

# Building a “Course Community” in a Digital Age for Teaching Undergraduate Probability

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## Abstract

The Mathematical Association of America (MAA) Mathematical Sciences Digital Library, MathDL, is developing online Course Communities in undergraduate Mathematics. These online Course Communities contain a collection of resource recommendations for effective teaching and learning materials found on the web that are directly associated with specific math courses, such as Single Variable Calculus or Probability. These Course Communities are an extension of digital libraries such as MathDL and CAUSEweb. For each Course Community, the initial developers organize links to existing online materials based on the topics typically taught in the specific course. A description of and metadata about each resource are provided on the website. Examples of types of resources include online applets, videos, PDF files, and teaching activities. These Course Communities are freely available on the web for faculty and students. End users can also be part of the community by rating the resources, starting discussions, and recommending additional resources. MathDL's newest Course Community is for the undergraduate course in probability. This article will discuss the MathDL Probability Course Community.

**Key Words:** Probability education, digital library, online educational resources

## 1. Digital Teaching and Learning Resources: Background

It is now common for instructors to incorporate digital resources into their courses, possibly by presenting a simulation or film in class, requiring students to do research or homework online, or finding interesting examples or problems to assess students' understanding. Existing educational digital libraries such as MathDL<sup>1</sup>, MERLOT<sup>2</sup>, and CAUSEweb<sup>3</sup> have created collections of links to and descriptions of online resources to help teachers select from the large number currently available.

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<sup>1</sup> Mathematical Sciences Digital Library hosted at [www.mathdl.org](http://www.mathdl.org).

<sup>2</sup> Multimedia Educational Resource for Learning and Online Teaching hosted at [www.merlot.org](http://www.merlot.org).

<sup>3</sup> The Consortium for the Advancement of Undergraduate Statistics Education (CAUSE) digital library hosted at [www.causeweb.org](http://www.causeweb.org).

Digital resources have continued to evolve with the introduction of electronic social networking. The advent of social media has impacted how people interact with each other and has the potential to allow teachers of similar courses to form communities. The Mathematical Association of America (MAA), with support from the National Science Foundation, is building on the success of existing online resources for learning mathematics by adding networking opportunities in its newly developed Course Communities.

In particular, the MAA would like to use the Course Communities in undergraduate mathematics education to help extend the reach of their online digital library for undergraduate mathematics, MathDL. This Digital Library was originally developed with the support of the National Science Foundation's Division of Undergraduate Education grant #0435198 within the program supporting the National Science Digital Library (NSDL). MathDL was designed to provide an internet site where the MAA community can publish online articles and learning materials; to support the creation of new, innovative online learning materials in mathematics; to promote the widespread use of new and innovative online learning materials; to provide online materials that support the professional development of mathematics faculty; and to support and publicize the online efforts of MAA communities and associated projects in providing online services and content.

### **1.1 Mathematical Sciences Digital Library Course Communities**

MathDL Course Communities were created for a wide range of undergraduate math courses. Users can browse materials organized by course and then by topic within the course, and they can post and access reviews about these materials. MAA envisions that users could “join a community of colleagues working on the same curricula.” (MAA)

The Course Communities website can be reached through a link at the bottom of the MathDL page ([mathdl.maa.org/](http://mathdl.maa.org/)) or directly ([mathdl.maa.org/mathDL/61/](http://mathdl.maa.org/mathDL/61/)). The main Course Communities page contains links for developmental mathematics, one- and multi-variable calculus, and ordinary differential equations. Starting in October 2012 a link will be added for probability. For each of these courses, teams have identified an initial set of resources. The links from the main Course Community page go to a page which allows basic and advanced searching of these resources. It also contains an outline of topics so that teachers can browse for resources. At the bottom of the page is the option to make comments on a course or open a discussion thread. Users can also make comments on each resource.

### **1.2 Existing Online Resource Communities for Probability**

The MathDL Probability Course Community will be the first such resource to focus on the probability course alone, rather than as part of the statistics curriculum. Well-established communities already exist for this curriculum, notably CAUSEweb, MERLOT Statistics Portal, and the Advanced Placement (AP) Statistics Teacher Community.

### *1.2.1 CAUSEweb*

The Consortium for the Advancement of Undergraduate Statistics Education (CAUSE) has succeeded in building a statistics education community, partially around the website [www.causeweb.org](http://www.causeweb.org). This site contains a digital library of statistics resources, organized by material type, statistical topic, and pedagogical approach. It also contains a list of resources for researchers in statistics education, links to webinars on various statistics education topics, and information about conferences on teaching statistics.

The digital library at [causeweb.org](http://causeweb.org) currently contains 164 resources for teaching probability. Each of these is catalogued with a description of the resource and a URL, as well as metadata such as the author, the mathematics level, etc. Commenting is possible on this site but in practice has not been used frequently. Users cannot add new resources to [causeweb.org](http://causeweb.org)'s library directly but can suggest additions.

### *1.2.2 MERLOT*

The Multimedia Educational Resource for Learning and Online Teaching, MERLOT, ([www.merlot.org](http://www.merlot.org)) contains collections of online resources for a variety of disciplines ranging from Agriculture to World Languages. The MERLOT Statistics Portal ([statistics.merlot.org](http://statistics.merlot.org)) houses some probability resources which can be found by clicking on Browse Collection: Mathematics and Statistics, then Statistics and Probability, then Probability. There are currently 95 probability resources in this library. Some of the resources have been reviewed and rated by a peer reviewer. Users can and do leave ratings and comments on resources. Registered users can contribute material to the collection by giving the URL and descriptions of the material.

### *1.2.3 Advance Placement Statistics Teacher Community*

The Advanced Placement (AP) Statistics Teacher Community ([apcommunity.collegeboard.org/](http://apcommunity.collegeboard.org/)) is hosted by the College Board. It is the home for over 75 resources and over 100 statistics-related conversation threads organized by 14 categories. These categories cover topics within the scope of the AP Statistics course as well as probability and statistics topics beyond that scope. Also, members of the community have the option of rating resources using a five-star system and leaving specific comments for each resource. The community has made over 500 posts since the format change in August 2012.

Each of these methods to find online content is useful to teachers of probability. The MathDL Probability Course Community hopes to supplement them by explicitly focusing on the community development aspect for the undergraduate course in probability. It will allow commenting on the individual resources, as these sites have done; however, it will also allow comments for the entire course as well as discussion threads. The Course Community also considers probability on its own, rather than a sub-topic of a statistics class. Finally, the Course Community will present an outline of a probability course as the main way to browse the material.

## 2. The MathDL Probability Course Community

The Probability Course Community will be the newest course added to the MathDL Course Communities. It is designed to address probability topics at the high school and undergraduate levels for courses in probability. A limited number of the indexed resources are appropriate for lower-level graduate courses.

An initial set of 224 existing, online resources (applets, videos, tutorials, webpages, collections, etc.) has already been reviewed, described, and indexed by a project team headed by Dr. Lawrence Moore, and the site is scheduled to go live in October 2012. Members of the project team are listed in Table 1. Once the site is live, users will be able to add favorite items, make comments, and participate in discussions.

**Table 1.** The MathDL Probability Course Community Developmental Team

<b>Dr. Lang Moore (Principal Investigator)</b>	Duke University, Professor Emeritus
<b>Dr. Kyle Siegrist (Probability Course Community Lead)</b>	University of Alabama at Huntsville
<b>Dr. Carolyn Cuff</b>	Westminster College
<b>Dr. Ivo Dinov</b>	University of California at Los Angeles
<b>Dr. Diane Fisher</b>	University of Louisiana
<b>Dr. Dennis Pearl</b>	Ohio State University
<b>Natasha Gerstenschlager</b>	Middle Tennessee State University, PhD Student
<b>Dr. Lisa Green</b>	Middle Tennessee State University
<b>Brandon Hanson</b>	Middle Tennessee State University, PhD Student
<b>Dr. Ginger Rowell</b>	Middle Tennessee State University
<b>Dr. Olaf Stackelberg</b>	Kent State University

The project team began by outlining a typical probability course. Each major topic in the outline became a category under which an online resource can be classified. A few more categories were added that can be threaded through an entire semester, such as famous problems, randomizing gadgets, games of chance, and history. The topic-based outline for the Probability Course Community will be the first thing the user will encounter when they access the Probability Course Community website from the Course Communities site as described in Section 1.1. Clicking on the topic-based links will lead to resources for each part of a probability course. Users may also perform a keyword search by using a search box in the upper left corner. An advanced search capability is also present that allows the user to specify a number of attributes.

Clicking on a topic in the course outline yields a list of relevant resources. For each resource, the title, format, rating, and number of comments is shown. Clicking on the title of the resource takes you to the resource. There is also a link for “More Information.” Clicking this link yields an information page about the resource including a description, a rating, any related resources, and comments. Users can send the Course Community resource description to their own or someone else’s email account by clicking the link “send to a friend.”

A registration and login capability allows users to access the MyLibrary feature. In the MyLibrary feature, users can maintain their resources, allow members to access their

materials, comment on resources, and begin and/or contribute to discussions. These discussions can be viewed by anyone in the community. The user can also invite others to be a part of their community by adding in the person's email address.

Near the bottom of the page is a link to post comments about the course as a whole and an option to start a discussion thread. Login is not required for the commenting aspect of the site. The MathDL Course Community project includes components such as making a comment, viewing comments, submitting resources, and rating resources with the explicit intent of encouraging the development of a community of users.

### 3. Specific Examples of Resources in the Collection for Use in Probability Classes

This section of the paper highlights a few of the resources contained in the collection and describes how they might be used in a class. Some online resources are used mainly by the teacher while others are used mainly by the students. For example, teacher-driven resources could include simulations that the teacher would present as part of lecture or hands-on activities to be completed by a team of students. An example of a student-driven resource would be a video used to supplement a lecture. Finally, some resources are most usefully thought of as assessments. For example, a set of questions that teachers could modify for use on an exam or an online quiz. Of course, these categories may overlap.

#### 3.1 Example: The Khan Academy

The Khan Academy website<sup>4</sup> contains videos on a wide-ranging list of topics. Its video introducing probability, titled *Basic Probability*<sup>5</sup>, is indexed in the Probability Course Community database. This video explains the probability of getting heads in a toss of a fair coin and the probabilities of various events in the roll of a fair die. The video could be used as a student driven resource, required prior to a lecture covering basic probability topics. The instructor could then ask questions in class pertaining to the video to formatively assess student learning and understanding. The video itself is short in length (less than ten minutes) and also has an interactive aspect about it. Any user can ask questions and post answers underneath the video. Users can also view previous questions and answers that have been posted. Any user can also make tips and comments on how the video could be improved. Instructors could use these interactive features to post student comments and feedback.

#### 3.2 Example: SOCR Law of Large Numbers Applet and Activity

The Statistics Online Computational Resource (SOCR)<sup>6</sup> *Law of Large Numbers Applet and Activity*<sup>7</sup> could be used for presentational purposes, but it is detailed enough to be completely student-driven. As students complete the activity they use an online applet to perform probability simulations and to observe the Law of Large Numbers (LLN) in

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<sup>4</sup> <http://www.khanacademy.org>

<sup>5</sup> <http://www.khanacademy.org/math/probability/v/basic-probability>

<sup>6</sup> <http://www.socr.ucla.edu/>

<sup>7</sup> [http://wiki.stat.ucla.edu/socr/index.php/SOCR\\_EduMaterials\\_Activities\\_LLNNLN](http://wiki.stat.ucla.edu/socr/index.php/SOCR_EduMaterials_Activities_LLNNLN)

action. In particular, the host site lists the activity's goals as follows:

- Illustrate the theoretical meaning and practical implications of the LLN;
- Present the LLN in varieties of situations;
- Provide empirical evidence in support of the LLN-convergence and dispel the common LLN misconceptions. (SOCR Statistics)

With little guidance from the instructor, the students could complete the activity by themselves or in small groups. The activity includes multiple experiments, and after each one is completed, students could be encouraged to discuss their findings with their classmates and propose hypotheses for future outcomes before moving on to the next experiment. The applets are user-friendly and allow just enough customization for students to study the LLN in a variety of settings. As part of the Course Community, instructors could share discussion points made by students, revise either the lesson or the experiment instructions to better suit the needs of different levels of students, or suggest additional questions that can help lead students to a better understanding of the LLN.

### 3.3 Example: Virtual Labs

The Virtual Labs in Probability and Statistics<sup>8</sup> on *Definitions and Properties of Expected Value*<sup>9</sup> can be thought of as a faculty-driven item. The description of this item in the Probability Course Community database is:

This web page contains the definition of expected value for discrete and continuous random variables. It also defines moments and conditional expected value. It contains properties, with proofs, of the expected value: the change of variables theorem; linearity; independence; etc. It also contains a discussion of Jensen's inequality. It also has discussions about expected value for special distributions, some of these are given, some the reader is asked to find (answers are given through a small link at the end of the page). It contains links to simulators and directions for the student to use the simulator to observe various properties. (Probability Course Community Team)

Such a complete exposition on expected value can be used by the teacher as an organization tool for their own thoughts or lecture, or as a resource separate from the textbook. Because it has exercises with answers, it could also be used as a student-driven item. A student who has missed class could be assigned to work through the page to learn missed material. The fact that there is so much material on the webpage could even allow a teacher to assign different parts of the page to different students for in-class presentations. That is, students could be assigned to present a proof in class and be given the page as a resource.

### 3.4 Example: Random Gadgets

The Probability Course Community provides links and descriptions to “random gadget” resources such as dice, coins, and spinners. One example of such a resource is the

<sup>8</sup> <http://www.math.uah.edu/stat/index.htmlpage>

<sup>9</sup> <http://www.math.uah.edu/stat/expect/Properties.html>

National Council of Teachers of Mathematics Illuminations’<sup>10</sup> *Adjustable Spinner*<sup>11</sup>. This spinner allows the user to adjust the number of sectors and the probability with which each of these sectors occurs. The user can spin the spinner once or multiple times. The output includes the corresponding experimental and theoretical probabilities. Thus, the teacher could demonstrate how the experimental probabilities reflect the theoretical probabilities when the number of spins is large. This particular website provides instructions for using the learning object as well as an exploration for students to complete.

#### 4. Future Work: Community Building

The Free Dictionary<sup>12</sup> has several definitions of the word “community.” One is “a group of people having common interests.” In that sense, a community of probability instructors already exists. However, under another definition, the word “community” means “sharing, participation, and fellowship.” Developing this kind of community is a more difficult process in this context.

There are existing models of academic communities that are successful. The Statistics Education community and the AP Stats community have already been mentioned in Section 1.2. Conferences like the US Conference on Teaching Statistics (US COTS) help bring together people with common interests in teaching statistics and research about statistics education. The MAA has Special Interest Groups (SIGMAAs) that are excellent examples of successful communities, sharing common interest through face-to-face and online interactions.

With the Probability Course Community, the educators who are interested in improving the teaching of undergraduate probability now have some additional tools for creating an online community. Interested users are encouraged to develop a sense of ownership in the success of this venture. To this end, they are encouraged to share favorite resources, participate by rating and commenting on existing resources, and create fellowship by discussing the course as a whole.

The growth of the community of users will be monitored as the project progresses. To accomplish this, Google Analytics will be used to provide the total number of page views for the site for specified time periods, such as each month. Google Analytics can also provide how many visitors viewed the Course Community’s homepage and the number of searches.

One difficulty that has been encountered with the previously launched Course Communities is that all the resource average ratings are 3. This happens because automatic systems, “bots,” always choose a rating of 3 when they explore a site like this. While the system team finds a way to exclude bot ratings from the average, users can overcome this disadvantage by reading the comments.

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<sup>10</sup> <http://illuminations.nctm.org/>

<sup>11</sup> <http://illuminations.nctm.org/activitydetail.aspx?ID=79>

<sup>12</sup> <http://www.thefreedictionary.com/community>

## 5. Conclusions

The Probability Course Community Project Team has started the work of creating a Probability Course Community by collecting, describing, and organizing existing, high-quality, online resources around the topics taught in undergraduate probability. However, the website alone does not guarantee the development of a community. A starting place has been established for initiating the type of conversations that create a community. The hope is that the teachers of undergraduate courses in probability will work together to improve the collection by adding new resources, describe the best practices for teaching probability, and build a community to continue to improve the teaching of probability.

## Acknowledgements

This material for this paper is based upon work supported by the National Science Foundation under Division of Education Grant No. 1043879. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation (NSF).

The authors are especially appreciative of the Mathematical Association of America MathDL Probability Course Community project team for their work on this project. The project is directed by Dr. Lawrence Moore, the Principal Investigator of the DUE 1043879 NSF Grant. The Probability Course Community team was led by Dr. Kyle Siegrist (University of Alabama at Huntsville) and assisted by Dr. Ginger Holmes Rowell (Middle Tennessee State University). Other members of the team are Dr. Carolyn Cuff (Westminster College), Dr. Ivo Dinov (University of California at Los Angeles), Dr. Diane Fisher (University of Louisiana), Dr. Dennis Pearl (Ohio State University), Dr. Olaf Stackelberg (Kent State University), Dr. Lisa Green, Ms. Natasha Gerstenschlager, and Mr. Brandon Hanson (Middle Tennessee State University).

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