

Connecting students' homework to their participation in a course-based social network

Dr. A Gavrin, Indiana University Purdue University, Indianapolis

Andy Gavrin is Associate Professor and Chair of Physics at Indiana University Purdue University Indianapolis (IUPUI), and a member of IUPUI's University College faculty. He is a co-developer of the Just-in-Time Teaching method, and an award-winning teacher. He is a member of the Project Kaleidoscope 21st Century Faculty, and of Indiana University's Faculty Colloquium for Excellence in Teaching. His research is focused on the use of technology in science education. He received his BS in physics from MIT, and his MS and PhD in physics from The Johns Hopkins University. He joined the faculty of IUPUI in 1995.

Prof. Rebecca Susan Lindell

Rebecca Lindell, PhD, is a former physics faculty member at Southern Illinois University Edwardsville*. With over 20 years experience in the fields of Physics and Astronomy Education Research (PER), Rebecca is an award winning curriculum developer and has received national recognition for her redesign of her introductory astronomy course at Southern Illinois University Edwardsville. She has redesigned or assisted in the redesign of numerous physics courses at every level. She founded Tiliadal STEM Education in 2014 to allow her to continue to contribute to the field of Physics and Astronomy Education Research. Rebecca received her BS in Physics from Purdue University and her MS and PhD in Physics and Astronomy from the University of Nebraska – Lincoln where she specialized in Physics and Astronomy Education Research.

Connecting students' homework to their participation in a course-based social network

Abstract

This paper presents a comparison between students' efforts on homework (problem sets delivered and completed online using WebAssign) and their participation on a course-focused social media site. The social media platform, CourseNetworking (CN), has many features typical of Learning Management Systems (LMSs), but is distinct in several important ways. The interface is far more "student centric" than traditional LMSs, and is designed to increase engagement; most of the CN window is devoted to student-authored content. Also, the site measures and "gamifies" participation, using an algorithm that includes posts, completion of surveys, comments on other students' posts, and other actions. The setting for our efforts was an introductory calculus-based mechanics class enrolling approximately 150 students, most of whom were engineering majors. Course exams, problem sets, and labs followed a traditional model. Social media participation was not required, but it was encouraged and students could earn a small extra-credit bonus. We investigated correlations between social media "micro-points" and three variables associated with the homework: time on task, points earned, and assignments skipped. Our results show small to moderate correlations and statistical significance in all three cases. Pearson's correlation coefficients are $r = 0.286$, 0.444 , and -0.436 for time on task, points earned, and assignments skipped, respectively. The associated p values are 1.2×10^{-3} for time on task, and $p < 10^{-5}$ for the other two variables. Because the variables we measure are not normally distributed, we verify these results by also calculating Kendall's tau statistic. This analysis confirms both the size and significance of the correlations we observe. We do not suggest a causal connection; rather, our conclusion is that participation in the social network is a form of engagement with the class comparable to traditional measures of engagement such as homework effort and outcome.

Introduction

Social media is, for all practical purposes, ubiquitous among students in higher education. The Pew Research Center estimates that as of 2014, 89% of all Americans aged 18-29 use social media.¹ Although it is less dominant than it once was, Facebook remains the most popular social media site, used by over 90% of social media users. The Pew center data also shows that Facebook users exhibit engagement levels higher than users of other social media sites, with 70% of users visiting the site at least once each day.²

Much has been written describing problems that social media may cause students. Improper use or overuse of social media has been associated with problems ranging from reduced grades^{3,4} to negative body image⁵ and excessive drinking.⁶ Social network addiction is an oft-cited problem in and of itself.⁷ This has caused some faculty members to avoid or actively suppress social media in the academic setting. However, recent studies show that the negative academic effects of social media are primarily associated with multitasking, and that judicious use of social media is not detrimental to academic performance.^{8,9} Indeed, many faculty are beginning to experiment with methods to use Facebook or other platforms as an asset in the academic environment, and that some studies show positive effects.¹⁰ Several social networking systems have now been

designed for academic purposes, notably Piazza,¹¹ Perusall,¹² and CourseNetworking.¹³ Furthermore, use of social media is rapidly expanding in professional practice among scientists.¹⁴

Against this backdrop of uncertainty, we adopted a social media platform specifically designed for the academic setting, and attempted to use it to enhance student engagement with our classes. CourseNetworking (CN) is free for educational use, and has over 100,000 users worldwide. It is a web-based environment that includes both LTI¹⁵ and SCORM¹⁶ interoperability integration, allowing it to exchange information with other academic systems. CN is also FERPA and ADA compliant. CN supports all common browsers and platforms, and is also accessible through iOS and Android Apps.

Although CN includes many of the features of a traditional learning management system (LMS), CN offers several unique benefits, and is quite distinct from typical LMS systems such as Canvas and Blackboard. It is notable that the CN interface highlights student contributions, rather than faculty-defined course structure. The bulk of the screen “real estate” is devoted to a running list of students’ posts and reflections on posts. The appearance is similar to a Facebook “wall.” Students and faculty can post freely to this area in a number of formats, including “posts,” “polls,” and “reflections” on previous input. Posts may include images, videos, links to other online sites, and downloadable files. Students can also “rate” others’ posts. Faculty posts have the same appearance as student posts. The only distinction is that faculty posts remain at the top of the page for a short period before joining the students’ posts in a first-in last-out format. A full list of CN features can be found on the CN web site.

Another feature that distinguishes CN from other LMSs is its system for tracking student activity. CN awards students “anar seeds” (pomegranate seeds) based on an instructor-editable algorithm. The seeds, which we describe as “micro-points” can be earned in various quantities for actions such as creating a new post, reflecting on others’ posts, and rating others’ efforts. When a student logs into the system, he or she is shown their anar seed total as a dynamic bar graph, with comparisons to instructor-established goals and to the maximum number earned by others in the class. This slight “gamification” motivates students to participate. Faculty may also award extra credit for anar seed accumulation.

The first author (AG) implemented CN in an introductory calculus-based mechanics course in the Fall semester of 2015. The setting was IUPUI, an urban, public university, with a total enrollment of approximately 30,000 students. The majority of students commute to campus, and many are employed off campus as well. The course had an enrollment of 150 students initially, with about 85% completing the course. The course used WebAssign¹⁷ for homework, with the text by Tipler and Mosca¹⁸ provided as an e-book linked through WebAssign. The Peer Instruction¹⁹ technique was used in lecture, using the Turning Technologies “clickers.” The LMS provided by the university was Canvas. This was used primarily for its gradebook function, and for a few “high stakes” messages during the semester. CN was used for all day-to-day course communications, including making announcements, distributing handouts, etc. Students could earn extra credit proportional to anar seed accumulation up to a maximum of 5% extra credit for 350 anar seeds; beyond that level, further participation was encouraged but not directly rewarded.

Students were informed in the syllabus and during the first class period that CN would be used as a communications tool, and that the Anar Seeds would be worth a small amount of extra credit. Students find the CN interface easy to use, in part due to its similarity to Facebook and other systems. The first period discussion of CN included a brief demonstration (approx. 3 minutes), but no technical instructions on CN were provided.

Homework was assigned through WebAssign, and consisted of 28 problem sets over the course of the semester. In almost all weeks, two assignments were due, one on Sunday, one on Thursday. Students were allowed 5 attempts at each problem, and the two lowest assignment scores of the semester were dropped. Homework accounted for 15% of the course grade. As described in the next section, we used WebAssign to take three measures of students' homework efforts: time on task, points earned, and assignments skipped. We used anar seeds as a sole measure of students' participation in CN.

Research Question

Based on this data, we wish to answer a single research question. Is participation in CN correlated with familiar behaviors that faculty members consider positive forms of engagement?

In particular, we consider three such behaviors: attending class; attempting the homework; and scoring well on the homework. We use these as measures of engagement since a large majority of faculty would consider these behaviors to be evidence of engagement. Although other measures of engagement are possible, we believe these measures, which directly reflect student behavior are good choices. There will be noise in this data, due to, e.g., students who work in groups, we discuss this and other issues in the analysis and results section, below.

Data collection and extraction

This study relies on data extracted from both WebAssign and from CourseNetworking. In the case of CourseNetworking, only the number of anar seeds earned by each student was used. This data is readily available from the CN roster by download in .csv format. The WebAssign data used here include the total points earned by each student, the total time spent on homework by each student, and the number of assignments skipped by each student. While the total score is easily downloaded from WebAssign, the number of skipped assignments, and the time spent require extraction. This process is not difficult, but neither is it obvious, so we provide a brief summary.

Under the WebAssign grades menu, there is a choice titled "reports." This menu choice brings up a page showing all assignments during the semester in order of due date. Selecting one assignment brings up a report page. The default report is for "current students," thus, it will be blank once the semester has ended. The user must select "All" or "Dropped" to see those possible sets of students. Selecting "All" will produce the desired report, with each row representing a student, and columns for %score, time, total points, and points for each problem. Unfortunately, this cannot be downloaded, so we "scraped" the screen, copying the report portion, and pasting the results into a spreadsheet.

Some additional processing was required, as, for example, time on the assignment for each student is stated as, for instance, 116m, for 116 minutes. Skipped assignments are indicated in the total points column as “NS” for “not submitted” or “ND” for “not downloaded.” For the purposes of this paper, we did not differentiate between these results; however, we did not consider students who earned zero points to have skipped the assignment, as long as they attempted even a single submission.

Examples of student work

Some readers may be interested in a few examples of students’ contributions to CN. With thousands of posts and reflections each semester, it is difficult to give a full picture in the limited space of this paper. However, we would like to note a few categories of posts we believe are important. The samples that follow are verbatim, the grammar and typography are typical of student-to-student communications!

Many posts are focused on seeking or sharing resources. For instance, posts such as “I have seen many of you struggling with the vectors. Here I have something that can help us all” or “Hey y'all! Here's a helpful video about collisions, momentum, impulse, center of mass, and all that other good stuff we've been learning about. It helped me understand it better, hope it helps you too!” In each case, the poster shared a link to online resources (Khan Academy and Crash Course, respectively).

Other posts are focused on requesting or providing help on particular assignments. We encourage this, but let students know that they should give hints, not “formulas” or “answers.” Enforcement of this has not been a major hurdle. As an example, one student asked “Does anyone have any tips on HW 14a question 4 (find the period of the spring)? I'm stuck about how to find m and k. Any help would be appreciated.” To which another student answered “To find k use the net force equal to zero. then use conservation of energy to get the period. In your expression you will need to divide your displacement by 2.”

We would also like to note posts that are more “social in nature.” In one case, a student wrote “Hey team! I just wanted to wish you guys good luck tomorrow. Normally the test is not hard but I just wish I knew what exactly to study.” Another posted “ i actually dropped this class last semester(bad decision) because i thought i wasn't smart enough but this cn networking helped me realize that i shouldn't of done that because i realized that lots of people were in my shoes..... just try your hardest and you won't let yourself down!”

Analysis and results

As discussed above, faculty opinions have been divided on whether the introduction of a social media component would have positive consequences for an academic course. There is potential for enhanced engagement outside the classroom, but there is also a risk that students will invest a fixed amount of time each week for physics, and thus “subtract” the time they spend on CN from the time they spend on other activities including the homework, reading the text, etc. In the analysis that follows we excluded students who formally withdrew from the class and students who informally dropped out (did not show up for the final and one or more exams). We also

exclude two students who had adaptive services exemptions from the use of one or more technologies. $N = 127$ students remain in the sample.

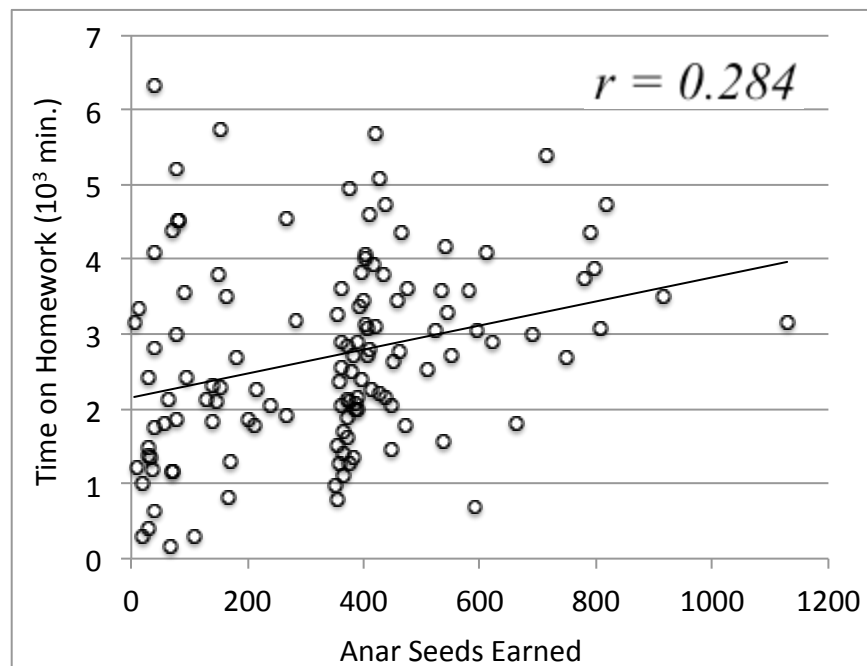


FIG. 1. Time spent on homework as a function of anar seeds earned. The fit is a linear regression, with Pearson's correlation coefficient, $r = 0.284$ and $p = 1.2 \times 10^{-3}$.

We wish to compare students' effort on homework with their participation in CN. We characterize CN participation in terms of anar seeds earned by students. During the semester studied, the median number of seeds earned was 372, with a minimum of 5, and a maximum of 1129. Figure 1 shows a plot of time spent on homework vs. anar seeds earned for all 127 students in the sample. The scatter is large, but there is a clear correlation between the variables illustrated. The line is a regression fit with Pearson's correlation coefficient $r = 0.284$. With $N = 127$, this result is statistically significant, with $p = 1.2 \times 10^{-3}$. We wish to note that r is a measure of effect size.²⁰ Many researchers are accustomed to R^2 , which is a measure of the variance explained by the independent variable in a linear model. Here, we expect that many other factors account for variance, including students' level of preparation in physics, their background in calculus, their work habits, etc. These appear as sources of noise (unexplained variance) in our data. We are not attempting to develop a model that explains most of the variance. This would require multiple linear regression, using additional independent variables such as students' scores in prerequisite courses and work responsibilities, and is beyond the scope of this work. Rather, we wish to characterize the size and significance of the correlation between a well-understood behavior (working on the homework) and a new behavior (participating in CN).

We also note that there is an ambiguity in measurement of time inherent within WebAssign. In brief, the system cannot account for time students spend working but not logged in, or for the

time they spend logged in but not working. This is described in the WebAssign instructor help pages.²¹

We also find a clear correlation between CN participation and homework outcomes. As shown in Fig. 2, the effect is stronger ($r = 0.444$), and also statistically significant. For this correlation, $p < 10^{-5}$. As noted above, there is still substantial variance due to factors we cannot include in this work, such as student preparation. The data shown in Fig. 2 also clearly shows a “ceiling effect.” There is a “perfect score” students cannot exceed, and the distribution of homework points is cut off at that level. As a result, the use of Pearson’s r as a measure of correlation may be questioned, since this analysis generally assumes normally distributed data.²⁰ Although Pearson’s r is quite robust against deviations from normality, we also verify our results using Kendall’s tau statistic, which is completely insensitive to non-normal distributions, and to nonlinear relationships.²² These results are reported below.

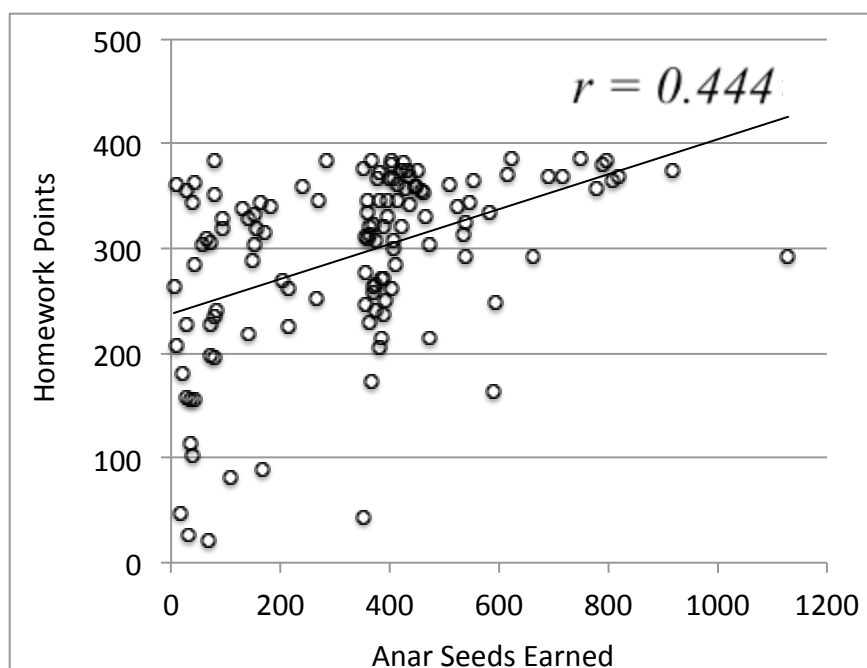


FIG. 2. Points earn on homework as a function of anar seeds. For the fit, $r = 0.444$ and $p < 10^{-5}$.

We also investigated the correlation between students’ use of CN and the number of homework assignments that they skipped. Skipping homework assignments is a strong (negative) indicator of engagement with the course. For the semester described in this paper, no student earned a grade of “B” or higher while skipping more than 3 of the 28 assignments. Figure 3 shows the relationship between skipped assignments and the number of anar seeds earned. Once again, we see a clear correlation, in this case negative, between students’ effort on CN and their effort on the homework.

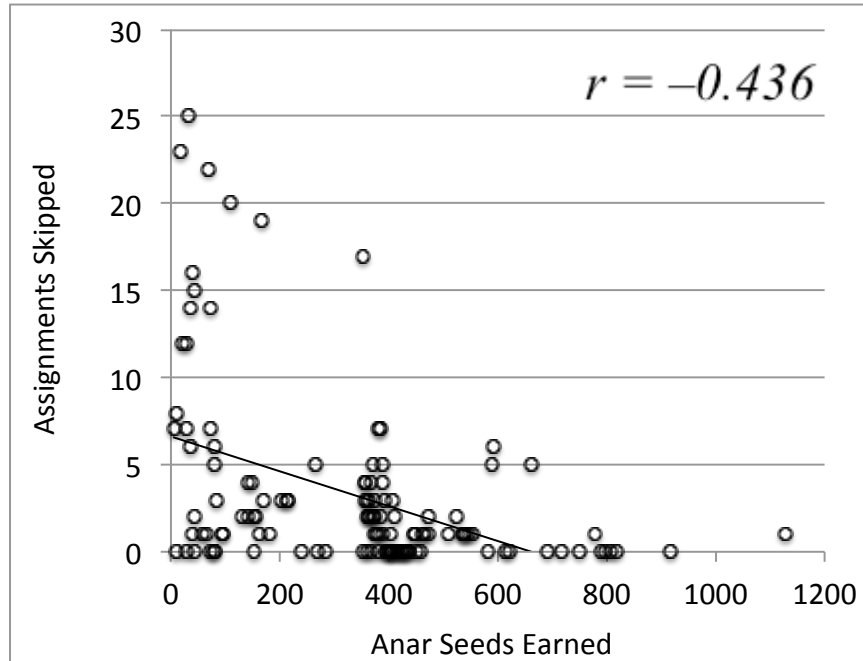


FIG. 3 Number of homework assignments skipped vs. anar seeds earned. Pearson’s correlation coefficient for the fit is $r = -0.436$, with $p < 10^{-5}$.

The analysis above, using linear regression and characterizing the effect size using Pearson’s r , relies on the assumption that the data is normally distributed. This is a common assumption, however, there is good reason to question it. Some of the data is affected by ceiling or floor effects, e.g., near zero assignments skipped, and near zero seeds earned. Also, the number of seeds earned has an asymmetric peak near 350, the level beyond which no additional extra credit was awarded. Pearson’s r is known to be robust against moderate deviations from normality. Nevertheless, it is worthwhile to recalculate the correlation using an appropriate non-parametric test. We carried out this analysis using Kendall’s tau test (version B). This is a robust test that does not require normal statistics or linear relationships.²³ The only requirement is that it be possible to rank order the data. All that is assumed is that the x and y values can be rank ordered, and that the relationship be monotonic. We used the standard implementation of Kendall’s tau in the R language, calculating the correlation between anar seeds earned and each of the three homework-based quantities. For each correlation, we calculate τ_B , which is a measure of the strength of the correlation, similar to r . Given τ_B and the sample size, N , we can calculate standard z -scores, and then statistical significance in terms of p . The results, summarized in Table I, confirm both the statistical significance and effect sizes we identified using Pearson’s r .

Table I. Kendall’s tau test results

Statistic	Time on HW	HW Points	Assignments skipped
τ_B	0.264	0.340	-0.357
z	4.40	5.66	-5.54
p	$<10^{-4}$	$<10^{-7}$	$<10^{-7}$

Conclusions

The correlations between anar seeds earned by students and three measures of homework effort are significant, as established by both linear fits to binned data and by direct calculation using Kendall's τ_B . This strongly suggests that students do not, in fact, "trade off" time in CN for time spent on the homework. Rather, students who spent the most time on CN also spent more time on the homework, earned higher scores, and skipped fewer assignments. This clearly implies that we can treat participation in CN as a form of engagement with the class. Although students' use of CN deserves further study, we conclude that our research question has an affirmative answer: our students' use of CN is positively correlated with measures of effort and outcomes on homework that faculty view as positive. At one level, this may not be surprising, as the most dedicated students will generally take the greatest advantage of new opportunities. On the other hand, the concerns regarding use of social media outlined in the introduction are real, and deserved consideration. In light of our results, we believe instructors who are interested in adopting course-focused social media (either on CN or a similar platform) may do so with reduced concern about potential negative impacts.

In the future, we will continue to explore the possibility that CN use can generally be viewed as a positive form of engagement. This can be accomplished by investigating the connections between students' participation in CN and additional measures that reflect traditional forms of engagement. CN participation can be quantified by earned anar seeds (as in this paper) or by other methods, e.g., numbers of posts. Other traditional measures would include class attendance, visits to the tutoring center, etc. If we can verify the connection between CN and overall engagement, we may find that CN has differential effects for underrepresented students, or for students who have difficulty, e.g., speaking in class. We will also make efforts to improve our implementation. In the present study, little guidance was given to students regarding "what CN is for" and the instructors did not use CN significantly as an instructional tool. We will explore the possibilities for refining our use of CN to enhance learning outcomes.

References

- 1 Pew Research Centers (2014) "Social Media Fact Sheet" <http://www.pewinternet.org/fact-sheet/social-media/> Downloaded 11/29/14.
- 2 Pew Research Centers (2013) "Social Media Update 2013" <http://www.pewinternet.org/2015/08/19/the-demographics-of-social-media-users/>
- 3 Kirschner Paul A.(2010), and Karpinski' A. C., "Facebook® and academic performance," *Computers in Human Behavior* **26**, 1237–1245.
- 4 Junco, R. "Too much face and not enough books: The relationship between multiple indices of Facebook use and academic performance," *Computers in Human Behavior* **28** (1), 187-198 (2011).
- 5 Eckler, P., Kalyango, Y., and Paasch, E. "Facebook Use and Negative Body Image among U.S. College Women," *Women & Health* (2016) DOI: 10.1080/03630242.2016.1159268; <http://dx.doi.org/10.1080/03630242.2016.1159268>
- 6 Rodriguez, Lindsey M., Litt, D., Neighbors, C., and Lewis, M. A., "I'm a Social (Network) Drinker: Alcohol-related Facebook Posts, Drinking Identity, and Alcohol Use," *J. Social and Clinical Psych*, **35** (2), 107-129 (2016).

- 7 Hormes, Julia M., Kearns, B., and Timko, A., "Craving Facebook? Behavioral addiction to online social networking and its association with emotion regulation deficits," *Addiction* **109** 2079-2088 (2014).
- 8 Junco, R. (2015), "Student class standing, Facebook use, and academic performance," *Journal of Applied Developmental Psychology* **36**, 18-29.
- 9 Junco, R. (2012), & Cotten, S.R., "No A 4 U: The relationship between multitasking and academic performance." *Computers & Education*, 59, 505-514.
- 10 Gregory, Peter, Gregory, K. and Eddy, E. "The Instructional Network: Using Facebook to Enhance Undergraduate Mathematics Instruction," *J. Computers in Math. And Sci. Teaching*, **33** (1), 5-26 (2014).
- 11 <https://piazza.com>
- 12 <https://perusall.com>
- 13 <http://www.thecn.com>
- 14 Noorden, Richard, E. (2014), "Online Collaboration, Scientists and the Social Network," *Nature* **512**, 126-129.
- 15 Learning Tools Interoperability is described at <https://www.imsglobal.org/activity/learning-tools-interoperability>
- 16 The "Sharable Content Object Reference Model" is described at <http://adlnet.gov/adl-research/scorm/>
- 17 <https://www.webassign.net>
- 18 Tipler, Paul A., and Mosca, G., *Physics for Scientists and Engineers* 6th edition, W. H. Freeman, New York, (2008).
- 19 Mazur, E. (1997), *Peer Instruction: A User's Manual*, Pearson, Upper Saddle River, NJ.
- 20 Sheskin, David J. (1997), *Handbook of Parametric and Nonparametric Statistical Procedures*, pp. 540-552, CRC Press, New York.
- 21 http://www.webassign.net/manual/instructor_guide/c_i_time_estimate_assignment.htm, accessed 3/18/2016.
- 22 Hervé Abdi, "The Kendall Rank Correlation Coefficient," in *Encyclopedia of Measurement and Statistics*, N. J. Salkind, ed. Sage, Thousand Oaks, CA, pp. 508-510 (2007).
- 23 Sheskin, *op. cit.*, pp. 627-640.