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# Ubiquitous Technology-Enhanced Learning of Complex Financial Concepts

## Pedagogy Improvement in Face-to-Face and Online Teaching Environments

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**Abstract.** Technology-based finance education is designed to fully engage students during lectures and individual study times in order to increase their learning efficiency. Students are immersed in a new teaching environment where the emphasis is on achieving high knowledge retention rate by synchronously presenting the material through non-sequential links of learning objects such as graphics, multimedia files, and links to external documents. While studying, students have possibilities to refer to earlier material when learning more complex ideas in the later part of a lecture, as well as to relate to the material that may be following the topics being introduced. The integrative technology-enhanced approach to learning provides students with a possibility to maintain the overall view of the material, while absorbing detailed explanations of the individual study components. We have conducted a preliminary pilot program testing this approach, and we found, based on student feedback, that the integrative technology-enhanced approach to teaching improves student overall learning experience in face-to-face as well as in online courses. Moreover, course material organization and instructor presentation of the material contribute significantly to the overall student satisfaction while technology per se is not a statistically significant factor for overall course experience.

**Keywords:** Face-to-face & online programs; Synchronous & asynchronous teaching; Technology enhanced learning; Distance education

## 1. Introduction

A major challenge in teaching advanced finance courses today is to fully engage students and to increase the efficiency rate of learning important financial concepts and risk management tools. Just few years ago the world financial system was on the brink of collapse creating a fundamental need for finance graduates to thoroughly understand the intricacies of complex financial and risk management tools. At the time when we have seen some of the most

outrageous government rescue interventions in the corporate world (Fender and Gyntelberg, 2008), we strive to equip our students to approach financial risk management meticulously and methodically, in order to be prepared to face the challenges of today's financial industry.

There is a need to constantly upgrade and update not only the course material to incorporate novel concepts and risk management techniques, but also to create a learning environment that introduces effective approaches and utilize technological advancements to facilitate meaningful teaching of complex financial models, decision-making tools, and structured financial products.

One of the goals of advanced finance education is to teach students how to utilize existing financial concepts and tools and to prepare graduates to have analytical and flexible open minds to effectively grasp new, innovative financial products and utilize them appropriately in their workplace environments.

Sequential educational style has historically been traditional and most common method of presenting lecture material (Saunders, 2001). It is based on presentation of different concepts to be learned in a serial mode, one following the other, without stressing the correlation and causality between various topics. This is similar to a short-term memory process, where relationship is established only between consecutive topics. Despite the benefits of this widely adopted teaching style, it also has number of drawbacks, especially for complex, highly correlated relational subject matters, such as finance.

One of the most significant shortcomings of sequential teaching methods is a reduced knowledge retention rate of novel concepts acquired in a lecture format (Butler, 1992). Students have different learning styles and it is important to offer teaching approaches to accommodate different student types (intuitive, visual, active) to capture their attention for the duration of the class and prevent learning-teaching mismatch that could result in inattentiveness, boredom, and ultimately dropping from the class (Felder & Spurlin, 2005). Longer-term memory is essential when students are building knowledge based on material introduced in a finance lecture. Hence, it is important to refer to earlier material when learning more complex ideas in the later part of the lecture. Equally important is to be able to relate to the material that follows the topics being introduced. In the sequential teaching environment students often lose the thread of the presentation. That can reduce the benefits of the lecture to a point when students stop accepting and processing information.

To address this limitation of sequential classroom teaching techniques, we introduce comprehensive computer-aided approach to teaching, where the complete lecture is presented interactively allowing students to learn the material through various components that are linked in a non-sequential way. This approach provides the students with a possibility to maintain the overall view of the material while the instructor explains the lecture material building blocks in detail.

## 2. Comprehensive technology-enhanced learning

The integrative technology-enhanced approach matches well the teaching style of the instructor with different learning preferences of individual students. This methodology provides virtual step-by-step instruction for a subgroup of students who prefer learning the material by hearing and seeing the concepts in a sequence. At the same time it gives an opportunity to students who prefer the non-sequential learning style to connect differently the presented material objects. This approach allows instructors to reach out and successfully teach much broader population of students. Since some students are passive and some are active learners (Rodrigues, 2004), they can choose the type of computer-aided modules that correspond to their learning style. We believe that giving students an opportunity to non-sequentially navigate through the material will provide immediate benefit to their understanding of the presented concepts and may detect and correct promptly certain misconceptions with instructor's assistance and feedback. Students will also be able to study the material outside the classroom, at their own pace, and to solidify their knowledge on their own after the lecture. This approach will present a possibility for students to benefit from both, immediate and delayed knowledge transfer to obtain solid conceptual understanding of the material by developing improved retention skills over time (Mathan and Koedinger, 2005).

In finance courses it is extremely important to understand all the building blocks of risk management or the decision-making process. If students do not completely understand an important theory or if they learn a model incorrectly, this introduces confusion and potentially erroneous understanding of the overall material. Needless to say, this inaccurate understanding can trickle down to future, more complex concepts and can lead to incorrect solutions of multifaceted problems.

We tested the integrated approach to learning within both, face-to-face and online formats, and demonstrated that this methodology can be modified to fit both of these different environments. For example, in online classes, we preserve the traditional component of teaching by using tablet computers in addition to already prepared integrative lecture material (Hoppe et al., 1999, Turban and Muhlhauser, 2007). In face-to-face classes, we utilize technology to bring the integrative approach to teaching in the classroom.

In Figure 1 we illustrate how the integrative approach to teaching corresponds better to real world corporate and economic systems, by showing the difference between sequential and interconnected network-like flow of links among learning objects.

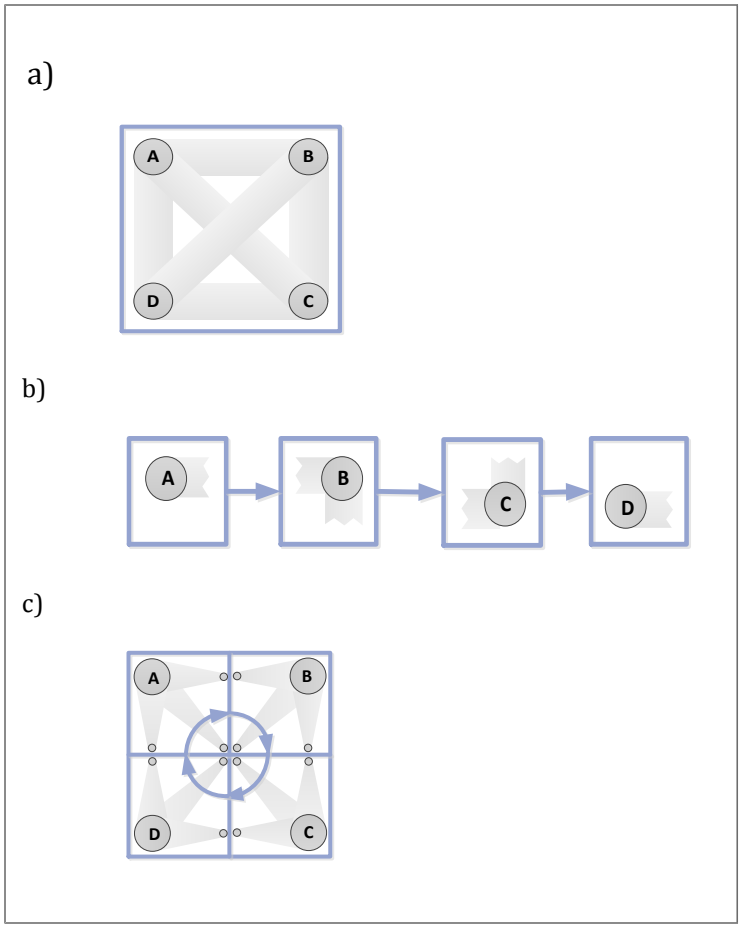


**Figure 1: a) shows a real world system where links exist among all the nodes in the graph; b) illustrates example of sequential instruction where certain links (A-C, A-D, and B-D) are missing; c) represents a comprehensive integrative approach to delivering complex financial concept teaching material.**

Within the integrative technology-enhanced approach to teaching, students are given an opportunity to focus on individual teaching components while learning sophisticated financial models and obtaining a thorough understanding of multifaceted economics concepts.

As illustrated in Figure 2, a complex concept of pricing a derivative instrument, such as "option", involves integrative approach to carry on the option valuation process. In this example, we show the binomial tree option pricing approach and present the entire process integratively, giving students an overall big picture of the pricing steps, with a possibility to zoom into specific pricing segments, while keeping the overall evaluation procedure visible.

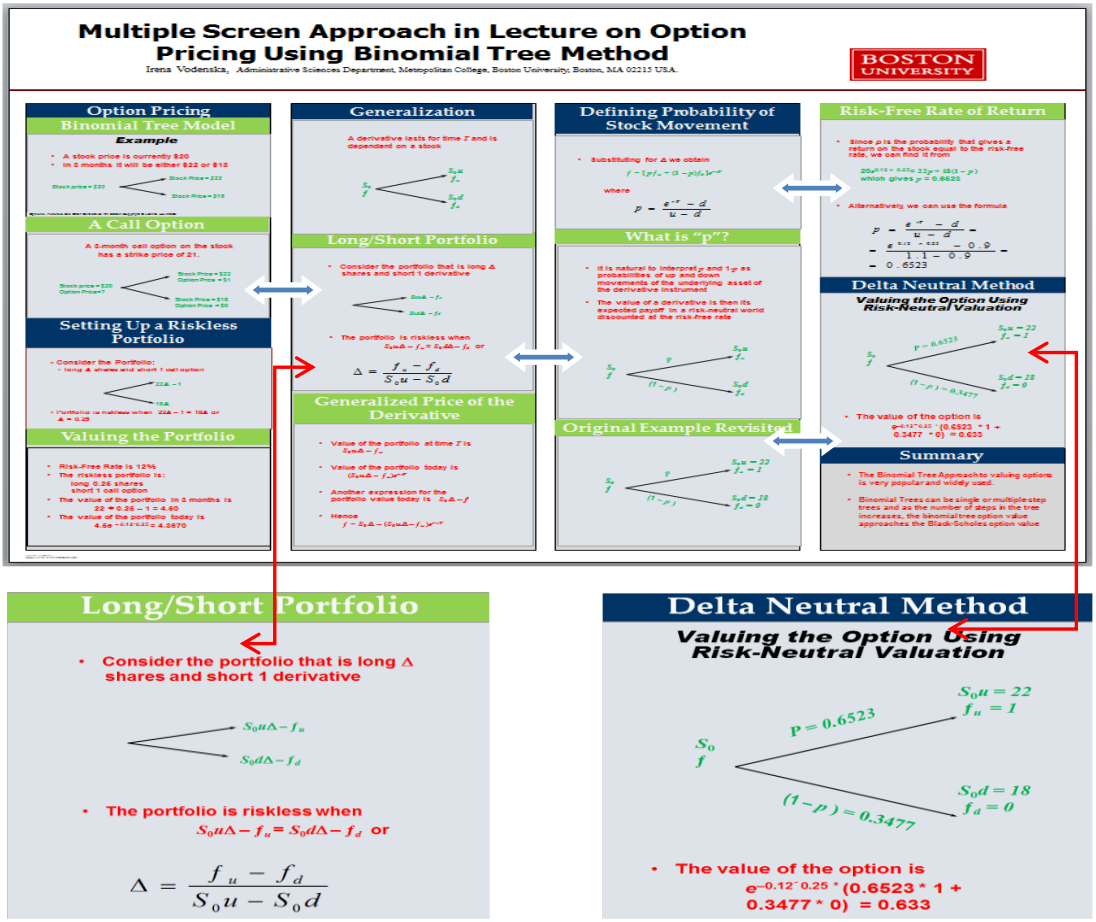


**Figure 2: Example of multiple-screen lecture delivery format which allows students to see the overall lecture material at all times with a possibility to zoom in and out of ...**

## 2.1. Teaching with Non-sequentially Linked Learning Modules

Instructors use multiple screens and enhanced presentation tools to link the learning components delivered non-sequentially within a lecture. The objects are connected in a network where directional links exist to successfully navigate through the required material. This teaching approach keeps student attention to multiple lecture

Although, the integrated technology-enhanced approach to teaching brings benefits to students, based on our experience, it also creates additional burden to instructors, who experience approximately 20-25% increase in their workload. This overload is a result of the need to create the video or audio objects, to link the lecture objects appropriately, and to learn how to utilize new technologies.

Introducing cutting edge integrative technology-enhanced teaching approach keeps the students abreast with new developments in the financial industry, especially in the fast-paced advances in the area of financial risk management.

The non-sequentially linked lecture components could represent 1) embedded lecture notes 2) hyperlinks to additional learning sources, 3) links to outside applications such as PowerPoint, Excel, or Access, or 4) pointers to pre-recorded multimedia objects either developed by the instructor or accessed on the Web.

The integrative teaching model can work well in large or small groups or in laboratory or practical classes where students need to deliver computational results based on a set of learning objects by planning, developing, and managing their own learning (Bourner and Flowers, 1999). Concurrent to introducing the integrative approach to learning, it is important to determine proper use of technology to optimize customized course development and delivery and streamline technical support (Bates and Poole, 2003).

The comprehensive computer-aided teaching approach is becoming more attractive to students because it relates better to the advanced multimedia technologies that they use in their daily lives and it's more suitable for designing personalized learning environments (Franzoni et al., 2008). Students nowadays are accustomed to multitasking and rapid switching between various information-providing devices, such as smart phones and iPads. They are used to browsing between applications like email and Internet browsers, music and video downloads, various social media sites, or getting access to online shopping, travel booking, and making restaurant reservations. This trend is expected to continue, which could make the integrative approach to learning a preferred teaching model. In addition to focusing on creating appealing learning environment for students, professors also need to adapt successfully to technology-enhanced education and morph their instruction to be more compatible with distance learning and cyber teaching environments (Fuller et al., 2000). Additionally, research has shown that in general students are more engaged in achieving course learning outcomes when technology is used in teaching. Another interesting angle of assessing the importance of online, or computer-based, technology-enhanced courses is the minority student participation and performance as they are more likely to enrol in online courses, where the exposure to classmates is reduced (Chen et al., 2010). An important aspect of using technology in the classroom or online courses is understanding how pedagogies evolve to ensure effectiveness of teaching and learning materials. New technological breakthroughs, self-paced learning software design, or interactive learning tools have tremendous impact on the computer-based learning style and scope (Stephenson, 2001).

## 2.2 Data Analysis and Methodology

We tested the integrated technology-enhanced approach to teaching, by conducting a pilot study of overall student experience for three finance courses, delivered in online and face-to-face formats in 2011. We also performed a comparative analysis of the courses included in the pilot study and previously delivered courses from fall 2009 to fall 2011. During this period we studied student feedback for 15 graduate finance courses with total enrolment of 645 students. Out of the 15 courses, 9 were face-to-face and 6 were delivered in an online format. The online courses had 464 students enrolled, while the face-to-face courses had 181 students. To evaluate student satisfaction rating, we surveyed students about their overall course experience. The survey questions were organized in 4 groups evaluating the course, the instructor, the technology, and teaching assistants if applicable. The questions were rated on a 5-level Likert scale from 1-negative/strongly disagree to 5-positive/strongly agree. We

selected 4 survey questions 1) course material organization; 2) instructor's ability to present material; and 3) use of technology, and 4) overall course experience to conduct our analysis. We selected these questions because they most appropriately cover the aspects of the overall course evaluation. The survey response rate was 41% for online courses and 90% for face-to-face courses or total of 350 students.

We performed regression analysis for 95% confidence level by designating the *Overall course experience* as a dependent variable, and *Course material organization, Instructor's ability to present course material,* and *Use of technology* as dependent variables.

Our hypotheses that we test in this paper are as follows:

*H1: Course material organization is significant determinant of Overall course experience*

We demonstrate in Figure 3 that *Course material organization* is statistically significant factor with a p-value of 0.00007 < 0.05 and it is an important determinant of overall course satisfaction with R-square of 0.7121.

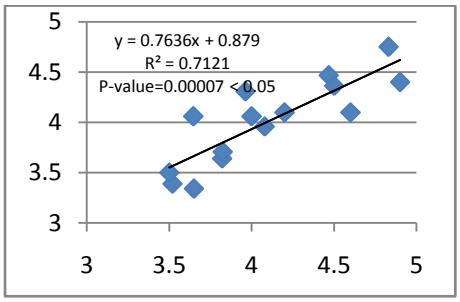


**Figure 3: *Overall course experience* vs. *Course material organization* for fall 2009 to fall 2011. (Statistically significant for p < 0.05 at 95% confidence level).**

*H2: Instructor's ability to present course material is significant determinant of Overall course experience*

Figure 4 shows that *Instructor's ability to present course material* also offers significant explanatory power to the *Overall student course satisfaction* with p-value of 0.000006 and R-square of 0.8010.

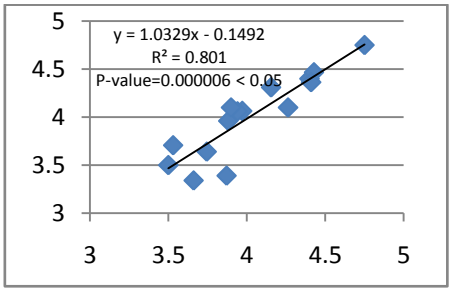


**Figure 4: *Overall course experience* vs. *Instructor's ability to present material* for fall 2009 to fall 2011. (Statistically significant for p < 0.05 at 95% confidence level).**

*H3: Use of technology is significant determinant of Overall course experience*

While the *Course material o*rganization and *Instructor's ability to present material* are statistically important factors for *Overall course experience*, in Figure 5 we show that *Use of technology* is not statistically significant factor for *Overall course satisfaction*. The coefficient of determination R-square for this regression is 0.5042, while the p-value is 0.1138.

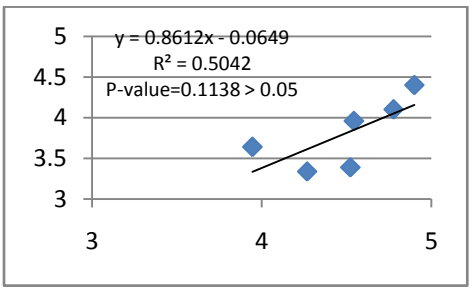


**Figure 5: *Overall course experience* vs. *Use of technology* for fall 2009 to fall 2011. (Not statistically significant for p > 0.05 at 95% confidence level).**

Similar results were obtained by Zlateva et al., 2011 for the statistical analysis of computer information system courses, contrary to the findings by Volery and Lord 2000, Soong et al., 2001, and Sun et al., 2008, where technology was presented as one of the critical success factors in online education. We argue in this paper that the technology is an extremely important factor that facilitates creation of novel approaches to present course material and significantly enhances instructor effectiveness in presenting course material; however, if we only have great technology, and do not utilize it creatively, the technology *per se* will not be the determining factor for overall course satisfaction. Additional explanation to not finding the *Use of technology* statistically significant could be that the technology is underlying, necessary, and expected prerequisite in delivering today's education, hence, it is not perceived as significant determinant of the *Overall course experience.* In other words, while *Course material organization* and *Instructor's ability to present material* varies greatly from course to course, the *Use of technology* is more stable as measured by the standard deviation (s.d.) of these variables (i.e. 45% s.d. for *Course material organization* vs. 32% s.d. for *Use of technology*).

In addition to the regression analysis of Likert scale rated questions, we also analysed the descriptive feedback from students. Table 1 shows samples of student written feedback from the pilot courses, pointing to the different teaching style, material organization, and course structure as positive course developments. Chitkushev et al., 2014 show that student course satisfaction is strongly related with students' instructor satisfaction, and that there is a positive correlation between students' final grade distribution and their overall satisfaction with the course.

We argue that statements from students such as "*very organized course*", "*instructor teaching style is unique*" or "*the approach made it easy for us to learn the material*" that appear in the pilot courses and are absent from other course feedback, testify that the new integrated technology-enhanced approach to teaching is effective and makes a difference in student learning.

**Table 1: Student Feedback**

| Descriptive Student Feedback for pilot courses with integrated technology-enhanced approach to teaching |
|---|
| |
| a) "One of the strongest aspects of the course was the simplicity in the layout of each week. It was easy to follow the structure, the lecture notes were outlined and organized very clearly" |
| b) "Very organized class and learned a lot of material" |
| c) "This is the most organized class I have had in the program" |
| d) "I thought it was an excellent course and I would not change anything about it" |
| e) This has been an excellent course |
| f) "I thought this was the best course so far. Professor did an outstanding job in teaching us the different aspects of finance. This course has helped me to get a good perspective on the markets, economic environment, systemic risk, and what the future may hold" |
| g) "Thank you for all that you taught us. Your teaching style is unique along with your detailed explanation, which made it easy for us to learn the material" |

In addition, in Figure 6 we plot the ratings for *Course material organization* for different terms including pilot courses (circled), and found that the pilot courses feedback is persistently positive.

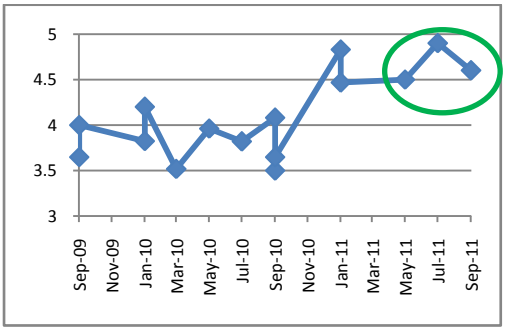


**Figure 6: *Course material organization* ratings for fall 2009 to fall 2011 including the pilot courses (circled) where the integrative technology-enhanced approach to teaching was adopted.**

## 3. Conclusion

The integrative technology-enhanced education essentially increases the dimension of the space in which the lecture material is being presented, going from a flat sequential two-dimensional system to a three-dimensional space

where connections between spatially and temporally distant components is possible. This methodology is based on lecture delivery where the entire material is presented as a poster in the beginning of the lecture. There are various techniques that can be used to implement this approach such as multiple screens with links between the learning objects or hyperlinks to multimedia files or relevant documents. This teaching methodology enhances students' educational experience. While actively participating in the lecture, students can point out objects in the overall material and ask for further explanations or clarifications of the lecture building blocks. We use interactive object focus tools to emphasize the relevant components that need further discussion without moving backward or forward through the material in order to search for a concept or a definition.

Besides having many benefits, the comprehensive technology-enhanced education has shortfalls as well. One of the major drawbacks of computer-aided education is excessive reliance on technology. Any technical problem can contribute to major frustration and derailment in the class. To overcome this weakness, and improve the technology reliability, it is important to secure redundant resources that can be activated in case of technical difficulties to enable seamless continuation of the class.

We performed a pilot study introducing the integrative technology-enhanced approach and found that C*ourse material organization* and A*bility of the instructor to deliver the lecture effectively* are statistically significant factors for overall course satisfaction, while interestingly enough *Use of technology per se* was not a statistically significant factor for overall course satisfaction.

The initial feedback from students has been very positive in regards to the benefits that the integrative technology-enhanced approach to teaching brings into the online and face-to-face educational programs. Overall, the use of advanced technologies to create integrative *big picture* delivery of the course has helped students understand better the complex risk management and financial decision making for the global financial industry.

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