Noteflight as a Web 2.0 Tool for Music Theory Pedagogy

By Brendan McConville

The term Web 2.0 has played a significant role in the evolution of technology worldwide during the past decade. Tim O'Reilly, founder and CEO of O'Reilly Media, and co-founder of the annual Web 2.0 Summit,[1] has pointed to the "bursting of the dot-com bubble in the autumn of 2001" as a "turning point for the web."[2] He has stated, "bubbles and consequent shakeouts" often "mark the point at which an ascendant technology is ready to take its place at center stage."[3] In 2005 he defined Web 2.0 as:

> …the network as platform, spanning all connected devices; Web 2.0 applications are those that make the most of the intrinsic advantages of that platform: delivering software as a continually-updated service that gets better the more people use it, consuming and remixing data from multiple sources, including individual users, while providing their own data and services in a form that allows remixing by others, creating network effects through an "architecture of participation," and going beyond the page metaphor of Web 1.0 to deliver rich user experiences.[4]

He has also identified examples of web resources that demonstrate the migration from Web 1.0 to Web 2.0, such as "Ofoto à Flickr" and "Britannica Online à Wikipedia."[5] Corporations, media outlets, and

[1] For more information regarding this event see "About Web 2.0 Summit" at http://www.web2summit.com/web2011/public/content/about.

[2] Tim O'Reilly, "What Is Web 2.0: Design Patterns and Business Models for the Next Generation of Software," *International Journal of Digital Economics* 65 (2007): 17.

[3] Ibid, 17.

[4] Tim O'Reilly, "Web 2.0: Compact Definition?" *O'Reilly Radar - Insight, Analysis, and Research about Emerging Technologies* (web log), October 1, 2005. Accessed July 1, 2011. http://radar.oreilly.com/archives/2005/10/web-20-compact-definition.html.

[5] Tim O'Reilly, "What Is Web 2.0: Design Patterns and Business

popular culture have all explored the potential advantages of using Web 2.0 applications to facilitate improved communication with and among audiences. Music teachers have begun to do the same.[6]

For theory instructors, the following question might arise: "Is there a relatively uncomplicated method of utilizing interactive musical notation within the Web 2.0 network?" Consider the following scenarios:

- You are teaching a Freshman counterpoint class of 30 students. You would like to post a cantus firmus to a website where your students could: access it; add counterpoint to it and re-post a new version; save successive versions of it, and; collaborate with other students to write species exercises against it.
- You are teaching a chromatic harmony course with 25 students. You would like to embed a student-modifiable part-writing template right into your learning management system (LMS) blog.
- You are teaching an undergraduate aural skills course of 27 students. You would like to provide your students with an online location for accessing hearable melodies that you feel they need to practice to sharpen their sight-singing skills.

Models for the Next Generation of Software," *International Journal of Digital Economics* 65 (2007): 18.

[6] For some examples of scholarly literature on music educators' pursuits in using Web 2.0 technologies, see Mikka Salavuo, "Social Media as an Opportunity for Pedagogical Change in Music Education," *Journal of Music, Technology and Education* 1, no. 2-3 (2008): 121-36; Steve Cooper, Crispin Dale, and Steve Spencer, "A Tutor in Your Back Pocket: Reflections on the Use of iPods and Podcasting in an Undergraduate Popular Music Programme," *British Journal of Music Education* 26, no. 1 (2009): 85-97; and Eddy K. M. Chong, "Blogging Transforming Music Learning and Teaching: Reflections of a Teacher-researcher," *Journal of Music, Technology and Education* 3, no. 2-3 (2011): 167-82.

If the above strategies seem like attractive pedagogical options, you may wish to consider Noteflight (hereafter "Nf") as a tool for theory instruction.

This review provides a critical evaluation of the online music notation software Nf (www.noteflight.com), a web application that acutely seeks to harness the power of the "network as a platform." Nf is a subscription and cloud-based notation editor where students can join a community of users to create, edit, store, and share musical scores (note: the term "cloud" will be discussed in detail in a moment). They can also access, edit, and comment on their classmates' scores within the community. Most specifically, this review will assess Nf as a tool for music theory pedagogy in higher education.

Nf President Joe Berkovitz and his team maintain that their vision for the software grew from frustration with expensive notation applications such as Finale and Sibelius.[7] In 2007, Berkovitz, a New England Conservatory-trained musician, also felt that musicians needed notation software fully online in order to successfully evolve the "reason music notation was developed in the first place," which is, "to efficiently communicate musical ideas."[8] They also explain that most notation software "treats the Internet as an afterthought."[9] In the pages that follow, I will first discuss the software's functionality within the context of practical theory teaching situations. Second, I will report on research from our School of Music's recent use of Nf in graduate and undergraduate courses. Finally, I will provide conclusions about the software, which are based on both teacher and student evaluations.

What is Nf and What Can it Offer in Theory Teaching Situations?

I will begin by describing four principal characteristics of Nf's business model and Web 2.0 architecture. I will consider beneficial and problematic aspects of each characteristic, as well as envision how each might affect theory-teaching situations. Although a

[7] Elizabeth Gazda, VP of Business Development, telephone interview by author, June 21, 2011.

[8] Ibid.

[9] For more information regarding the origins of Nf, see "About Nf: the Story of Nf," at http://www.noteflight.com/info/about.

comprehensive list of possible Nf uses in music theory pedagogy would be both impossible and impractical, each characteristic's section will conclude with a suggestion or two, I hope stimulating the reader's imagination.

1. A Revised Approach to Notation Software Pricing

One of Berkovitz's initial frustrations with notation software was that its expense deterred many musicians from ever having their own copy of a usable program. Thus, Nf redesigned pricing models for notation software. Before considering the helpful and problematic aspects of the models for higher education, I must first outline Nf's account categories with pricing.[10]

- Individual: The two individual account categories are the "Basic" (free) and "Crescendo" (pay; $7.95/month, $49/year) options. Basic accounts restrict more advanced software features such as unlimited score saving, direct MIDI note entry, and use of the full SONiVOX-sampled library of sounds.[11] Though most instructors will opt for Nf Campus accounts (below), Basic accounts are a nice way for instructors to preview Nf's design and functionality before purchasing. Basic and Crescendo accounts also allow users to access the global Nf community of shared scores amassed on the site's servers, found in the "Browse" menu of an account.

- Higher Education: At Nf-adopted institutions, student accounts reside in the Nf Campus version of the full software. Campus adoption has two models: university-pay and student-pay options. With either option, a private community is set up for the institution accounts to share and save all of their own scores to their own partition of the Nf servers. In the university-pay option, the school pays $30 per year per account within the community, while in the student-pay option each student pays $49 per year or $7.95 per month for accounts. Nf Campus also allows institutions to link Nf-generated content with their school's LMS. For this reason, Nf charges a one-time setup fee for adopting institutions; the price of this fee is based on the size of the school.

- K-12 Education: K-12 educational settings use versions of the software called Nf Classroom and Nf District. Like Campus, Classroom can connect to a school's LMS, such as Haiku. For K-12 institutions that do not use a LMS, Classroom provides a private Nf website that offers the same community setting of a LMS. Classroom costs $195 per year for up to 250 users on one private site. A District community is designed for larger enrollments (i.e. school districts) and administrators must contact Nf for a price quote. Finally, the new Nf Teacher edition costs $295 per year and allows a single user to maintain 5 private sites with up to 75 users per site.

- Private Instruction: Nf Studio uses the same private website design as Classroom, but costs $150 per year and allows for up to 75 users per site.

It is evident that Nf has disrupted the normal methodology for purchasing school notation software. Institutions are faced with the task of reexamining how and where they want their students to use the software, as well as who should pay for it. With Nf, there are no seat licenses for a lab, rather, there are accounts floating in a "cloud" that are required of each student. Schools using the university-pay model must purchase individual student copies annually. This is somewhat different than purchasing shared and stationary seat licenses. Comparing the university-pay price of Nf to Finale and Sibelius lab licenses is thus like comparing apples to oranges. Even though a single license (account) for Nf is cheaper than a Finale or Sibelius seat license, in many cases an institution will have to purchase more of them. Consider the following: should your department's theory/composition area make use of (1) a lab with 30 licenses of Finale at $130 per seat (plus $65 annually for license upgrades), (2) a lab with 30 licenses of Sibelius at $145 per seat (plus $70 for periodic license upgrades, which come about every 2-3 years), or (3) 100 online licenses of Nf at $30 per year for each individual student enrolled in theory/composition courses

[10] For Nf's descriptions of account categories see http://www.noteflight.com/info/learn_more. Though category names and prices are subject to change, these details were current at press time.

[11] For more information on SONiVOX products and sample technology, see http://www.sonivoxmi.com/.

(all upgrades are included in price)?[12] Depending on a department's enrollment and usage, it might be more expensive for an institution to budget (in the university-pay model) for Nf than it would be for Finale or Sibelius. In the above example, over a 10-year time frame a school would pay $21,450 in license fees for Finale, and $30,000 for Nf accounts.[13] Not only should institutions weigh average enrollments with prices, but they should also *carefully* consider their precise agenda for class use of notation software. Nf could end up being cheaper—or more expensive—than other software, but it should ultimately fit the department's needs. The question is: what exactly does Nf offer that Finale and Sibelius do not? The remaining three sub-sections of this section hope to answer this question.

The student-pay price model is another redesigned approach to institutional adoption of notation software.[14] Nf affirms that approximately two thirds of their client institutions in higher education currently use this option.[15] The company's approach here is to make the software a "textbook fee" for students and

[12] Finale and Sibelius prices listed here are quotes only, and readers are encouraged to contact a reseller for precise license fees for their institutions. Though the comparison here uses an estimation of 100 Nf licenses (i.e. students taking theory/comp courses), this will vary greatly from school to school. Finale and Sibelius licenses are *stationary*, or installed on only one computer at a time. Since Nf is a web-based application with *"cloud" storage* it can be accessed anywhere. For this reason, departments adopting Nf must count the number of total student users requiring a notation editor, rather than the total lab computers available for notation editor installation.

[13] These figures are based on the following rationale: Finale: YR1 = ($130 x 30 licenses) and YRs2-10 = ($65 x 30 licenses); YR1 = $3,900 and YRs2-10 each = $1,950; [$3,900 + ($1,950 x 9 years)] = $21,450. Nf: YRs1-10 = $30 x 100 accounts each year; YRs1-10 = $3,000 x 10 years = $30,000. These figures do not consider additional required hardware costs or price changes that may arise. Here I selected to specifically compare Nf to Finale because our institution has recently used both of these programs.

[14] I acknowledge that some institutions might already require students to purchase individual copies of Finale or Sibelius, though few require the full version of these (Finale and Sibelius educational copies are $350 and $295, respectively).

[15] Elizabeth Gazda, VP Business Development, *Nf*.

remove an institutional software expense (and perhaps making it more attractive for adoption). In a positive sense, this option relieves the school from paying up-front costs for software based on projected enrollments in future years. Yet this alternative might be problematic for many institutions, as it has the potential to place a financial burden on the student, especially if a standard textbook is still required for their course.

2. An Online Music Notation Program

Nf currently uses Adobe Flash technology to deliver its program completely online, which generates two very valuable aspects of the software for theory instructors. First, just as Nf certifies, "all your instructional materials are accessible from any online computer from the moment they're created. Students can access and work with scores wherever they happen to be — in the classroom, in a computer lab, in a dorm room or at home."[16] The full software has the ability to "appear" at any Flash, Internet connected location; indeed, "the lab" is made mobile. Consequently, students using Nf in a written skills course who might be expected to complete a short project are not able to use the excuses "the lab was closed," or, "my computer is broken" at deadlines. Multiple computer locations can work. The lab's "mobility" can also cut down on the common excuse, "I couldn't print my homework," as Nf allows you to print from anywhere. Second, since Nf resides online, it is also possible to connect music created and stored in the software to other locations on the Internet, such as LMSs (e.g. Blackboard, Moodle) and private websites. Users can embed their notated music into other locations or paste links into websites that take students back into Nf for examples. Campus accounts permit Nf to integrate with LMSs that are Basic LTI (Learning Tools Interoperability) enabled, which includes systems such as Blackboard 9, Desire2Learn, and Moodle.[17] The company has posted several convenient tutorial videos on the Nf website that demonstrate the program's ability to

[16] See http://www. noteflight.com/info/learn_more_highered.

[17] For more information on Basic LTI and the IMS Global Learning Consortium's standards for connecting remote tools such as Nf to LMSs, see http://www.imsglobal.org/lti/index.html; for a list of Basic LTI compliant products see http://www.imsglobal.org/cc/statuschart.cfm.

integrate with LMSs.[18]

The benefits of fully online music notation software are not without drawbacks. First, students must have an Internet connection in order to do their work. Even in today's Internet-saturated environment there are plenty of students who do not have an Internet connection in their homes (though they could use campus locations). Second, even though many portable devices such as the Android tablet support Adobe Flash, a very important one does not: Apple. At present, students who wish to edit their Nf scores from their iPad, iPhone, or iPod will need to wait for an Apple supported mobile application. Thankfully, Nf says that one is under construction.[19] In fact, in May 2012 Nf announced their plan to move their entire platform to the Apple-compatible HTML5 language.[20] With this announcement came the new ability for users to view and play back their scores on their iOS devices, though, they will need to wait for Nf's completed migration in order to access the full editor from these devices. Third, despite being a very usable notation editor, Nf's current Flash platform simply does not enable the same kind of power and capabilities that software such as Finale and Sibelius can deliver. Its single-license price properly reflects this discrepancy in functionality. Nf's traditional features include inputting (via a mouse, keyboard shortcuts, or a MIDI controller), editing, printing, and saving one's music.[21] Beyond this, Nf's offerings trail those from the leaders in notation software. For instance, Nf has 32 score templates to choose from as users begin

[18] See http://www. noteflight.com/info/learn_more_highered to view these videos.

[19] Elizabeth Gazda, VP Business Development, Nf.

[20] See "Mobile, HTML5, Flash, and Noteflight," at http://blog.noteflight.com/2012/05/17/mobile-html5-flash-and-noteflight/.

[21] Incidentally, its saving/exporting features are actually stronger than those from some programs. Users can not only save music to Nf's servers, but they can export it as MIDI or MusicXML files—the latter being a format that allows other notation software (e.g. Finale and Sibelius) to open the file. Sibelius has not always offered MusicXML. Sibelius 6, for instance, reads MusicXML files yet requires a Dolet 5 plug-in to export them, which costs about $200. Sibelius 7 now includes full MusicXML export capability. Readers should be warned that not all notation programs offer MusicXML exporting, as some require a plug-in. For more information on MusicXML technology and software that supports it, see http://www.recordare.com/musicxml.

a new score and approximately 65 instrument types for playback. These provide a respectable number of options, but not as many as offered by Finale and Sibelius. The leading programs also provide larger vocabularies of staff and system lines, more document layout options, scanned-music importing (i.e. Finale's SmartScore and Sibelius's PhotoScore), and more plug-ins than Nf.[22] Yet the team at Nf pays careful attention to customer feedback regarding problems and requests concerning their software; updates could one day close this gap of functionality between Nf and the larger notation products.[23]

It is easy to envision specific examples where the theory classroom might benefit from online notation software. One such case is the ease of linking assignments for a written skills class to the course LMS. Teachers can build part-writing or short composition assignments in Nf and embed them directly into their LMS assignment board. Then, all of the student's assignment materials can be placed in one central location. Teachers can also make changes to assignments without uploading a new score to their LMS; the embedded content always changes with the saved Nf score. In addition, writing assignment templates that are placed online in the LMS enable students to *hear* their part-writing exercises as they work on them. This capability could likewise allow teachers to embed hearable musical examples into a blog or discussion board section (e.g. class notes) of the LMS.

Aural skills classes can take advantage of the "mobile" account functionality of Nf to support instruction. For instance, teachers can post hearable singing exercises to Nf so that students can practice with them from various private locations outside of the lab. Nf's capacity to connect with other Internet access points, as well as its account mobility, spawn attractive pedagogical possibilities.

[22] Sibelius and Finale both offer an assortment of plug-ins. Plug-ins range from composing, arranging, and analytical tools to proofreading. See www.sibelius.com and www.finale.com for more information on current plug-ins.

[23] See Nf's Facebook page for constant user questions, feedback, and requests for the company, which is found at https://www.facebook.com/noteflight.

3. A "Cloud" Based Infrastructure

Before engaging this characteristic of Nf, "cloud" computing first requires a proper definition. The National Institute of Standards and Technology has offered the following: "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."[24] In other words, a "cloud" server is an Internet self-storage facility; users rent space to amass their files. Popular "cloud" service websites such as Dropbox, Just Cloud, and Mozy also allow you to share the keys to your storage unit with others.

Content built within Nf likewise makes use of "cloud" storage and file sharing technology, engendering several benefits for theory instructors. First, the "cloud" facilitates smoother score passage between students and instructors. All work is saved online to the user's own depository of scores within their larger Nf community. The menu for accessing a personal storage area is called "Home" in Campus and Basic/Crescendo accounts. The saved work in the "cloud" can then be accessed by or shared with others, depending on the user's share setting for the score. Nf furnishes five options for sharing scores from the "Sharing" drop-tab.[25]

(1) Keep the score private. This option makes the score only accessible from the original user's "Home" menu.

(2) Share with individuals. This setting shares the score with specified Nf user names. The person sharing the score must also designate the level of shared access: "view only," "view and comment," or "make any change."

(3) Site members can view this score. In Campus, this setting enables the entire school community to view but not edit the score. In individual accounts, the community becomes the global network of Nf users. Community shared scores are accessed from the "Browse" menu.

(4) Site members can view and comment on this score. This choice allows members of the community to post comments to scores using the speech bubble option, which is discussed in Web 2.0 Communities and Social Media below.

(5) Site members can make any change to this score. This option authorizes anyone in the community to alter their score. There is no option for password in Nf.

Students who wish to share their work with only the instructor would select option two above. The design removes the intermediate steps of uploading a file to a server on one end and downloading it on another end. Students no longer need to email or even print up their scores for instructors: once it is saved it is accessible. Second, users need not worry about losing their saved work, since it is stored safely in the "cloud." Third, since work is constantly saved to Nf's servers, all versions of the working score are cataloged in the "Versions" drop-tab within the program. The cataloged versions are listed chronologically by the date and time of each save. Instructors are familiar with students who say they have started a homework assignment yet not finished it. Those who use Nf can verify this in the "cloud" server!

Nf's use of the "cloud," however, has a few drawbacks. First, the Internet requirement for the software means that students without connections cannot access their saved scores. This can again be a disadvantage for students who wish to continue their work at home. One possible way to circumvent this problem—though not without a bit of hassle—is to save a Nf score to a local disk as a MusicXML file and work with it offline in other software such as Finale NotePad or MuseScore (both are free). MusicXML files can then be moved back into Nf when the user is able to access an Internet connection. A second problem, and related to the first, is that users never really have their own copy of a native Nf file to save to their local disk or computer. There is no Nf file extension name; users can only transport files locally as MIDI and MusicXML types. True, these file types can be reopened in Nf, but there is

[24] U.S. Department of Commerce, National Institute of Standards and Technology, *The NIST Definition of Cloud Computing*, by Peter Mell and Timothy Grance, (Gaithersburg: Computer Security Division, 2011): 2.

[25] For options 3-5 below, the words "site members" are replaced by "anyone" in individual accounts (Basic/Crescendo).

always a degree of re-editing in this process.[26] Though the security of work saved in the "cloud" is comforting, some users still want a native, physical copy in hand. It is not known if Nf is working on an additional offline version of their software or even a native way to save files.

Music theory assignment strategies can often unfold in a manner that enables students to comprehend topics as they grow from one to the next; or as Michael Rogers has written, "each new achieved goal becomes a springboard for additional study."[27] In this regard, Nf's "Versions" tab can simplify assignment strategies that require constant revisions or expansions. For example, a fundamentals assignment sequence might include having students first build a major scale and later revise and annotate their scores to illustrate all of the diatonic intervals. Or, in a more advanced assignment sequence, students might compose a short melody and then subject it to subsequent compositional procedures such as harmonization, etc.. Other instances for using Nf might be for completing tasks with a given cantus firmus, ranging from species counterpoint, to figured and unfigured basses, outer-voice counterpoint settings, and melody harmonization. Instructors can post a cantus firmus template to the LMS and use it for multiple assignments. Student work is automatically saved to their student account on the Campus page and linked to their instructor's template. A cantus firmus assignment strategy can allow students to enter their account and review their assignments to study and observe musical growth from one assignment to the next.

4. Web 2.0 Communities and Social Media

Nf's various communities facilitate two practices that can potentially strengthen music theory instruction: collaboration and communication. First, since score sharing is an integral part of the Nf Web 2.0 community, there are favorable settings for theory student collaboration. Nf Campus gathers community-shared work by all

[26] I found that simple scores usually retained their appearance when exported, saved locally as a Music XML file, and then imported back into another Nf account. More complex scores were somewhat distorted, and score text was often misplaced in the imported scores or deleted altogether.

[27] Michael Rogers, *Teaching Approaches in Music Theory: an Overview of Pedagogical Philosophies*. Second ed. (Carbondale: Southern Illinois University Press, 2004), 40.

members of a music department into the "Browse" menu of an institutional account (within Nf's page, not in the LMS). The open forum of scores not only makes group projects within individual theory classes easy to execute and supervise, but it also fosters the unfettered exchange of musical ideas among students within a department. Students can (1) browse for their group's current project or share working scores privately with their collaborators, (2) compare their work with other student groups saved to the community, or (3) peruse any works from other students within the institution that are saved to the community. Of course, a school's LMS can certainly establish a sense of community on its own. One could wonder if instructors or students might just as well scan their scores and post them to their LMS for free. But scanned versions would not allow other users to edit the scores, which in turn could impede the exchange of musical ideas. Meanwhile, instructors can peek in on openly shared scores to track the progress of student collaborations.

Second, Nf communities are venues for social interaction, thanks to several tools that the program provides. Speech bubble tabs found above scores allow students and teachers to comment on the music, thereby creating work-specific dialogs. All speech bubble correspondence appears in this dedicated tab and not near a specific "floating" spot in the score (unfortunately). Users also have the option of marking their "Favorite" scores from the "heart tab" found in the menu options—a tool somewhat analogous to Facebook's "Like" button. The tool is useful in that it collates favorite scores into a special tab in the user's "Home" catalog of their account, which saves them time when they wish to return to a specific score. In late 2011, Nf introduced the "Forums" menu to the software. This menu assembles topical, blog-style discussion boards in either global or educational (e.g. Campus) communities. Having used social media in theory courses over the past several years, I have witnessed that students are very adept in utilizing this type of technology, and that it can enhance communication among them. For instance, my students often acknowledge that our class Facebook groups help them observe many contending analytical perspectives.[28] I remind them that not everything posted to the Internet is correct or constitutes a successful analysis; while at the

[28] In certain classes I set up Facebook groups as discussion forums outside of the standard LMS. I do not advocate such groups in all classes, however the forums are very popular in twentieth-century analysis courses and particular graduate seminars.

same time I value their critical assessment of numerous analytical interpretations. In many situations the students effectively teach each other, whether it is by way of examining their peers' clever *or* problematic contributions. Though Finale and Sibelius each include an online community connected to their software (Showcase and SibeliusMusic, respectively), Nf presently has a much greater ability to create a true communal online environment. Showcase is usable, but the community is not integrated into the software and users must upload and download scores to a server to share them. SibeliusMusic, which in 2012 has been redirected to ScoreExchange.com, is more of an online marketplace for buying and selling music.

However, there are several shortcomings found when attempting to utilize the Web 2.0 communities and social media experiences. First, overcrowding can develop in Campus communities. If 150 theory students at an institution all share their scores to the "Browse" menu it can be very difficult for students and teachers to find what they are looking for. A simple fix would be to have further classroom-specific subdivisions within the Campus "Browse" community. Second, there is currently no seamless connection between Nf's global community (accessible from Basic and Crescendo accounts) and the private Campus community. Campus accounts are closed environments and do not permit students or teachers to "cross over" into the global community. Granted, the passage should not necessarily be a two-way street (i.e. global users should not be able to access Campus communities), but it would be helpful for teachers to be able to access the global community scores for use in their classes. If this were possible, Nf could cultivate a shared repository for pedagogical resources and take full advantage of the "cloud." There are presently several Web 2.0 environments that offer shared pedagogical resources, and one of the best examples is YouTube, notably, for its videos that display musical scores along with a recording. A somewhat laborious way to work around this problem is for instructors to: (1) search for a score (e.g. "Mozart sonata") in the global community from an individual account, (2) save it as a Music XML file to their local disk, and (3) import it back into Nf from the Campus account. Third, though Nf has introduced elements of social media into their software, there is still work to do to build a more interactive design. For instance, if a user could connect scores to Facebook or Twitter accounts, receive emails when someone has commented on their scores, or even take part in live chat discussions regarding their work, the experience would

successfully emulate other types of popular social media.

One common in-class activity for written skills courses is to have each of the students contribute to an analysis of a work. Nf is a helpful medium for employing this activity outside of class as well. A collaborative student analysis could be carried out in a few ways. One way would be to embed a Nf score into a LMS and then ask students specific questions about the music in a threaded discussion. Since the score is malleable, an instructor (or student) could then annotate the score in Nf according to student comments. In other words, the score is presented and annotated in a LMS threaded discussion just as it would be through a projector in class. A second way would be to post a score within an institution's Nf community and assign students to either annotate it or add speech bubble comments directly into the program. This example activity is just one way teachers can use Nf to extend classroom activities into cyberspace.

A Small Study: Nf for Music Theory Pedagogy

Although I hope my critical assessment of Nf is of value to readers, it is important to also consider the evaluations of students who have recently used the software in music theory courses. It is for this reason that I include the following small study.

Participants, Method, and Data Collection

The primary participants in this small study were 19 graduate students enrolled in a Music Theory Pedagogy (Written Skills) course at the University of Tennessee-Knoxville (UTK) during the spring semester, 2011. At UTK, this graduate course is comprised of first and second-year Master's students (all disciplines) and focuses on preparing them to teach written skills courses in a typical undergraduate music theory sequence at the post-secondary level. Secondary participants were 13 undergraduate students in a Theory III course. At UTK this is a second-year chromatic harmony course designed for music majors. The entire sample is divided into primary and secondary groups because the graduate students used Nf for many projects throughout the semester while the undergraduates used it for only one project at the end of the term. All students then anonymously filled out a questionnaire at the end of the term that provided feedback regarding the software. This

study is not rigorously statistical, rather, it reports on a survey of questions for first-time Nf users in music theory courses.

Our method of utilizing Nf was slightly different than some will find with the Campus edition. At the time of this study and our evaluation of the product, our university was in the process of transitioning from Blackboard 8 to Blackboard 9, which is BasicLTI enabled. Though we were not able to utilize BasicLTI integration for this study, our Nf website and campus community, "UT Music Theory Pedagogy 2011," had the same internal functionality as any other Campus edition website. Our site was a one-time only, temporary solution for utilizing Nf before our migration to Blackboard 9 was complete.

At the beginning of the term, the pedagogy class was divided into six teams of three students each (one group had four students). They used Nf accounts to complete seven projects; each project had three stages. First, each team collaboratively created an undergraduate theory "assignment" and filled it in with "dummy student," color-coded responses (with potential errors). The "assignments" were saved to the "Browse" community and were named and coded by the number of the project in the sequence (1 through 7) and the group who built it (e.g. Nf-1, Group 1). Second, fellow student teams accessed, printed, discussed, and graded "assignments." Each team graded three other "assignments" (one team graded four), or in other words, each student graded one "assignment." Third, after turning in their graded "assignments," we projected each of them through a SMART Sympodium system for in-class discussion. Each project provided graduate students experience in not only writing but also grading assignments for various levels of theory instruction. At the end of the term, the students applied final editing to their scores and printed them for inclusion in their course portfolio. Figure 1 provides a description of each project and its potential target course level in an actual undergraduate theory sequence.

Near the end of the semester, the "assignments" in Nf-6 (Fig. 1) were stripped of their "dummy student" responses and were actually assigned to the undergraduate students in the secondary participant group. The undergraduate students completed three Nf-6 assignments each—which helped them study for their final exam—and submitted them back to the shared Nf community. Graduate students ultimately had an opportunity to grade real responses.

Project	Description	Potential Target Course Level
Nf-1: Intervals	Teams design and "complete" (color-coded) an assignment assessing the comprehension of musical intervals	Theory Fundamentals
Nf-2: Simple Analysis	Teams post a short chorale or popular song for simple harmonic and / or formal analysis	Theory Fundamentals
Nf-3: Species Counterpoint	Teams generate a cantus firmus with "student realized" 4th species both above and below it	Theory I
Nf-4: Diatonic Part-Writing	Teams design a diatonic figured bass realization exercise and include "student responses"	Theory I
Nf-5: Chromatic Part-Writing	Teams build a chromatic figured bass realization exercise and include "student responses"	Theory II
Nf-6: Modulation / Part-Writing	Teams design a more advanced part-writing exercise (roman numerals given) and include "student responses"	Theory III
Nf-7: Set Theory Analysis	Teams devise an exercise to assess student application of pitch-class set theory analysis; include "student responses"	Theory IV

Figure 1. Seven graduate student projects for UTK's Music Theory Pedagogy course, spring 2011

Results

The questionnaire responses from all students provided quantitative and qualitative feedback regarding Nf. For most of their responses, the students used a five-point Likert scale to assess their agreement with statements (though the first question was slightly different; see Figures below). Students were also given the option to select "did not use this functionality" if they did not utilize a specific feature they were questioned about. If this option was selected the student's response did not contribute to the mean values. Figure 2 presents the graduate student questionnaire results to Likert-scale questions, while Figure 3 displays the undergraduate student questionnaire results to similar questions. Figures 4 and 5 include qualitative graduate and undergraduate student feedback, respectively. The comments shown here are representative of the major points the students seemed to make about the software.

All mean values were gathered using a five-point Likert-scale.
[For question 1: 5 = very experienced, 4 = experienced, 3 = neutral, 2 = inexperienced, 1 = very inexperienced]
[For questions 2-16:
5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, 1 = strongly disagree]

Question	Mean/Std.Dev.
1) How experienced were you with using Nf before taking this course?	1.16 / 0.69
2) "Logging into and navigating the Nf class page was very simple and intuitive."	3.89 / 0.94
3) "With Nf, it was a very simple and intuitive process to build homework assignments and musical examples to look exactly the way I wanted them to look."	2.11 / 0.88
4) "Inputting musical notation into Nf was very simple and intuitive."	3.26 / 1.19
5) "Adding text such as directions, name blanks, figured bass accidentals, and roman numerals to the score was very simple and intuitive in Nf."	2.32 / 1.42
6) "Building a pivot chord modulation was very simple and intuitive in Nf."	1.72 / 1.13
7) "Outlining a specific pitch by color was very simple and intuitive in Nf."	4.32 / 0.48
8) "Creating a four voice SATB texture for part-writing examples was very simple and intuitive in Nf."	3.89 / 0.99
9) "The pop-up edit box and score editing menus in Nf were very easy to use and navigate when building my examples and assignments."	3.53 / 0.90
10) "Saving my shared work to the 'Browse' menu was a very simple process in Nf."	3.42 / 1.46
11) "Saving my private work to the 'My Home' menu was a very simple process in Nf."	4.12 / 1.17
12) "Sharing my work with other individuals (not to the 'Browse' menu) in my group was very simple and intuitive within the Nf platform." [Note: this is using the Share → "share with individual" menu]	2.94 / 1.51
13) "Commenting on my and other students' work within the Nf platform was very simple and intuitive."	3.79 / 1.19
14) "Playback of scores and mixing features were helpful aspects of Nf."	4.06 / 0.77
15) "Overall, using Nf as a tool for Music Theory Pedagogy greatly enhances the course."	4.69 / 0.91
16) "I recommend the use of Nf as a notational and collaborative application for a music theory sequence."	4.19 / 1.12

Figure 2. Graduate Student Questionnaire Results. (Primary participants)

All mean values were gathered using a five-point Likert-scale.
[For question 1: 5 = very experienced, 4 = experienced, 3 = neutral, 2 = inexperienced, 1 = very inexperienced]
[For questions 2-17: 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, 1 = strongly disagree]

Question Mean/Std.Dev.

1) How experienced were you with using Nf before taking this course? .....1.00 / 0.00
2) "Logging into and navigating the Nf class page was very simple and intuitive." .....2.92 / 1.32
3) "Finding and pulling up my practice assignments was very easy in the Nf class page." .....3.77 / 0.83
4) "Inputting musical notation into Nf was very simple and intuitive." .....2.38 / 1.04
5) "The pop-up edit box and score editing menus were very easy to use when completing practice assignments." ..... 3.31 / 1.11
6) "Saving my shared work to the 'Browse' menu was very simple in Nf." .....3.42 / 1.16
7) "Saving my private work to the 'My Home' menu was very simple in Nf." .....3.77 / 1.17
8) "Sharing my work with my professor (not to the 'Browse' menu but directly with her) was very simple within the Nf platform" [Note: this is using the Share → "share with individual" menu .....3.92 / 0.90
9) "Commenting on my and other students' work within the Nf platform was very simple and intuitive.". .....3.14 / 0.90
10) "Playback of my work is a helpful feature of Nf."....5.00 / 0.00
11) "I would like to have the ability to share ideas on our homework assignments to an open forum such as the Nf 'Browse' page." .....3.69 / 1.11
12) "Overall, using Nf as a music theory tool can greatly enhance a theory course." .....3.54 / 1.05

Figure 3. Undergraduate Student Questionnaire Results. (Secondary participants)[29]

[29] I would like to thank Dr. Barbara Murphy (University of Tennessee-Knoxville) for her assistance in executing assignments and collecting data for the undergraduate portion of this research study.

1) What specific aspects of Nf aided your learning process?

- "I think that the idea of Nf is great. It's good to be able to work on a score at the same time with the other members of your group without being in the same location."
- "It was helpful that Nf was online and I could do the assignments from home (vs. having to go to a lab to use Finale)."
- "Nf is not initially overwhelming because you are presented with a small, accessible score."
- "The ease of sharing files with the class aided my learning process. It made class discussions easier and more engaging."
- "I thought it was a good way of sharing our homework assignments. Once we figured out how to share our assignments so everyone could see them, it was easy to see everything. We didn't have to print out tons of copies for everyone, as we would have had to do if we used Finale or Sibelius, and we didn't have to either buy an expensive program or come to a computer lab to use it. We could just use it from the convenience of our own homes."
- "I really liked using this tool in the classroom. It was very helpful with the group projects because students could access the same information online and add comments to the document about changes that were made or questions that they had."

Figure 4. Graduate student comments. (Primary participants)

2) What specific aspects of Nf detracted from your learning process?

- "The fact that Nf caused confusion for group work. In this, I mean the various "versions" of Nf files. Quite frequently group members and I would be working on assignments unaware that someone else was working a different version of the same assignment and then trying to bring all the versions together was quite challenging."
- "There are complications when trying to work together on an assignment because the program continues to save multiple versions of the same score and oftentimes the program doesn't keep the scores updated with the latest changes."
- "The platform wasn't that easy to use, especially when coming from a program like Finale."
- "It was very basic and limited."
- "It was hard to get analysis aspects, for example Roman numerals and figured bass symbols, to work logically."
- "Trying to input directions/blanks/text in general into the assignments was kind of a pain. It would have been nice if there was a font sizing option for the individual text boxes."

Figure 4. *(continued)* Graduate student comments. (Primary participants)

1) What specific aspects of Nf aided your learning process?

- "I like being able to neatly input my work."
- "Playing the music and hearing the pitches as I put them in; and saving paper."
- "Hearing your part-writing played back was cool."

2) What specific aspects of Nf detracted from your learning process?

- "The tools to input the notes were slightly difficult to use."
- "Having trouble with making the tails [stems] of the notes go up or down."
- "The input tools took a bit to adjust to."

Figure 5. Undergraduate student comments. (Secondary participants)

Overall Conclusions

Although there are beneficial and problematic aspects of Nf, I compiled my observations and research into this review because I believe the product illustrates an important leap forward in music notation software. The four characteristics of Nf described above (i.e. the pricing model, online platform, "cloud" technology, and Web 2.0 characteristics) are all bold advancements for music notation software and bring online score sharing successfully into the Web 2.0 environment of today. After considering the whole of my students' and my own observations, the largest problems that currently exist for theory teachers and students include (1) design features for inputting music, and to an even greater degree, text and analytical annotations[30], (2) overall limitations with the editor, (3) certain characteristics of community score sharing, and (4) the required Internet connection. However, the first three of these problems are very fixable and the fourth already has maneuvers around its detrimental effects. I perceive these problems as temporary roadblocks for online notation software. In further consideration of my students' and my reflections of the software, Nf's greatest strengths for theory teachers and students are (1) its ability to be accessed from a web browser at various locations, (2) its capability of communicating with a "cloud" for rapid access and sharing of music files, (3) its potential to facilitate collaboration through its online infrastructure, and (4) its capacity to make any theory assignment heard. These and the many other benefits of Nf are outstanding features and in my opinion far outweigh its weaknesses.

[30] Note: encourage your students to *read Nf's "help section*," found at: http://www. noteflight.com/info/help. Some of the problems the students had regarding text input could have been avoided by carefully reading this page.

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