and they recommended that site coordinators emphasize to potential VHS students that VHS courses are "real" courses requiring regular attendance, work, and participation.

As with the statistical models, the student comments indicate that a good NetCourse contains frequent and meaningful communication among the participants. When communication and interaction is lacking, the students' satisfaction with the course declines. Following are student comments about poor communications within their NetCourses:

Communication Problems

There was a lack of student participation in the course.

There was little interactivity in the course.

There were few group assignments, or the group assignments did not work well.

There was infrequent or inadequate communication from the teacher.

The teacher did not make the course expectations or policies clear.

It was difficult to engage with students on so many different schedules.

Deadlines were inflexible.

The local site coordinator was not accessible or helpful.

Technical problems

VHS is too slow.

The LearningSpace interface is too slow and complicated; it is too graphics-heavy.

My computer or Internet connection was inadequate.

I had too many access and login problems.

I had little or no computer access at school, and/or no time scheduled to work on my VHS course.

Students without home computers are at a disadvantage.

The login process is too complicated and takes too long.

I was frustrated by many technical problems throughout the semester.

The student comments generally point to a lack of consistency in course quality. Some students who had taken two courses in a row remarked that one course was great and the other was disappointing. Such feedback justifies the need for national NetCourse standards and ongoing course evaluations.

Some suggestions offered by students include the following:

Suggestions

Add a live chat feature to the VHS web site or inside VHS courses.

Create a student yearbook.

Add a spring break.

Extend the VHS drop period.

Schedule VHS students at the same school in class at the same time.

The VHS drop period has since been extended to better match participating schools' drop periods. A student yearbook is in development, and the addition of a live chat feature to VHS courses is under investigation. A spring break has not been added to the VHS spring semester, but the VHS semester timeline has recently been overhauled to better fit with participating schools' calendars.

5 Conclusions and Future Directions

Both the statistical models and the summary of student comments point to a real need for VHS NetCourse standards, to ensure and maintain a high level of quality in all courses. In response to this need, VHS has recently initiated a massive evaluation effort. All VHS NetCourses will be designed according to NetCourse standards that have been prepared by university-level distance learning experts, state Department of Education (DOE) curriculum experts, as

well as VHS teachers, trainers, administrators, and students. In addition, all NetCourses will go through a series of evaluations as they move from the design to the implementation stages. The standards focus on important topics highlighted in this study - interesting and quality course content, clear and frequent communication within courses, activities to encourage student interaction within courses, use of interesting course materials in the MediaCenter, etc.

Both the statistical study and the student comments indicate that improvements in teacher and site coordinator training should continue to be a priority for VHS. Since this survey was delivered, the Teachers Learning Conference syllabus has been completely reworked. Teachers now begin developing their courses early on in the TLC, instead of waiting until the end of the course to begin actual course design. The new syllabus covers some course design, pedagogical matters, and technological matters each week, instead of covering pedagogical matters for the first part of the course before moving on to course design as it did in the past. All current teachers in training have been given a copy of the new NetCourse standards, to assist them while they are still in the course development stage.

Since the spring 1998 surveys were delivered, a mini-NetCourse has been developed and delivered to all new site coordinators. The training course covers VHS administrative policies and guidelines and site coordinator strategies. It also includes a Guidance handbook so that site coordinators can better work with their schools' guidance offices to recruit students who are well matched and better prepared for the VHS courses they enroll in.

We will analyze and compare subsequent student surveys to determine if these changes have had a positive effect on student satisfaction with VHS NetCourses.

This study found that a student's final grade had no statistical effect on whether or not the student found the VHS experience to be beneficial. This is an interesting finding, and one that should be investigated further in future studies. In addition, future studies might want to include the student's NetCourse and high school as a possible predictor of satisfaction with VHS.

Overall, we are pleased to find a high level of student satisfaction. We are also pleased to confirm that most of the significant predictors for student satisfaction coincided with those expected by VHS staff members, based on their anecdotal experiences and their own goals for the program.

References

- Chambers, John & Hastie, Trevor (1992) *Statistical Models in S* AT&T Bell Laboratories, Wadsworth & Brooks/Cole Advanced Books & Software
 Fox, John, (1997) *Applied Regression Analysis, Linear models, and Related Methods* London, Sage Publications
 Hosmer, David & Lemeshow, Stanley, (1989) *Applied Logistic Regression* Wiley-Interscience Publication
 Kopka, Helmut & Daly, Patrick, (1995) *A Guide to L^AT_EX 2 ϵ*

Tinker, Robert, (1998) *The Virtual High School: A Scalable Cooperative*
[http://vhs.concord.org/Pages/About+Us-What+is+VHS+\(VHS+October+1998\)](http://vhs.concord.org/Pages/About+Us-What+is+VHS+(VHS+October+1998))
Venables, W.N. & Ripley, B.D. (1994) *Modern Applied Statistics with S-Plus*
Springer-Verlag

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A Appendix: Overview of the VHS Learning Environment

In order to place the survey into a context for the reader, a brief overview of the VHS environment is presented here. VHS NetCourses are developed and delivered using a software package called LearningSpace created by Lotus Development Corporation. LearningSpace is a set of five interrelated Lotus Notes databases that are served as Web pages using Lotus Domino, and which are accessed by students using a graphical web browser:

- The Schedule database is the course calendar/syllabus; it contains a list of assignment overviews, with due dates and links to supporting materials and discussions;
- The CourseRoom database houses threaded discussions, student and teacher comments, and work assignments;
- The MediaCenter database houses all course materials and resources, including text and multimedia files, as well as Internet links;
- The Profiles database houses teacher and student profiles that give each participant password-protected access to the course and offer the capability of multiple groupings and pairings of students for assignments; students can fill out their profiles with pictures and biographical information, and in addition, they can review all their work and grades to date using the special Portfolio view in this database; and
- The Assessment database allows teachers to deliver surveys, quizzes, self-assessments, and exams online, and allows teachers to assess and grade all student work submitted within LearningSpace.

Lotus Development has worked closely with VHS technical support and VHS instructors and participants to modify Learning Space to best serve VHS's educational needs. Ongoing participant feedback will help VHS staff members to communicate additional needs to LearningSpace developers.

Up to 20 students take a VHS course together. The students are spread throughout the country, and the majority of them will never meet their classmates or VHS teachers face-to-face. All communications take place via asynchronous postings in the CourseRoom. Students are expected to spend between five to seven hours a week on their VHS NetCourse, to complete all work assignments by their weekly due dates, and to participate regularly in threaded class discussions. The site coordinator is a local administrator who assists the VHS teacher and students with their administrative, technical, and other needs.

B Appendix: Coding of the variables

A1: TimeofSec When did you select the VHS course?

A2: firstchoice	Was this VHS course your first choice?
A4: schedule	How does this VHS course fit into your schedule?
A5a: NotOffer	Compared to the normal school program, an advantage of VHS is that I can take a course that I want but that is not offered at my school.
A5b: FlexTime	Compared to the normal school program, an advantage of VHS is that I can take a course at any time.
A5c: HomeClass	Compared to the normal school program, an advantage of VHS is that I can take a course from home.
A5d: Knowpeople	Compared to the normal school program, an advantage of VHS is that I can get to know people (teachers and students) from other schools and other parts of the country.
A5e: VHS Dif	Compared to the normal school program, an advantage of VHS is that VHS courses are a very different way to learn.
A5f: TechUse	Compared to the normal school program, an advantage of VHS is that I can use technology on a regular basis.
B1: MatchedDes	This VHS courses matches the description in the VHS catalog.
B2: content	The content of the course is of high quality.
B3: discuss	Discussion is a regular part of the course.
B4: StudTeam	This course has well managed student discussion/project teams.
B5: graphics	This course utilizes graphics and pictures.
B6: video	This course utilizes sound and video.
C1: ComWstud	Within my course, I frequently communicated with other students.
C2: ComWstudI	Communications with other students are an important part of my learning.
C3: ComWteacher	The teacher communicated frequently with me, individually or as part of a group.
C4: ComWteacherI	Communications with the teacher are an important part of my learning.
C5: CommentsOnTime	I received comments and/or grades from the teacher in a timely manner.
C6: standard	The teacher has established clear grading standards.
C7: ExpectedGrade	I know now what my final grade is expected to be.
C8: ComWCoord	I communicated with my VHS site coordinator on a regular basis.
C9: VHSRespon	VHS Administration has been responsive if needed.
D1: MediaCenter	The MediaCenter is used in my course.
D2: MCuseful	The materials in the MediaCenter are useful.
D3: WWWlinks	The teacher has provided students with active WWW links.
D4: MCvideo	Resources in the MediaCenter include audio/video clips.
E1: CoordExplain	The Site Coordinator sufficiently explained the VHS program.
E2: CoordAva	The Site Coordinator was available on a regular basis for assistance.
E3: CoordAssi	The Site Coordinator was able to assist me with technical problems.
F1: computerS	A suitable computer for my VHS course is available to me at school.

F2:	computerH	I often use a computer at home to work in my VHS course.
F3:	StudOrien	I gained enough knowledge in the Student Orientation to successfully navigate in my VHS course.
F4:	VHSmat	It is easy to find assignments, communications, and materials in my VHS course.
G7a:	NotAva	I took a VHS course because the course subject is not taught at my local high school.
G7b:	IntCourse	I took a VHS course because I thought the VHS course sounded interesting.
G7c:	IntProgram	I took a VHS course because I thought the VHS program sounded interesting.
G7d:	LearnTech	I took a VHS course because I wanted to learn more about technology and the Internet.
G7e:	OtherStud	I took a VHS course because I wanted to learn with students from around the country.
G7f:	parents	I took a VHS course because my parent(s) wanted me to.
G7g:	admin	I took a VHS course because a school administrator wanted me to.
G8a:	Interests	How important is interest in the subject for a student to succeed in your VHS course?
G8b:	TimeEffect	How important is ability to schedule time effectively for a student to succeed in your VHS course?
G8c:	CompBack	How important is a strong background with computers for a student to succeed in your VHS course?
G8d:	Keyboard	How important is an ability to keyboard well for a student to succeed in your VHS course?
G8e:	InternetBack	How important is a strong background in using the Internet for a student to succeed in your VHS course?
G8f:	WorkIndep	How important is it to enjoy working independently for a student to succeed in your VHS course?
G12:	Satisfaction	(the response variable)
H1:	year	What grade is the student in.
H2:	FuturePlan	What are the student's future plans after high school?
H3:	NumCourse	How many courses were you enrolled in this semester (including VHS)?
H4:	sex	

C Technical Appendices

C.1 Calculation of Probability in Model One

In the analysis for Model One, we mentioned that group c in **TimeofSec** enjoys the highest estimated satisfaction probability, the following is the simple calculation to support our claim.

- a) When the student selected their regular courses last school year;

- b) After the student selected their regular courses but before the end of last school year;
- c) During the summer vacation;
- d) During the first semester of this school year;
- e) During the spring add/drop period;

TimeofSec is treated as dummy variables, and Splus codes it in the following way:

TimeofSec	D_1	D_2	D_3	D_4
a	-1	-1	-1	-1
b	1	-1	-1	-1
c	0	2	-1	-1
d	0	0	3	-1
e	0	0	0	4
Coeff	0.049	-1.165	0.99	0.119

We want to examine which **TimeofSec** would give the highest satisfaction probability. First, we hold every other variable in the regression model as constant. So the prediction model looks something like

$$P(1) = \frac{\exp(K + 0.049D_1 - 1.165D_2 + 0.99D_3 + 0.119D_4)}{1 + \exp(K + 0.049D_1 - 1.165D_2 + 0.99D_3 + 0.119D_4)}$$

Just for the sake of illustration, let's pretend that the constant term in this equation, K , equals to 1. The corresponding probabilities for each of the groups are listed as the following:

TimeofSec	Probability
a	0.25
b	0.79
c	0.85
d	0.75
e	0.62

As we can see, that group c enjoys the highest probability.

C.2 Goodness-of-Fit measure

C.2.1 Hosmer-Lemeshow tests:

Hosmer and Lemeshow (1989) proposed grouping based χ^2 test as a measure for goodness-of-fit for logistic regression models. Their idea was to group the values of the estimated probabilities, and test the discrepancies between the expected probabilities and observed numbers. The test is to see where there is a significant difference between the observed and expected numbers. They claimed that this test statistics followed a chi-squared test with degrees of $g - 2$ where g is the number of groups:

$$\chi_{g-2}^2 = \sum_{k=1}^g \frac{(p_{observed} - p_{expected})^2}{p_{expected}}$$

I used two functions to test this statistics for my models. Function one (written by Brian Junker) is based on finding groups according the number of quantiles of the expected probabilities. For example, use of $g=10$ groups results in the first group containing $n/10$ subjects having the smallest estimated probabilities, and the last group containing the $n/10$ subjects having the largest estimated probabilities.

```
hI.test_function(y,mymod,g=10)
{
  p_fitted(mymod)

  cut_c(-1,quantile(p,(1:(g-1))/g),1)
  expected_rep(0,g)
  observed_rep(0,g)

  nobs_rep(0,g)
  for (h in 1:g)
  {
    group_(p>cut[h])&(p<=cut[h+1])

    expected[h]_sum(p[group])
    observed[h]_sum(y[group])
    nobs[h]_sum(group)
  }
  chi_(expected-observed)/sqrt(expected)

  print(data.frame(cuts=cut[2:(g+1)],nobs,expected,observed,chi))

  Chisq_sum(chi^2)
  pval_(1-pchisq(Chisq,g-2))
  cat('\nChisq =',
round(Chisq,4), 'on', g-2, 'df; p-value =',
round(pval,4), '\n\n')

  invisible(return(Chisq,df=g,pval))
}
```

Another method applies fixed values of probabilities. For example, use of $g=10$ groups results in cutpoints defined at the values of 0.1, 0.2, ..., 0.9, 1.0, and numbers in each groups vary. The first group contains all subjects whose

estimated probability is less than or equal than 0.1, while the last group contains those whose estimated probabilities is greater or equal than 0.9.

```
Hosmer.fun_function(y,
mymod,g=10)
{
temp_cbind(predict(mymod,
type='response'),y)
temp_ord_temp[order(temp[,1],temp[,2]),1:2]
cc_seq(0,1,1/g
)
bb_matrix(0,g,2)
dd_0
for (i in 1:g)
{
x_temp_ord

bb[i,1]_sum(x[(cc[i]<x[,1] & x[,1]<cc[i+1]),1])
bb[i,2]_sum(x[(cc[i]<x[,1]
& x[,1]<cc[i+1]),2])
dd_dd+(bb[i,1]-bb[i,2])^2/bb[i,1]

}
return(bb,1-pchisq(dd,g-2))
}
```

smallskip Model 1 Test of goodness-of-fit using the first method:

cuts	expected	observed
0.392	4.45	3
0.810	18.3	22
0.916	25.3	23
0.977	26.4	27
0.995	27.8	27
0.9982	28.9	29
0.9998	27.9	29
1	29	29
	188	188

This gives a chisquare value of 1.4555, and the corresponding p -value computed from the chisquare distribution with 6 degrees of freedom is 0.9624. This indicates that the model seems to fit very well.

Method two table:

%	expected	observed
[0,0.125)	0.33	0
[0.125,0.25)	1.45	0
[0.25,0.375)	2.27	2
[0.375,0.5)	1.60	3
[0.5,0.625)	4.52	6
[0.625,0.75)	6.32	9
[0.75,0.875)	18.07	15
[0.875,1]	153.42	153
	188	188

This gives a chisquare value of 5.186, and the corresponding p -value is 0.637.

Model 2

cuts	expected	observed
0.484	7.8	11
0.800	19.2	15
0.893	24	25
0.948	25.9	25
0.970	26.9	27
0.988	27.4	28
0.996	27.8	28
1	29.9	29
	188	188

This gives a chisquare value of 2.3389 on 6 df, the corresponding p -value is 0.886.

%	expected	observed
[0,0.125)	0.48	0
[0.125,0.25)	0.48	1
[0.25,0.375)	3.28	3
[0.375,0.5)	3.54	7
[0.5,0.625)	4.46	2
[0.625,0.75)	8.54	7
[0.75,0.875)	24.01	24
[0.875,1]	143.19	144
	188	188

It has a chisquare value of 6.07, and the corresponding p -value is 0.532.

I am a bit worried about the discrepancies between the two p -values in both models.

In general, it is hard to examine whether a logistic regression model is a good/correct fit for the data. A prime reason, I think, is because the logistic regression model tends to sacrifice data at either very low or very hi ends (i.e.

with estimated probabilities close to either 0 or 1) for the sake of data that is sort of in the middle. This can lead to big variations in fitting at the two ends. This difference can show up more dramatically in the second chisquare-test method. Because in the second method, the probability interval is set at 12.5% (8 groups), even though the model can fit reasonably well in the middle quantiles, upper and lower quantiles can bring down the chisquare-test values. While with the first method, the length of each group interval varies depending on the expected probabilities. In fact, the first method divides the intervals so that each group approximately has the same number of observations. Discrepancies among the lower/upper ends are not as obvious as in the second method.