# An Investigation of Subject-Area Differences in K-12 Virtual Schooling

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**Abstract:** As part of a year-end evaluation of the North Carolina Virtual Public School (NCVPS), student survey items were compared across subject area groups. Several significant differences were noted across subjects suggesting an inconsistent online experience. English/language arts students were significantly more likely than several other subjects to agree with the quality of teacher facilitation and course support for several 21st century skills. Foreign language and math students, however, were significantly less likely than several other subjects to agree with teacher quality, course support for 21st century skills, and advocacy for the virtual school. While differential teacher quality and course design cannot be ruled out, the possibility that certain content areas are more easily designed and facilitated online is considered.

## Introduction

In spring 2009, external evaluators surveyed students and teachers in the North Carolina Virtual Public School (NCVPS) to help the school improve its student services, technology systems, course designs, and teacher preparation. As part of analysis, survey respondents were divided into six subject-specific groups (i.e., science, math, social studies, English/language arts, foreign language, and career/technical) to seek any significant differences in how courses and teaching were perceived. Significant differences were noted across several survey items, particularly for foreign language and math groups, who were less enthusiastic about their online course experience overall. Follow-up questions were distributed to foreign language and math students to seek explanations for reported differences. This paper details the overall findings regarding online foreign language and math instruction in NCVPS courses during spring 2009 to highlight the perceived challenges in teaching foreign language and math online as well as recommended best practices from course participants.

## Literature Review

Given the relatively recent emergence of K-12 virtual schooling, it is not surprising that research in this field is limited. DiPeitro, Ferdig, Black, and Preston (2008) noted a shortcoming of research in refereed academic journals and conference papers, as well as research into best practices in K-12 online learning. In their review of virtual schooling literature, Cavanaugh, Barbour, and Clark (2009) also noted that current research is primarily limited to either published accounts of personal experiences or is available in unpublished masters' theses or doctoral dissertations.

### Online Math Instruction

Studies about the teaching of mathematics online have focused primarily on comparing the academic achievement of online and traditional students, while "research investigating student satisfaction, motivation, engagement, and interaction... is scarce" (Hughes, McLeod, Brown, Maeda, & Choi, 2007, pg. 200). Moreover, the few studies related specifically to online mathematics instruction have revealed conflicting results regarding both academic achievement and student satisfaction.

Depending on the study, online math students have been shown to perform poorer than, as well as, or better than traditional students. In a report on K-12 online learning in Alberta, Ballas and Belyk (2000) found that traditional students in grades 3, 6, 9, and 12 mathematics courses performed better on end-of-year exams than virtual school students, though performance in English and social studies courses was similar. In a study of the effectiveness of an Algebra I online course in Louisiana, O'Dwyer, Carey, and Kleiman (2007) found that even though online students outperformed traditional students on 18 of 25 posttest items, after controlling for pretest scores, there were no differences between the groups. In a comparative study of virtual and

traditional schools in three different states, Hughes et al. (2007, p. 199) found that virtual school students in an Algebra I course "consistently outperformed traditional students."

Oddly enough, online student perceptions when compared with academic achievement have shown an inverse relationship. Ballas and Belyk (2000) report that despite underperforming on end-of-year exams, "95% of students, parents, and teachers participating in online schooling were satisfied or very satisfied with the quality of education delivered" (as cited in Gadanidis, Graham, McDougall, & Roulet, 2002, pg. 5). Conversely, Hughes et al. (2007) found that although online Algebra I students perceived greater teacher support and outperformed traditional students on post-tests, they had less positive perceptions of student cohesiveness, involvement, and cooperation. Likewise, O'Dwyer et al. (2007) found that a smaller percentage of online students reported feeling confident in their algebra skills and a higher percentage responded "no" when asked if their course provided a good learning experience.

While meta-analyses of online learning at the K-12 level have suggested no significant differences in the effectiveness of distance education when compared to traditional settings (Bernard et al. 2004; Cavanaugh et al. 2004), O'Dwyer et al. (2007) noted concerns about differences in the teaching and learning environments when compared to face-to-face instruction. Some notable differences include the level and types of student-student and student-teacher interactions, the lack of a "social presence," and the structure of the class itself. O'Dwyer et al. (2007, p. 302) concluded that Louisiana's online Algebra I model required changes to the type and level of interaction upon finding that the majority of online students reported that "interaction with their teacher was somewhat less than adequate or should have been a lot more." In a study of Canadian secondary students' online experience, Tunison and Noonan (2001) found that students regretted they were not in a classroom with their peers and they missed the physical

interaction. Perhaps aware of the sense of isolation that an online environment can cause, Gadanidis et al. (2002) recommended that various forms of online collaboration should be available so the online experience is that of a community of learners rather than isolated individuals.

Differences in how content is delivered in online and traditional environments can also impact students' perceptions towards learning mathematics online. Daniels (2008, p. 27) noted that online courses must do more than simply present material electronically and argued that course material must be "adapted for the environment and technology for which it is delivered." Summer, Waigandt, and Whittaker (2005) found that online students reported less satisfaction than traditional students in a college statistics class despite the fact that the course was taught by the same professor using identical course materials and lectures. Interviews of sixteen Michigan Virtual School teachers examining best practices in online instruction revealed the limitations of simply using text and audio to deliver instruction and noted the importance of using video lectures and recorded whiteboard sessions so students could see the problems worked out step by step (DiPietro, 2007). Gadanidis et al. (2002) also noted difficulty in expressing ideas with mathematical language and graphical representation and that appropriate on-line tools that allow for text, symbolic, and visual representations would be necessary for communicating these ideas.

**Online Foreign Language Instruction**

Research on distance language learning research has progressed over four decades from studies of print-based and audio-visual materials to studies of information and communication technology (ICT) and synchronous communication tools (Wang & Sun, 2001; White 2006). Most common are descriptive studies focusing on course development and course components with small groups of students at the college level (White 2006; Yang & Chen, 2007).

Online language learning possesses similar characteristics to computer assisted language learning (CALL), and research has shown CALL is beneficial to reduce anxiety (Ushida, 2005), improve writing skills (Lee, 2005), equalize participation (Warschauer, 1996), and promote student-centered learning (Sullivan & Pratt, 1996). Studies of achievement through CALL have also shown either equivalent or improved performance on formative and summative student assessments (Adair-Hauck, Willingham-McLain, & Youngs, 1999; Blake, Wilson, Cetto, & Pardo-Ballester, 2008; Cahill & Catanzaro, 1997; Chenoweth & Murday, 2003; Nagata, 1996).

Despite the potential advantages of computers in language learning, researchers have noted it is often the teacher that plays the key role in whether or not a technology-intensive environment is successful. In a study of three online language courses at Carnegie Mellon University, Ushida (2005) concluded that the teacher variable was the primary source of difference in student satisfaction between the three courses. The teacher played the most important role in shaping a classroom culture in which students could learn with less anxiety. Stepp-Greany (2002) also noted in her study of college Spanish courses that negative perceptions about the instructional components may have implied that instructor facilitation was insufficient and concluded that the instructor plays an important role in technology-intensive environments, especially those incorporating constructivist or whole-language principles.

Hampel and Stickler (2005) suggested online language teachers require a "pyramid" of seven interdependent competencies: understanding basic ICT skills such as keyboarding, understanding the basics of teaching software such as course management systems, understanding the barriers and advantages inherent in specific teaching applications, understanding how to foster community through such techniques as netiquette and discipline, understanding how to promote online communication through tasks and interactions,

understanding how to creatively integrate tools and resources into complex language activities, and understanding one's own unique teaching style. Most research into online language learning is related to levels 4-6 of the pyramid and tending to requirements for student socialization, communication, and the creative integration of resources and tools.

In terms of socialization, a key challenge facing instructors in online environments is the sense of isolation or lack of support felt by students due to the lack of interaction found more readily in face-to-face classrooms. Weiner (2003) concluded that a high degree of student-teacher interaction was a necessity in a virtual high school classroom, "otherwise students felt ignored, lonely, and lost in their course" (as cited in Rice, 2006, p. 436). Lack of prompt feedback and immediate assistance were also found by Hara and Kling (1999) to be a major source of frustration among graduate students in an online language course. Studies in which teacher support and interaction were perceived as high, however, have been shown to counter these feeling of isolation and lack of support. Ushida (2005) compared three online foreign language courses at the undergraduate level and concluded that instructors who used various strategies to maintain student interaction without relying entirely on student self-motivation and responsibility can influence students' attitudes toward their learning experience. In a similar study, college students in an online Spanish course frequently cited the importance of the instructor's facilitation, which included guidance, assistance, and constructive feedback (Lee, 2005).

Another challenge for teachers is adequately supporting oral communication that is critical to the study of foreign languages. Numerous challenges have been reported, however, in employing tools for this purpose. Coverdale-Jones (2000) found that students viewed video-conferencing as a "reduced form of communication compared to face-to-face interaction" (as

cited in Stepp-Greany, 2002, p, 167). Similarly, Yang and Chen (2007) found that among the various forms of computer-mediated communication (CMC), video conferencing ranked the lowest among student satisfaction. Murphy and Coffin (2003) reported on the use of a set of online synchronous communication tools to support classroom discussion in a Web-based Canadian high school French course and noted that the inherent constraints of these tools (i.e. lack of private oral discussions, visual gestures, and cues), could only be minimized and compensated for in limited ways despite the instructors best efforts. Additional limitations found by Yang and Chen (2007) that affected students' attitudes towards online synchronous communication were difficulty following conversations, keeping up due to slow typing, and maintaining a conversation with poor writing skills.

Teachers must also make decisions about the organization of instructional materials and activities, as these elements have been found to impact student perceptions of online courses. Felix (2001) investigated undergraduate foreign language students' views on the learning utility of online activities, their comfort levels and enjoyment working in an online environment, and how their perceptions changed over time. Significant relationships were noted between students' perceptions of the usefulness of Web materials and how well the course content was clearly and logically organized, as well as the clarity of course objectives. Based on feedback from questionnaires from foreign language students in a blended learning environment, Green and Youngs (2001) concluded that, "as with any activity, instructions must be clear and the relevance of the activity to classroom goals must be obvious" (p. 108). Lee (2005) also attributed foreign language students' satisfaction with online tasks and student motivation to the well-structured nature of the tasks within a logically organized course management system interface.

Research in the area of online language learning has made the recommended shift from studies about content delivery to studies about how to best facilitate "transactions between learners, teachers, and native speakers" (White, 2006, p. 260). While findings are available to help teachers better socialize learners, support communication, and integrate resources and tools, results are disproportionately derived from post-secondary studies with small groups of students. Further studies are warranted to determine challenges faced by online language learners at the virtual high school level and how teachers can best support these younger learners who may have different learning needs.

## Methods

### Design

This study is based on an embedded mixed methods design with a small selection of qualitative results embedded in a primarily quantitative case study (Creswell & Clark, 2007). Quantitative data are used to report student and teacher reactions to online foreign language and math courses and highlight significant differences between these and other subject areas. Validity is supported by embedding qualitative data to help explain the significant differences and recommend solutions to perceived challenges with teaching foreign language and math online. Instances where students disagreed with the significant differences are noted in the findings (i.e., there wasn't a problem for me), to fairly represent the proportion of students who did not experience the same challenges in online foreign language and math as their peers.

### Participants and Demographics

Participants in NCVPS online courses completed end-of-course surveys in Spring 2009. Overall response rates are shown in Table 1. Out of the total sample, 11.6% of students took math courses (n=242), and 13.1% of teachers taught math courses (n=17). Also, 26.8% of

students took foreign language courses (n=559), and 24.6% of teachers taught foreign language courses (n=32). Following analysis of the first survey, a follow-up survey was distributed to math and foreign language students to seek their explanations for why their courses were rated significantly lower than courses in other subject areas on some items. In this second online survey, all math teachers and 186 math students responded to the follow-up questions, and 119 foreign language students and 19 foreign language teachers provided feedback.

Table 1
*Survey Respondents Overall*

| Survey Groups | Total # in Sample | Total # of Surveys | Response Rates |
|---|---|---|---|
| Students | 9256 | 2089 | 22.6% |
| Teachers | 207 | 130 | 62.8% |

**Data sources**

The first online survey included predominantly multiple choice items on a five-point Likert scale from strongly disagree to strongly agree. Survey questions elicited participant feedback on four primary topics:

1. perceptions of student learning and barriers to success
2. teacher preparation
3. course content and teaching
4. critical non-teaching factors--leadership, advisement, and community

After a quantitative analysis of the first survey indicated perceptions of math and foreign language courses were significantly different than other subject areas on a number of items, a second follow-up survey with predominantly open-ended qualitative items asked math and foreign language students and teachers to comment on why they thought math courses were perceived differently.

**Analysis**

Since the two surveys contained both Likert-scale and open-ended items, both quantitative and qualitative analysis procedures were employed. *SPSS* was used for all quantitative analyses. To determine the percentage of respondents who agreed or strongly agreed with items, the frequencies function was used with valid percents reported. Valid percents take into account respondents who skipped items or responded with "I do not have enough information to evaluate."

One-way ANOVAs were conducted to compare groups based on course type (i.e., math vs. science vs. foreign language, etc.) at the item-level of analysis. If the resulting F statistic was significant at the .05 level, the item was flagged. If the effect size was at least .009, small but trivial according to Cohen's (1988; 1992) guidelines, the item remained flagged. Items for which ANOVAs did not result in significant F values and did not have effect sizes that were at least .009, were excluded. Post hoc tests were employed to conduct pairwise comparisons on the means for the items retained for discussion. Specifically, the REGWQ (Ryan/Einot/Gabriel/Welsch) procedure was used to make pairwise comparisons between course types for both students and teachers.

Responses to open-ended items on the follow-up survey were imported into *NVivo* qualitative analysis software and open-coded by meaning. Commonly appearing comments were sorted into categories, with categories reported in the findings to help explain why significant differences were evident between math and foreign language courses and other subject areas.

**Validity and reliability**

Validity was supported by embedding qualitative follow-up data with quantitative data to give participants a chance to confirm or disconfirm the significant differences and elaborate on

specific variables that may be related to the lower ratings. Further, whenever participants disagreed with the quantitative results (e.g., "a lack of communication was not a problem for me"), these findings are reported as well to fairly depict student and teacher reactions to the results.

## Findings I: Student Success

When students were asked if they were succeeding in their NCVPS online course, the percentages of foreign language and math students who agreed or strongly agreed were the lowest among the six subject areas queried, and foreign language students' responses were significantly lower than four other subject areas (see Table 2).

When students were asked how much they were learning in their online course compared to face-to-face courses they had taken in similar subjects, the percentages of foreign language and math students who reported learning a little more or much more online were the lowest among the six subject areas queried. Foreign language students' responses were significantly lower than four other subject areas, and math students' responses were significantly lower than two other subject areas.

Since advocacy for an educational program often results from success in that program, students were asked if they would recommend more students take NCVPS courses. The percentages of foreign language and math students who agreed or strongly agreed they would were among the three lowest, and foreign language and math students' responses were significantly lower than three other subject areas.

Foreign language and math students were asked to explain the significant differences reported in Table 2 on a follow-up survey. Although the comments were coded separately, the

responses generated similar codes and were ultimately collapsed into the categories discussed below.

Table 2
*Main Effects of Course Type Among Students for Questions Associated with Student Learning*

| ***df*** | ***F*** | ***p*** | **$\eta^2$** | **Means (5-point Likert scale) (Standard Deviations) % agree/strongly agree**** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **English** | **Career** | **Soc. St.** | **Science** | **ForLng** | **Math** |
| *Q1. I am succeeding in this online course:* | | | | | | | | | |
| 5, 1748 | 7.86 | < .001 | .022 | $4.09_{a}$<br>(.98)<br>79.1% | $4.08_{a}$<br>(1.03)<br>82.2% | $4.06_{a}$<br>(1.08)<br>77.5% | $4.01_{a}$<br>(.97)<br>75.5% | $3.71_{b}$<br>(1.10)<br>68.3% | $3.88_{ab}$<br>(1.15)<br>74.4% |
| ***Q2. Compared to face-to-face courses you have taken in similar subjects, how much are you learning in this online course:* | | | | | | | | | |
| 5, 1453 | 19.35 | < .001 | .062 | $3.42_{a}$<br>(1.23)<br>48.1% | $3.18_{ab}$<br>(1.13)<br>37.1% | $2.80_{c}$<br>(1.23)<br>27.5% | $2.92_{bc}$<br>(1.25)<br>31.9% | $2.45_{d}$<br>(1.15)<br>16.2% | $2.61_{cd}$<br>(1.26)<br>23.9% |
| *Q7. I would recommend more students take NCVPS courses:* | | | | | | | | | |
| 5, 1768 | 6.50 | < .001 | .018 | $3.86_{a}$<br>(1.15)<br>68.3% | $3.74_{a}$<br>(1.24)<br>63.3% | $3.63_{a}$<br>(1.30)<br>61.7% | $3.52_{ab}$<br>(1.18)<br>52.1% | $3.40_{b}$<br>(1.26)<br>53.0% | $3.34_{b}$<br>(1.32)<br>47.5% |

Means with the same letter in the subscripts do not significantly differ from one another at the .05 level according to REGWQ tests. **Note: different scale, percent reporting "a little more" and "much more."

**Success Tied to Interaction with Teacher and Peers**

Many foreign language students (8 comments Q1, 12 comments Q2, 9 comments Q7) noted that they were doing more reading and self-teaching in their online courses than they expected or desired:

> I would assume that since the bulk of the course is self-education by reading large blocks of text, students feel overwhelmed and fall behind unless particularly motivated.

> Because to learn a language you need to learn it by speaking, reading, writing, hearing, and any other kind of interactions, but online courses only teach us by reading.

Some students (20 comments Q1, 20 comments Q2, 9 comments Q7) noted they were familiar with face-to-face interaction and help from their teacher, and they needed more of this personal

interaction in their online foreign language courses. A few teachers also commented that foreign language instruction required adequate modeling and explanation from the teacher:

> Languages are hard to learn without any direct face-to-face instruction time from the teacher.
>
> Sometimes computers won't let you do specific things, and you may not learn as much without an actual person teaching you.
>
> Because of the modeling--foreign language needs a lot of modeling from the instructors [teacher quote].

Similarly, in situations where online math teachers weren't providing explanations and elaborations of math content, and students had a limited ability to communicate with their teachers and peers, math students developed a perception of isolation in which they were largely responsible for teaching themselves the content. By far the most student comments (29 comments Q2, 24 comments Q7) were about the challenges in teaching themselves math through readings and notes with only limited access to a teacher:

> A lot of math is in demonstration and question/response sessions. Readings and pictures aren't a good substitute for a teacher drawing diagrams on a whiteboard and explaining as they go along.

Math students believed face-to-face classrooms provided more support than online classrooms because interaction and communication with the teacher and peers was more prevalent. In response to Q2, nine students and six teachers discussed a need for more one-on-one teacher-student interaction as well as student-to-student interaction in online math courses:

> Math is a very difficult subject and I personally think that it should be more one-on-one. Online a student doesn't get the same help they would get in the classroom, nor do they get taught in the same way.
>
> Math students strongly benefit from interactive work in small groups and that is difficult to attain online. This is a dominant activity in my f2f classroom [teacher].

One of the chief reasons math students believed face-to-face classrooms provided more benefits than online classrooms was because teachers were better able to explain or "go over" course content. Numerous comments (35 comments Q2, 10 comments Q7) suggested students wanted their teachers to explain material and visually work sample math problems:

> Well personally I learn if I can watch someone work out a problem of a certain type once... but online you can't watch them do it.

Several math teacher comments (5 comments Q2, 2 comments Q7) paralleled these student remarks, suggesting online math students do need to see their teachers working problems and explaining content. Teachers noted, however, that properly integrated tools for synchronous communication must be made available, students must be trained to use such tools, and logistically a common time must be available when all students can meet online:

> Technology isn't there to make explanations viable. I can't use [Geometer's] Sketchpad at all with Blackboard and it would really help these students.

> Math students need a teacher to show them how to do things. This can be accomplished online, but they need to set up synchronous times to do it.

For some foreign language students, lack of interaction with the instructor was related to limited or delayed feedback on questions they asked or on assignments they submitted:

> With a face-to-face course, any questions can be answered instantly by simply asking. In an online course, you have to send a message and it could take a few days to get an answer and is much more of a hassle.

> Foreign languages often require constant correction and assistance (e.g., la foto, not el foto) which simply isn't feasible online.

Similarly, several math students commented (9 comments Q2, 3 comments Q7) that it was challenging to ask questions in their online math course: "You cannot really ask questions and get a detailed answer as you can face to face." A subgroup of students commented (7 to question

one, 4 to question two) that questioning online was difficult because help was not immediate or "just-in-time" when problems were encountered:

> You need to be able to ask questions and get a quick answer. Sometimes I had to wait several days to get something I did not understand explained.

Just-in-time questioning and feedback may be particularly important in math, since concepts build on one another. In responding to question two, five students discussed the implications of not being able to keep up in an online math class:

> Math may be difficult online because you can't ask teachers questions face-to-face. In math if you don't understand a single concept, you will not be able to understand many other concepts related to it... that might cause you to not be able to work the rest of the problem. So, it might be harder to learn math online.

Only two teachers touched on student questions in their comments, suggesting it was the students who may not take the initiative to ask their questions to the teacher:

> They feel like they can't ask a question and get help. That's where Pronto is KEY! Email is fine, but students don't get the immediate and sustaining feedback that most of them need. When they Pronto, they are successful.

**Success Tied to Content**

Several students commented that foreign language content was just difficult to learn, and this complexity might have led fewer foreign language students to indicate they were succeeding (17 comments), to report they were learning more in an online environment (11 comments), and to recommend NCVPS courses to others (16 comments). A few teachers also suggested foreign language content was difficult and could lead to suppressed ratings overall (3 comments Q1, 3 comments Q7). Several students compared foreign language courses to math and science courses in their comments, noting foreign language content was "different" and "harder":

> Foreign languages are difficult to learn and making students take it online will not make it any easier.

> Foreign language is already one of the most difficult subjects to learn period. Foreign language instruction in an online environment is more difficult than classroom instruction [teacher quote].

A few foreign language students noted in comments that courses could be improved with additional projects and activities, particularly "hands-on" or "real-world" activities that involved students practicing their use of foreign languages:

> It is difficult to practice while staring at a computer screen. Real life experiences help people of all learning types gain knowledge.

> To learn a language you need to be involved and interacted in every way possible, instead of us just reading the course work everyday.

Interestingly, many math students also commented (13 comments Q2, 33 comments Q7) that math as a subject area was fundamentally challenging. The isolation they perceived online exacerbated the difficulty of the subject, particularly due to the inability to get teacher explanations:

> Math seems to be a harder concept to grasp, especially when you are trying to figure it out on your own with just a few examples to demonstrate.

A few students and teachers noted that math was made more challenging online by a lack of experience with online math tools such as equation editors:

> I'm used to working out problems by hand, not typing them up as an answer.

> It takes a lot longer to type up math-related answers and students become overwhelmed [teacher].

A small group of five students and two teachers commented that another reason math courses were challenging was because prerequisite skills were necessary in a curriculum where concepts build on one another. Students suggested lack of access to a teacher and not having questions answered could result in falling behind online, while the two teachers suggested a lack of screening for prerequisite algebra skills could influence student success online:

> Math requires you to take a problem and analyze it. It's much harder to analyze it by yourself. As you get older, you realize that each problem requires knowledge obtained from a previous unit.

Related to content difficulty, a few foreign language students noted foreign language content was time-consuming to learn online and the pace of instruction with recurring deadlines could be problematic (2 comments Q1, 3 comments Q2, 12 comments Q7):

> They say you do your work at your own pace but that is not true. There are many deadlines, and it is very time consuming. I wouldn't have taken the course if I had known it takes so much time.

> I think the content moves quickly and unless they are a strong student they struggle to keep pace. Then they only focus on completion of assignments and not learning [teacher quote].

Several math students also commented (7 comments Q2, 15 comments Q7) that math learning already takes time, while learning math on the computer takes more time:

> Math courses seem to be the hardest to complete online because it requires you to understand how to do the problems yourself and it is very time consuming on the computer.

**Success Tied to Student Characteristics**

Students and teachers suggested certain personal characteristics are important to succeed in online courses that have minimal interaction or challenging and time-consuming content. Some foreign language students discussed the "effort" trait in their comments, suggesting success was dependent on putting forth an effort to contact the instructor when help was needed and putting forth an effort to study hard rather than rushing through assignments and skipping optional exercises (12 comments Q1, 9 comments Q2, 9 comments Q7). Students used words such as "dedicated," "focused," "responsible," and "try hard" when describing the effort necessary to succeed:

> It needs to work both ways... the students themselves have to be willing to communicate with the teachers if they have problems, and the teachers need to be there for the students when they do.
>
> It is very time consuming and you have to be really dedicated to follow through and complete the course.
>
> I believe they do not spend the time required to be successful. They need to do a lot of listening and practices. I have students learning and doing great and others who do not. It is within the individual desire to succeed [teacher quote].

Six foreign language students reported it was possible to take short cuts in online foreign language courses and unmotivated students who took such actions might be learning less overall:

> Due to the fact that the course is online, it gives the student the opportunity to use resources that wouldn't generally be used in an official class setting. These resources such as search engines or translators can hinge the learning experience and allow more slack in actual participation in the course.
>
> It's very easy to just Google answers and not learn anything.

A few teachers suggested another reason foreign language students might report less success or learning less online than other subject areas in that students may have a false perception that anything less than fluency is not learning:

> They do not come out of the class fluent, and they are only able to write simple, non-compound non-complex sentences, so they feel like they have not learned enough.

Math students and teachers also used a number of words to describe dispositions beneficial to taking math courses online (e.g., disciplined, motivated, dedicated, and responsible). Such dispositions were seen as critical in light of challenging math subject matter and inaccessible teachers in some cases:

> You really have to be dedicated. Most of the online math learning is teaching yourself. You have to read the notes and ask a lot of questions to make sure you have a clear understanding. It is not easy taking a math class online, but if you're dedicated then you should pass.

> You need the daily reinforcement, and most kids do not possess the self-discipline to read the notes and examples thoroughly, work through the problems, and truly try to figure out where things went wrong (if they did). A f2f classroom would provide that discipline [teacher].

When young students lacked desirable dispositions, both students and teachers suggested their lack of maturity manifested in detrimental academic behaviors (e.g., procrastination, rushing, distraction):

> When you read the study pages, you kind of fly through them and don't work out all the problems in the examples, which you could if you were actually there with the teacher.

> I often receive questions from students that lead me to believe they are not reading the lesson. Many students are simply trying assignments, quizzes, and tests before reading the lesson [teacher].

## Findings II: Teaching

When asked if their teacher was appropriately prepared to teach an online course, foreign language and math students had the lowest percentages of students who agreed/strongly agreed, and foreign language students' responses were significantly lower than three other subject areas (see Table 3).

Table 3
*Main Effects of Course Type Among Students for Questions Associated with Teacher Preparation and Facilitation*

| ***df*** | ***F*** | ***p*** | $\eta^2$ | **Means (5-point Likert scale) (Standard Deviations) % agree/strongly agree**** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **English** | **Career** | **Soc. St.** | **Science** | **ForLng** | **Math** |
| *Q15. Teachers were appropriately prepared to teach an online course:* | | | | | | | | | |
| 5, 1641 | 3.87 | < .001 | .012 | $4.27_{a}$<br>(.82)<br>83.4% | $4.10_{ab}$<br>(1.02)<br>80.9% | $4.10_{a}$<br>(1.01)<br>79.1% | $3.99_{ab}$<br>(1.02)<br>79.5% | $3.91_{b}$<br>(1.05)<br>71.7% | $4.05_{ab}$<br>(.99)<br>75.0% |
| *Q24. My teacher does a good job teaching in this online environment:* | | | | | | | | | |
| 5, 1641 | 9.27 | < .001 | .027 | $4.32_{a}$<br>(.78)<br>85.5% | $4.13_{ab}$<br>(.96)<br>81.3% | $4.01_{bc}$<br>(1.07)<br>74.6% | $3.79_{cd}$<br>(1.04)<br>65.3% | $3.77_{d}$<br>(1.14)<br>64.4% | $3.84_{cd}$<br>(1.07)<br>66.1% |

Means with the same letter in the subscripts do not significantly differ from one another at the .05 level according to REGWQ tests.

When asked if their teacher did a good job teaching in the online environment, foreign language and math students had two of the three lowest percentages who agreed/strongly agreed. Foreign language students' responses were significantly lower than three other subjects, while math students' responses were significantly lower than two other subjects.

Students and teachers were asked on follow-up surveys to respond to the significant differences in Table 3. It should be noted that many foriegn language students commented that teachers met their expectations and were doing a good job teaching online (19 comments Q15, 12 comments Q24). In response to Q24, a subgroup of four students noted their teacher did a good job because they were available when needed:

> I believe that my foreign language is well prepared for the course, so I'm not really sure what the other teachers are not doing that students expect them to.

> I'm not sure. My teacher was online to help me when I needed help, she took phone calls if I needed help, stayed up late online with me explaining things, and suggested other students when she didn't have time to help.

One suggested improvement by seven math students and two math teachers was for math teachers to actually teach more online. Six students used the word "explain" in describing how they wanted their teachers to personalize a math course shell:

> I think it would be better if the math teachers could instead explain the notes to the students personally, instead of just giving notes to them and expect them to just learn by themselves.

Twelve math students and four teachers indicated that teachers needed to be more involved and engaged with communication in general. Specific forms of communication were recommended, including timely feedback on student work, timely responses to student questions, communication initiated by the teacher that encouraged students to ask questions, and communication initiated by the teacher that informed students of their progress in a course and encouraged them to persist.

Similarly, many foreign language students also said their teachers needed to teach, rather than facilitate a course shell and remind students of assignments (11 comments Q15, 12 comments Q24). These students wanted teachers to "explain," "go into more detail," and "clarify" course content. They also suggested teachers needed to make themselves more available online to answer students' questions (6 comments Q15, 13 comments Q24), respond to their questions and grade submitted assignments more quickly (7 comments Q15, 11 comments Q24), and stay in more frequent contact with students to ensure they comprehend the material (10 comments Q15, 12 comments Q24).

Foreign language students recommended two sources of "teaching"--teaching via synchronous online meetings, and teaching via written or recorded supplements provided by the teacher (i.e., "notes," "study guides," and teacher "videos"):

> The teacher was more reminding us to do our work than actually teaching. I was really hoping/depending on being 'taught.'
>
> The teacher should be more involved than just giving assignments... maybe online meetings or fewer textbook assignments as if the teacher was really teaching a class in school.
>
> The teachers do not seem to teach at all. ... The teachers seem to just grade. It might help if there were videos of the teacher actually teaching and online notes to help the student better understand.

Interestingly, five math students and nine math teachers also specifically mentioned the benefits of using synchronous, two-way communication tools such as the whiteboard in Wimba classroom, Pronto instant messaging, and Web-based Skype calls and regular phone calls:

> They don't really teach, but tell you what to do. It would be much better if we were all taught together, kind of in a class chat room, by the teacher, and not just by online notes.
>
> The addition of the whiteboard will make a difference. It has been great just hitting the button when I need to work with a student on a problem. They can see how I set it up and work neatly. Having a pen tablet is very useful also [teacher].

Also similar to foreign language students, 24 math students suggested math teachers could improve their online teaching by supplementing the content provided in their base course shell. Specifically, ten students wanted more examples for solving problems, five students wanted more practice problems, and a few students wanted recorded lectures to play back such as podcasts or PowerPoint presentations:

> I believe the teacher could give more practice problems to work with, without being graded on, so they know we understand the lesson.

> Maybe have more podcasts so you can actually hear the teacher's voice.

Four teachers agreed that additional resources would be helpful to students, including fee-based commercial products/tutorials, graphing calculator tutorials, and review units for course prerequisites (e.g., an Algebra I review unit for Geometry).

One category of comments from foreign language students stood out from math students. In response to Q15, five foreign language students discussed motivation, with comments split between students who believed motivation was the teacher's responsibility and students who believed motivation was their own responsibility:

> Motivate the students to complete all of their work on time.

> The student may be expecting the teacher to be more interested in making them work. The student needs to learn to seek help, not expect it.

A few foreign language students also recommended teachers better track student progress in a course and alter the pace of instruction as necessary for students who needed more time to learn (2 comments Q15, 3 comments Q24):

> They probably aren't letting students learn at their own pace. Since it takes a while to learn a foreign language, the teachers should probably slow down a little.

When foreign language teachers were asked to respond to the significant differences in Table 3, teachers more commonly attributed these perceptions to deficient student characteristics

rather than deficient teaching. Some teachers countered that they were well prepared and did a good job teaching online (2 comments Q15, 5 comments Q24). Other teachers touched on student motivation issues. In response to Q15, for example, three teachers noted they had made themselves available to students, but students were not taking advantage of this service. Also, some teachers suggested students were not doing the assigned work (4 comments Q15, 2 comments Q24):

> I know that I kept office hours throughout the school day via pronto or phone since I do not teach in a f2f classroom and am able to do so. I also made myself available in the evenings and weekends. However, most students did not take advantage of this. There are generally about five students per class that contact me periodically for help....
>
> Even in my face-to-face classroom, "poor" students would try to down play my ability to teach and speak a foreign language because they want to blame the teacher so they don't have to take responsibility.

Among the foreign language teachers who did suggest they could be doing more, two recommended more modeling of the foreign language (Q15), two recommended providing students with regular corrective feedback (Q15), one recommended providing students with a designated instructor they could contact at any time during the day (Q24), and one recommended differentiating instruction to benefit slower learners (Q24).

## Findings III: Course Content and Assignments

Since NCVPS was interested in how well their courses were supporting student acquisition of different 21st century skills, a series of seven survey questions inquired into these competencies. Foreign language and math students were almost always in the bottom two subject areas in terms of agreement that their courses supported these competencies, and differences were often significant (see Table 4).

Table 4

*Main Effects of Course Type Among Students for Questions Associated with How Well Courses Supported Different 21st Century Skills*

| *df* | *F* | *p* | $\eta^2$ | **Means (5-point Likert scale) (Standard Deviations) % agree/strongly agree** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **English** | **Career** | **Soc. St.** | **Science** | **Foreign** | **Math** |
| *This course has developed students' civic literacy by informing them of current events, ethical practices, and the roles of governments:* | | | | | | | | | |
| 5, 1641 | 19.30 | < .001 | .056 | $3.54_{a}$<br>(.99)<br>57.2% | $3.29_{ab}$<br>(1.09)<br>46.1% | $3.53_{a}$<br>(1.03)<br>57.3% | $3.28_{ab}$<br>(1.18)<br>43.2% | $3.17_{b}$<br>(1.06)<br>39.4% | $2.60_{c}$<br>(1.09)<br>15.9% |
| *This course has developed students' understanding of the global world through such activities as interacting with students and experts around the globe, using and/or creating maps, studying global current events, etc.* | | | | | | | | | |
| 5, 1641 | 15.57 | < .001 | .045 | $3.38_{ab}$<br>(1.01)<br>50.0% | $3.03_{c}$<br>(1.11)<br>36.8% | $3.43_{a}$<br>(1.10)<br>53.9% | $3.42_{a}$<br>(1.17)<br>52.1% | $3.13_{bc}$<br>(1.09)<br>38.0% | $2.63_{d}$<br>(1.07)<br>15.7% |
| *This course has developed students' information literacy, helping me research and gather appropriate source data to inform my studies through such means as webquests, online labs and exercises, social bookmarks, etc.* | | | | | | | | | |
| 5, 1641 | 22.38 | < .001 | .064 | $4.04_{a}$<br>(.86)<br>80.1% | $3.71_{b}$<br>(.98)<br>66.7% | $3.81_{ab}$<br>(.96)<br>70.9% | $3.88_{ab}$<br>(1.07)<br>74.4% | $3.45_{c}$<br>(1.04)<br>54.3% | $3.14_{d}$<br>(1.10)<br>37.1% |
| *This course supports group collaboration in some of the following ways: peer groups, group projects, discussion boards, wikis, web conferencing, etc.* | | | | | | | | | |
| 5, 1641 | 10.41 | < .001 | .031 | $4.11_{a}$<br>(.78)<br>83.6% | $3.97_{a}$<br>(.87)<br>75.8% | $3.97_{a}$<br>(1.04)<br>77.9% | $3.94_{ab}$<br>(.96)<br>80.0% | $3.71_{bc}$<br>(.98)<br>70.7% | $3.54_{c}$<br>(1.17)<br>60.9% |
| *This course is teaching students life and career skills (e.g., self-direction, social skills, responsibility):* | | | | | | | | | |
| 5, 1641 | 14.70 | < .001 | .043 | $3.92_{a}$<br>(.88)<br>73.9% | $3.86_{a}$<br>(1.04)<br>75.4% | $3.59_{b}$<br>(1.13)<br>61.4% | $3.60_{ab}$<br>(1.14)<br>62.1% | $3.29_{c}$<br>(1.11)<br>47.5% | $3.27_{c}$<br>(1.27)<br>51.4% |
| *This course has developed students' technology literacy, using such tools as Word, Excel, Powerpoint, Web development software, audio/video editors, photo editors, etc.* | | | | | | | | | |
| 5, 1641 | 10.64 | < .001 | .031 | $3.99_{a}$<br>(1.03)<br>77.1% | $3.99_{a}$<br>(1.01)<br>78.1% | $3.70_{b}$<br>(1.10)<br>64.5% | $3.86_{ab}$<br>(1.04)<br>71.2% | $3.51_{c}$<br>(1.08)<br>58.2% | $3.50_{c}$<br>(1.14)<br>57.9% |
| *This course is teaching students learning and innovation skills (e.g., creativity, critical thinking, problem solving):* | | | | | | | | | |
| 5, 1641 | 13.31 | < .001 | .039 | $4.03_{a}$<br>(.85)<br>82.5% | $3.89_{ab}$<br>(.96)<br>76.7% | $3.75_{b}$<br>(1.02)<br>68.9% | $3.65_{bc}$<br>(1.12)<br>64.0% | $3.40_{c}$<br>(1.05)<br>53.1% | $3.65_{b}$<br>(1.11)<br>66.4% |

Note: means with the same letter in the subscripts do not significantly differ from one another at the .05 level according to REGWQ tests.

Math teachers agreed with math students to an extent by suggesting courses were not overly supportive of three 21st century skills. As shown in Table 5, math teachers were

significantly less likely than teachers in three other subjects to "agree" or "strongly agree" that courses supported civic literacy. Math teachers were also significantly less likely than teachers in two other subjects to agree that courses supported an understanding of the global world and group collaboration.

Table 5
*Main Effects of Course Type Among Teachers for Questions Associated with How Well Courses Supported Different 21st Century Skills*

| ***df*** | ***F*** | ***p*** | $\eta^2$ | **Means (5-point Likert scale) (Standard Deviations) % agree/strongly agree** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | **English** | **Career** | **Soc. St.** | **Science** | **Foreign** | **Math** |
| *This course has developed students' civic literacy by informing them of current events, ethical practices, and the roles of governments:* | | | | | | | | | |
| 5, 103 | 8.734 | < .001 | 0.298 | $3.33_{ab}$<br>1.07<br>41.7% | $4.04_{b}$<br>0.93<br>78.3% | $3.93_{b}$<br>0.70<br>73.3% | $3.23_{ab}$<br>0.93<br>38.5% | $4.03_{b}$<br>0.91<br>74.2% | $2.33_{a}$<br>1.11<br>6.7% |
| *This course has developed students' understanding of the global world through such activities as interacting with students and experts around the globe, using and/or creating maps, studying global current events, etc.* | | | | | | | | | |
| 5, 103 | 9.261 | < .001 | 0.310 | $3.67_{bc}$<br>1.23<br>66.7% | $3.08_{ab}$<br>0.83<br>29.2% | $3.19_{ab}$<br>0.91<br>37.5% | $3.23_{ab}$<br>1.17<br>46.2% | $4.28_{c}$<br>0.88<br>86.2% | $2.27_{a}$<br>1.16<br>6.7% |
| *This course supports group collaboration in some of the following ways: peer groups, group projects, discussion boards, wikis, web conferencing, etc.* | | | | | | | | | |
| 5, 107 | 5.158 | < .001 | 0.194 | $4.33_{ab}$<br>0.65<br>91.7% | $4.33_{b}$<br>1.09<br>83.3% | $4_{ab}$<br>1.03<br>75% | $3.92_{ab}$<br>1.04<br>76.9% | $4.74_{b}$<br>0.44<br>100% | $3.41_{a}$<br>1.23<br>41.2% |

Note: means with the same letter in the subscripts do not significantly differ from one another at the .05 level according to REGWQ tests.

Of the skills that were supported significantly less in math courses according to both students and teachers, civic literacy and understanding the global world may not be as relevant to math instruction as they would be to other subject areas such as social studies. Support for group collaboration, however, does seem relevant since students were asking for more opportunities to interact with teachers and peers on their follow-up survey. This item was probed further on the follow-up survey. Similarly, since group collaboration seems particularly important for foreign

language courses, these students were also asked a follow-up question, "How could your course or teacher better support group collaboration?"

It should be noted 26 math students indicated collaboration in their course was adequate with no improvements needed. Likewise, 20 foreign language students reported group collaboration was already adequate in their courses and many cited tools that supported collaboration such as "blogs," "discussion boards," "Web chats," and "Wimba Pronto" synchronous audio:

> My teacher did an excellent job. We constantly had Web chats we could've taken advantage of and weekly we had a discussion board question or a blog.

Four foreign language teachers agreed that group collaboration was adequate:

> We already have discussion boards, group projects in wikis, blogs, *Wimba* tutoring sessions, peer tutor discussion board, messaging system, etc. They have ample opportunity to interact if they want to [teacher quote].

Not all foreign language students were pleased with the amount of collaboration, however, and 18 students recommended teachers hold more group discussions. Two foreign language teachers also recommended further group discussions. Students cited both asynchronous discussion boards and in particular synchronous discussion tools such as chat, instant messaging, and Wimba Pronto, to support collaboration:

> Use the discussion board to make them interact more in both English and Spanish.
>
> Hold Wimba Classroom sessions at set times or have a certain time to log into the class.

Similarly, twelve math students recommended their teachers establish a common time when students can either meet with the instructor online or with other students. Sixteen students and six teachers recommended synchronous chat and messaging tools employed by NCVPS such as *Wimba Pronto* to serve this purpose:

> I think there should be scheduled class times where students can meet in a chat room and discuss the week's work.

Eighteen math students and five math teachers recommended asynchronous discussion boards for general class discussions. More specifically, three math students (and one foreign language student) recommended using a discussion board to hold frequently asked questions, where students could see one another's questions about certain concepts and how the instructor had answered them:

> Possibly by posting a topic every week that asks a question or two about what the students learned that week and making it mandatory to reply at least once.
>
> If there was a message board posted with all the questions and answers so you could see what other students had asked and you could see the answers.

Other recommendations by foreign language students to bolster collaboration included assigning more group projects (twelve comments) and creating small study groups or partners to support peer review and conversation (two comments):

> The teacher could assign projects that require a group collaboration.
>
> The teacher could actually suggest that we have an assigned partner to proof read projects and papers.

The most common foreign language teacher recommendation to bolster group collaboration was to support additional group projects (eight comments). Two teachers recommended peer tutoring:

> Perhaps encouraging more "peer tutoring" would help. That would put them in a position to work together while talking about the Latin [teacher quote].

Similarly, 21 math students and five math teachers recommended improving collaboration by incorporating more group projects or assignments into online courses. Two students and one teacher recommended cooperative problems where students would have individual responsibility for completing different parts of a mutual project:

> Assign each student a function of one very large problem.

> Assign a group project and have each group be responsible for supplying the necessary information for a certain part of the project [teacher].

Like their foreign language peers, three math students and two math teachers suggested groups or partners could be created to peer-teach or ask questions of one another and provide another means of support throughout a course:

> In Geometry, it would be helpful if we were to explain a proof or theory to a student, rather than a teacher. By doing this, we will get better at explaining our proofs. If a student could understand it, then we would know that our proof was clear.

Some foreign language students suggested collaboration would be difficult using tools like email (two comments), using groups made up of students from different schools would not know one another (two comments), using students with divergent motivations who may not show up for optional meetings or who may inappropriately use their peers to derive answers (two comments), using novice foreign language learners who could perpetuate misconceptions among their group (one comment), and using students who are working at different paces through the material (one comment). Two foreign language teachers also noted that divergent student schedules and paces made it difficult to set up synchronous collaborations.

Similarly, a few math teachers noted two additional problems that could challenge online collaboration: students working at different paces who would benefit differentially from a common live session (four teachers), and students using collaboration as a crutch to derive answers from peers (two teachers). Eight math students and three math teachers recommended basic requirements to encourage participation, warning some students would not benefit from collaborations without "requiring" or "mandating" participation:

> Forcing students to use the discussion board and to meet in the live lectures (Wimba). Because this is optional, they do not attend, even though it is offered. They would get that interaction if they would come [teacher].

## Discussion

The volume of recommendations received on follow-up surveys suggest online foreign language and math courses may be improved in key ways with the possibility of improving student perceptions. Interestingly, foreign language and math students' recommendations to improve their online courses were often generic to any subject area and touched on identical issues (e.g., provide timely feedback, model appropriate practice), suggesting these two subjects may not require different treatments than other subjects, but rather, more in-depth treatments owing to the challenging nature of the content. While a social studies teacher might get away with holding just a few synchronous sessions, a math teacher might not given the need to regularly model problem solving.

One of the key findings of this study relates to the lack of actual teaching, at least in the common sense of the word with a "live" educator meeting with students to work through content. Students in both foreign language and math courses believed they were spending too much time in readings, course notes, and worksheets, with limited access to a teacher. Both foreign language and math students also noted teacher modeling was required for their subjects, including teachers working through dialogue in foreign language and teachers going over problems in math. For teaching and modeling purposes, both foreign language and math students recommended teachers employ either asynchronous tools or preferably synchronous tools. Teachers can use many asynchronous tools to record explanations for student playback. For example, Bernard (2009) described her use of *Voki* mini-avatars in math to play back her typed notes and explanations. Representatives of the Field Institute for Mathematical Research suggest synchronous tools are key for online math instruction:

> One of the key tools for an online learning environment for mathematics will be a shared whiteboard (and possibly synchronous voice and/or video). This is necessitated by the

> frequent need in mathematics for students and/or the teacher to discuss ideas in free-form while simultaneously editing mathematical information (Gadanidis et al., 2002, p. 10).

Beyond live instruction, both foreign language and math students also recommended teachers supplement the material that is already provided to them in a course shell with elements such as recorded presentations and content supplements. Following the principles of "content embeddedness," other researchers have recommended foreign language teachers record children's books and/or textbooks in the target language "to increase their vocabularies and to model reading strategies" (Hall and Campbell, 2007, p. 35). Commercial products such as Apangea Learning's *SmartHelp* tutorials can supplement math content with students talking, chatting, or screen sharing with online certified teachers retained by the developer (Huffmyer, 2008). The fee-based *Hotmath* Web site is also available for students to view step-by-step solutions to odd-numbered problems from popular math textbooks and review videos of the sort desired by students in this study (Niess, 2007). Students may also find the free online resource *S.O.S. Mathematics* useful with its problem-solving tutorials (Tuttle, 2008). Given the cost of many commercial products, it's unclear if virtual schools with limited budgets will be able to provide such products.

Another key recommendation by both foreign language and math students in this study was for teachers to provided timely feedback on student questions and assignments. Just-in-time feedback was seen as important in these two subject areas where content is cumulative and concepts build on one another. Without timely feedback, students can quickly fall behind.

The importance of feedback has been stressed in numerous studies of online foreign language learning. Stepp-Greany (2002) noted students of low ability or limited prerequisite knowledge may require additional instructor facilitation or they may perceive instructional elements negatively. Even university students using Web-based materials to learn a foreign

language reported meaningful feedback was one of the four most important elements contributing to a perception of usefulness of Web-based learning (Felix, 2001). In a small case study of six graduate students enrolled in an online course about technology-enhanced language learning, Hara and Kling (1999) reported students desired more instructor feedback given the lack of physical cues in the online environment. As a supplement to instructor feedback, online grammar, vocabulary, listening comprehension, and reading comprehension exercises can be utilized to provide students with immediate feedback as shown by Sagarra and Zapata (2008).

Timely response to questions has also been shown to be important in math instruction. In a study by O'Dwyer et al. (2007), students in a virtual Algebra I course were given daily access to an on-site teacher not certified in math to assist students with questions, and 59.6% of students reported asking the on-site assistant questions either a few times per week or daily. The findings suggest many math students would utilize on-site assistants if available, however it's unclear whether the infrastructure of an online teacher backed up by a school-based assistant is financially feasible to every virtual school or district.

Both foreign language and math students suggested their content was more challenging than other subject areas. Foreign language students recommended more authentic opportunities to help address this complexity. In their pyramid of seven skills for online language teachers, Hampel and Stickler (2005) noted teachers creatively choosing from a myriad of online resources and tools to design authentic activities was the sixth most challenging competency. Simon (2008) suggests language educators should leverage technology in teaching, noting the Internet in particular has the ability to expose students to "authentic language, material, and audiences" (p. 6). Tuttle (2007) describes numerous Web-based resources that can be found in a target language and lend authenticity to language learning including: audio music and newscasts;

movies and television shows; images geotagged by foreign locations; and advertisements of foreign products.

Experienced online teachers have been found to regularly "build in course components to reflect the interests of students" (DiPietro, Ferdig, Black, & Preston, 2008, p. 21). Emphasizing content relevance with examples from a student's background and interests, as well as illustrating connections to future work, have been shown to predict ninth grade math students' affective learning or self-directedness and thinking about math as a subject/career to pursue (Mottet, Garza, Beebe, Houser, Jurrells, & Furler, 2008). Online courses can readily leverage a number of Internet databases available from public sources such as NASA, the U.S. Census Bureau, and the Central Intelligence Agency (C.I.A.) to provide students with existing data for use in mathematical problems (Ou & Zhang, 2006). The ever-increasing supply of online video is another existing data source that can be leveraged to help students explore real-world applications of math (Bryan, 2005; Charles, 2008; Niess & Walker, 2009).

In the current study, both foreign language and math students desired more opportunities for collaboration with their peers either via asynchronous or synchronous tools. Added group projects and peer tutoring were recommended. In a study of 63 foreign language learners in Australia and the U.S. using the Web in a blended or fully distant mode, Felix (2001) reported students had a strong preference for working with partners (35%) or groups (44%) rather than alone (21%). Felix (2001) cites disadvantages to online environments that emphasize Web-based materials without tending to community and communication, including limited speaking practice, minimal interactions with the teacher and peers, and inadequate feedback (Felix, 2001). Research has shown speaking skills tend to be similar for online and offline students or slightly better for offline students, suggesting some online environments may not be adding much to the

acquisition of oral proficiency without an oral communication component (Adair-Hauck et al., 1999; Chenoweth & Murday, 2003; Chenoweth, Ushida, & Murday, 2006; Payne & Whitney, 2002). Strambi and Bouvet (2003) recommended two design considerations for distance foreign language courses, including the need to support student interaction with authentic audiences. A number of applications and resources are available to support authentic conversation online, including videoconferencing (Hampel & Stickler, 2005) and immersive environments (Sykes, Oskoz, & Thorne, 2008).

Similarly, in math, one strategy to ensure students are getting needed "explanations" of math content is to support more student-teacher and student-student interaction in the online course. As noted by Steinman (2007, p. 46) and others, "students' perceptions of online courses can be negative if they experience large transactional distance with the instructor and with other students...." Mathematics educators note "on-line collaboration should be available so the on-line experience is that of a community of learners rather than individuals doing and learning mathematics in isolation" (Gadanidis et al., 2002, p. 15). Collaborative activities can not only help students receive more explanations of math content, but also foster explaining activities useful in comprehension. For example, Graham and Hodgson (2008) described their use of both chat and discussion boards in support of intermediate algebra and secondary geometry classes. Prompting questions provided students with the opportunity to explain math concepts using important vocabulary, and students using discussion tools "exhibited significant improvements in their use and recognition of math vocabulary" (p. 27).

In addition to using traditional discussion boards and chats in online courses, students could also use new Web 2.0 tools such as wikis, blogs, and podcasts to collaborate as they resolve or present group responses to problems. Tuttle (2007, p. 34) notes podcasts are a good

way for math students to "synthesize their learning about concepts like functions." Fahlberg-Stojanovska, Fahlberg, and King (2008) describe the production of student "mathcasts" through the popular *Voicethread* tool with students responding to instructor problems using written annotations or audio. Mader and Smith (2008) recommend placing students in blog groups who take responsibility for defining key concepts and explanations for their peers during assigned weeks, both helping the teacher assess student understanding and helping other students review course material. Private wikis for a class such as those provided by *Socialtext* offer another forum for students to summarize a lecture or check peer work (Oishi, 2007).

A final explanation for lower student ratings of some foreign language and math courses was suggested in the form of inadequate student dispositions such as effort and perseverance and taking the initiative to contact and work more actively with teachers. Teachers discussing online foreign language learning in a study by Murphy (2002) noted weaker students would not adapt to new roles that required increased responsibility. In online foreign language courses, there is often an assumption that students will take advantage of optional exercises and listening to address their own weaknesses, yet research tends to demonstrate the opposite (Jones & Youngs, 2006). Often there are clues that students lack self-directedness as manifested in their behaviors. In her study of 30 college students taking online courses, Ushida (2005) noted that you could predict students who were motivated to learn a foreign language based on their participation in optional online exercises such as chats.

While it may seem contrary to the term, most agree teachers have a role to play in supporting student "self-directedness." In a longitudinal study of 13 hybrid online courses offered over a three-year period, Chenoweth et al. (2006) reported students consistently desired more assistance from their teachers to understand assignment due dates. The authors concluded

both teachers and students needed to take responsibility with teachers checking on student progress and site usage and students keeping up with assigned work. Mottet et al. (2008) found in their study of 497 ninth grade students that teacher clarity behaviors for providing organized outlines, examples, explanations, and reviews predicted math students' affective learning or self-directedness. Researchers have noted that teachers need to play a role in structuring tasks and helping students effectively utilize resources (Compton, 2009, p. 88; Doughty & Long, 2003; Ushida, 2005). Hampel (2006) notes language learners given access to multi-modal tools such as the Lyceum audio-conferencing suite with chat, whiteboard, image and file sharing, and document construction, will not necessarily possess the competencies to use the suite for learning without appropriately structured tasks that encourage and scaffold proper use of the suite's affordances.

In addition to teachers prompting students via tasks, some researchers have also experimented with systems to help students better self-regulate their learning. For example, in a study with 99 Taiwanese college students enrolled in a Freshmen English course, a Web-based prompt that asked students to self-monitor their learning with inputs such as time on task, adapted processes, and predicted test scores, led to higher assessment and motivational scores (Chang, 2007). Hodges (2008) found 125 undergraduates in a Web-based algebra and trigonometry course who were sent weekly motivational email messages designed to promote self-efficacy and self-regulation scored higher on a self-efficacy measure. Further, regression analyses indicated a weak but positive relationship between self-efficacy and math achievement. In another study, the use of female "interface agents" that were scripted to promote self-efficacy in engineering-related fields led to "more positive beliefs about math and hard sciences" and "greater self-efficacy" in middle school students (Plant, Baylor, Doerr, & Rosenberg-Kima,

2009, p. 213). Greater self-efficacy manifested in higher performance on math assessments in this study as well. Kramarski and Gutman (2006) incorporated metacognitive questions in e-learning with 65 ninth grade students studying linear functions. Students prompted to reflect on their processes and consider the nature of problems, connections to other work, and appropriate strategies, outperformed students in control groups on problem solving tasks and mathematical explanations (Kramarski & Gutman, 2006).

## Conclusions

The follow-up surveys utilized in this study sought explanation for some of the significantly lower student ratings of foreign language and math courses compared to student ratings of courses in other subject areas. To our surprise, student and teacher explanations and recommendations for improvement were somewhat generic and applicable to any online course regardless of subject area. However, comments suggest the difficult nature of foreign language and math content paired with the need for regular teacher modeling and communication in order to effectively convey this content may make the teaching of these subjects online a more challenging prospect than the teaching of other subjects online. It's not that foreign language and math teachers were necessarily teaching their online courses any differently than social studies or science teachers, but rather the nature of foreign language and math content may place added demands on students and require teachers to teach their courses in a more engaged way. The base level of teacher presentation and communication required in a foreign language online course to achieve student understanding and satisfaction may be completely different than the base level of teacher presentation and communication required in an English/language arts or social studies online course. Given that NCVPS currently trains all of its online teachers via a common online course (Learn NC, 2010), there may be room for improvement with more specialized preparation

courses that emphasize the critical nature of modeling, technology resource utilization, and communication in foreign language and math courses.

## References


Adair-Hauck, B., Willingham-McLain, L., & Youngs, B. (1999). Evaluating the integration of technology second language learning. *CALICO Journal, 17*(2), 269-306.

Bernard, S. (2009). How to teach with technology. *Edutopia, 5*(3), 22-27.

Bernard, R. M., Abrami, P. C., Lou, Y., Borokhovski, E., Wade, A., Wozney, L. (2004). How does distance education compare with classroom instruction? A meta-analysis of the empirical literature. *Review of Educational Research, 74*(3), 379-439.

Blake, R., Wilson, N., Cetto, M., & Pardo-Ballester, C. (2008). Measuring oral proficiency in distance, face-to-face, and blended classrooms. *Language Learning & Technology, 12*(3), 114-127.

Bryan, J. A. (2005). Video analysis: Real-world explorations for secondary mathematics. *Learning & Leading with Technology, 32*(6), 22-24.

Cahill, D., & Cantanzaro, D. (1997). Teaching first-year Spanish online. *CALICO Journal, 14*(2-4), 97-114.

Cavanaugh, C. S., Barbour, M. K., & Clark, T. (2009). Research and practice in K-12 online learning: A review of open access literature. *International Review of Research in Open and Distance Learning, 10*(1), 1-22.

Chang, M. M. (2007). Enhancing Web-based language learning through self-monitoring. *Journal of Computer-Assisted Learning, 23*(3), 187-196.

Charles, M. (2008). Measuring digital images in math and science. *Learning & Leading with Technology, 35*(6), 28-30.

Chenoweth, N., & Murday, K. (2003). Measuring student learning in an online French course. *CALICO Journal, 20*(2), 285-313.

Chenoweth, N., Ushida, E., & Murday, K. (2006). Student learning in hybrid French and Spanish courses: An overview of language online. *CALICO Journal, 24*(1), 115-145.

Cohen, J. (1988). Statistical Power Analysis for the Behavioral Sciences (2nd ed.). Lawrence Erlbaum Associates.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155-159.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155-159.

Compton, L. K. L. (2009). Preparing language teachers to teach online: A look at skills, roles, and responsibilities. *Computer Assisted Language Learning, 22*(1), 73-99.

Conacher, J. E., & Royall, F. (1998). An evaluation of the use of the Internet for the purposes of foreign language learning. *Language Learning Journal, 18*, 37-41.

Coverdale-Jones, T. (2000). The use of video-conferencing as a communication tool for language learning: Issues and considerations. *IALL Journal, 32*(1), 27-40.

Creswell, J. W., & Clark, V. L. P. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage Publications.

Daniels, B. M. (2008, November). Motivation, academic success, and learning environments: Comparing high school face-to-face and online courses. Unpublished doctoral dissertation. Fairfax, Virginia: George Mason University.

DiPietro, M., Ferdig, R. E., Black, E. W., & Preston, M. (2008). Best practices in teaching K-12 online: Lessons learned from Michigan Virtual School teachers. *Journal of Interactive Online Learning, 7*(1), 10-35.

Doughty, C. J., & Long, M. H. (2003). Optimal psycholinguistic environments for distance foreign language learning. *Language Learning and Technology, 7*(3), 50-80.

Fahlberg-Stojanovska, L., Fahlberg, T., & King, C. (2005). Mathcasts: Show-and-tell math concepts. *Learning & Leading with Technology, 36*(1), 30-31.

Felix, U. (2001). The Web's potential for language learning: The student's perspective. *ReCALL, 13*(1), 47-58.

Fleisher, P. (2008). ExploreLearning Gizmos: Interactive simulations exploring math and science concepts. *Tech & Learning, 28*(8), 18.

Gadanidis, G., Graham, L., McDougall, D., & Roulet, G. (2002). On-line mathematics: Visions and opportunities, issues and challenges, and recommendations. Toronto: The Fields Institute for Research in Mathematical Sciences.

Garcia, M. D. M., & Romero, I. M. (2009). The influence of new technologies on learning and attitudes in mathematics in secondary students. *Electronic Journal of Research in Educational Psychology, 17*(7), 369-396.

Graham, J., & Hodgson, T. (2008). Speaking math: Using chat in the multicultural math classroom. *Learning & Leading with Technology, 35*(5), 24-27.

Green, A., & Youngs, B. (2001). Using the Web in elementary French and German courses: Quantitative and qualitative study results. *CALICO Journal, 19*(1), 89-123.

Gruber-Miller, J., & Benton, C. (2001). How do you say "MOO" in Latin? Assessing student learning and motivation in beginning Latin. *CALICO Journal, 18*(2), 305-338.

Hall, L. D., & Campbell, A. E. (2007). Online resources and instructional strategies for K-8 ELL. *Learning & Leading with Technology, 35*(2), 34-36.

Hampel, R. (2006). Rethinking task design for the digital age: A framework for language teaching and learning in a synchronous online environment. *ReCALL, 18*(1), 105-121.

Hampel, R., & Stickler, U. (2005). New skills for new classrooms: Training tutors to teach languages online. *Computer Assisted Language Learning, 18*(4), 311-326.

Hara, N., & Kling, R. (1999). Students' frustrations with a Web-based distance education course. *First Monday, 4*(12). Retrieved January 27, 2010, from: http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/view/710

Hauck, M., & Youngs, B. L. (2008). Telecollaboration in multimodal environments: The impact on task design and learner interaction. *Computer Assisted Language Learning, 21*(2), 87-124.

Hodges, C. B. (2008). Self-efficacy, motivational email, and achievement in an asynchronous math course. *Journal of Computers in Mathematics and Science Teaching, 27*(3), 265-285.

Huffmyer, S. (2008). Succeeding at math. *Learning & Leading with Technology, 36*(3), 34-35.

Hughes, J. E., McLeod, S., Brown, R., Maeda, Y., & Choi, J. (2007). Academic achievement and perceptions of the learning environment in virtual and traditional secondary mathematics classrooms. *The American Journal of Distance Education, 21*(4), 199-214.

Johnson, M. E. (2002). The role of computer-supported discussion for langauge teacher education: What do the students say? *CALICO Journal, 20*(1), 59-79.

Jones, C. M., & Youngs, B. (2006). Teacher preparation for online language instruction. In P. Hubbard & M. Levy (Eds.), *Teacher Education in CALL* (pp. 267-280). Philadelphia, PA: John Benjamins Publishing Company.

Kolb, L. (2008). Enhanced podcasts: A new twist on an old tool. *Learning & Leading with Technology, 36*(2), 33.

Kramarski, B., & Gutman, M. (2006). How can self-regulated learning be supported in mathematical E-learning environments? *Journal of Computer-Assisted Learning, 22*(1), 24-33.

Learn NC. (2010). Teaching online courses: Carolina online teacher program. Retrieved March 19, 2010, from http://www.learnnc.org/courses/catalog/bb-DATOC1

Lee, L. (2005). Using Web-based instruction to promote active learning: Learners' perspectives. *CALICO Journal, 23*(1), 139-156.

Mader, J., & Smith, B. (2008). Blogging right along. *Learning & Leading with Technology, 35*(8), 36-37.

Mottet, T. P., Garza, R., Beebe, S. A., Houser, M. L., Jurrells, S., & Furler, L. (2008). Instructional communication predictors of ninth-grade students' affective learning in math and science. *Communication Education, 57*(3), 333-355.

Murphy, E. (2002). New tools in an old trade: Teachers talk about use of the Internet in the teaching of French as a second or foreign language. *The Canadian Modern Language Review, 59*(2), 215-235.

Murphy, E., & Coffin, G. (2003). Synchronous communication in a Web-based senior high school course: maximizing affordances and minimizing constraints of the tool. *The American Journal of Distance Education, 17*(4), 235-246.

Murphy-Judy, K., & Youngs, B. L. (2006). Technology standards for teacher education, credentialing, and certification. In P. Hubbard & M. Levy (Eds.), *Teacher Education in CALL* (pp. 45-60). Philadelphia, PA: John Benjamins Publishing Company.

Nagata, N. (1996). Computer vs. workbook instruction in second language acquisition. *CALICO Journal, 14*(1), 52-75.

Niess, M. L., & Walker, J. M. (2009). This rock 'n' roll video teaches math. *Learning & Leading with Technology, 36*(8), 36-37.

Niess, M. L. (2007). Hotmath homework help. *Learning & Leading with Technology, 35*(2), 42-43.

Niess, M. L. (2005). Scaffolding math learning with spreadsheets. *Learning & Leading with Technology, 32*(5), 24-25, 48.

O'Dwyer, L. M., Carey, R., & Kleiman, G. (2007). A study of the effectiveness of the Louisiana algebra I online course. *Journal of Research on Technology in Education, 39*(3), 289-306.

Oishi, L. (2007). Working together: Google Apps goes to school. *Tech & Learning, 27*(9), 46, 48.

Ou, C., & Zhang, K. (2006). Teaching with databases: Begin with the Internet. *Tech Trends, 50*(5), 46-51.

Payne, J. S., & Whitney, P. J. (2002). Developing L2 oral proficiency through synchronous CMC: Output, working memory, and interlanguage development. *CALICO Journal, 20*(1), 7-32.

Pierce, R., & Ball, L. (2009). Perceptions that may affect teachers' intention to use technology in secondary math classes. *Educational Studies in Mathematics, 71*(3), 299-317.

Plant, E. A., Baylor, A. L., Doerr, C. E., & Rosenberg-Kima, R. B. (2009). Changing middle school students' attitudes and performance regarding engineering with computer-based social models. *Computers & Education, 53*(2), 209-215.

Rice, K. (2006). A comprehensive look at distance education in the K-12 context. *Journal of Research on Technology in Education, 38*(4), 425-448.

Sagarra, N., & Zapata, G. C. (2008). Blending classroom instruction with online homework: A study of student perceptions of computer-assisted L2 learning. *ReCall, 20*(2), 208-224.

Salaberry, M. R. (2001). The use of technology for second language learning and teaching: A retrospective. *The Modern Language Journal, 85*(1), 39-56.

Sanchez, K., Zimmerman, L., & Ye, R. (2004). Secondary students' attitudes toward mathematics. *Academic Exchange Quarterly, 8*(2), 56-60.

Simon, E. (2008). Foreign language faculty in the age of Web 2.0. *EDUCAUSE Quarterly, 31*(3), 6-7.

Steinman, D. (2007). Educational experiences and the online student. *Tech Trends, 51*(5), 46-52.

Stepp-Greany, J. (2002). Student perceptions on language learning in a technological environment: Implications for the new Millenium. *Language Learning and Technology, 6*(1), 165-180.

Strambi, A., & Bouvet, E. (2003). Flexibility and interaction at a distance: A mixed-mode environment for language learning. *Language Learning and Technology, 7*(3), 81-102.

Sullivan, N., & Pratt, E. (1996). A comparative study of two ESL writing environments: A computer-assisted classroom and a traditional oral classroom. *System, 29*(4), 491-501.

Summer, J., Waigandt, A., & Whittaker, T. (2005). A comparison of student achievement and satisfaction in an online versus a traditional face-to-face statistics class. *Innovative Higher Education, 29*(3), 233-250.

Sykes, J. M., Oskoz, A., & Thorne, S. L. (2008). Web 2.0, synthetic immersive environments, and mobile resources for langauge education. *CALICO Journal, 25*(3), 528-546.

Tudini, V. (2003). Using native speakers in chat. *Language Learning and Technology, 7*(3), 141-159.

Tunison, S., & Noonan, B. (2001). On-line learning: Secondary students' first experience. *Canadian Journal of Education, 26*(4), 495-511.

Tuttle, H. G. (2007). Livening up foreign language. *Technology and Learning, 28*(4), 40-42.

Tuttle, H. G. (2007). Making math work. *Tech & Learning, 27*(8), 32, 34.

Tuttle, H. G. (2008). Technology = math success. *Tech & Learning, 28*(7), 30, 32.

Ushida, E. (2005). The role of students' attitudes and motivation in second language learning in online courses. *CALICO Journal, 23*(1), 49-78.

VanOlphen, M., Hofer, M., & Harris, J. (2009-10). Grounded tech integration: Languages. *Learning & Leading with Technology, 37*(4), 26-28.

Wang, Y., & Sun, C. (2001). Internet-based real time language education: Towards a fourth generation distance education. *CALICO Journal, 18*(3), 539-561.

Warschauer, M. (1996). Comparing face-to-face and electronic discussion in the second language classroom. *CALICO Journal, 12*(2-3), 7-26.

Weiner, C. (2003). Key ingredients to online learning: Adolescent students study in cyberspace--the nature of the study. *International Journal on E-Learning, 2*(3), 44–50.

White, C. (2006). The distance learning of foreign languages. *Language Teaching, 39*(4), 247-264.

Wu, W. C., & Marek, M. (2009). The impact of teleconferencing with native English speakers on English learning by Taiwanese students. *International Journal on E-Learning, 8*(1), 107-126.

Yang, S., & Chen, Y. J. (2007). Technology enhanced language learning: A case study. *Computers in Human Behavior, 23*(1), 860-879.

Youngs, B. L. (2007). Teaching teachers: Methodological questions for the online environments. In M. A. Kassen, R. Z. Lavine, K. Murphy-Judy, & M. Peters (Eds.), *Preparing and Developing Technology-Proficient L2 Teachers* (pp. 67-90). San Marcos, TX: The Computer-Assisted Language Instruction Consortium (CALICO).