Algorithms for Estimating Learning Opportunity and Productivity Impact at Clerkship Sites\textsuperscript{1,2}

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The purpose of this study was to develop a method for estimating and comparing the consequences of clerkship placements (i.e., learning opportunity) to estimates of clerkship training costs (i.e., impact on site productivity). Three administrators, 14 preceptors, 17 students participating in community, institutional, ambulatory care, drug information, and adult acute care clerkships affiliated with The University of Arizona provided the information used to develop and test two algorithms. Student activity was the unit of analysis used in both algorithms. The learning opportunity algorithm rank-ordered student activities based on the level of involvement, completeness of experience, completeness of experiential learning cycle, and performance feedback. The site impact algorithm rank-ordered activities based on the level of supervision, number of supervisors, training time to participation time ratio, and necessity. Use of the two algorithms can generate information about learning opportunity and impact for negotiating and evaluating clerkship placements.

INTRODUCTION

The clerkship component of the pharmacy degree program provides the student with critical experiential learning opportunities. The standards for accreditation suggest that such experiences should be of “adequate intensity, breadth, and duration” to ensure development of competencies for an entry-level pharmacist\textsuperscript{(1)}.

Increasing numbers of entry-level PharmD programs and students enrollments will necessitate an increased number of experiential placements throughout the professional program. The ability to provide an adequate number of placement sites for current and future PharmD students already concerns coordinators of clerkship programs at U.S. schools of pharmacy\textsuperscript{(2)}. The number of U.S. schools of pharmacy with agreements to reimburse training sites through student-based fees, site-based fees or in-kind support increased from 33 in 1992 to 45 in 1995\textsuperscript{(2,3)}.

The need for schools to develop a method to determine the costs and benefits of training students in institutional settings was recognized over ten years ago\textsuperscript{(4)}. Slack and Draugalis found the body of literature describing studies of the costs and consequences of training health care students inconclusive and, therefore, made the following recommendations: Use a production model to guide the selection of input and output variables, consider the effect the student-preceptor work relationship has on the site output, and conduct research to develop generalizable methods of estimation, rather than additional limited empirical studies (5, 6).

Costs of training were determined to be dependent on the effect of students on site productivity. When student activities were used as the unit of analysis, the Employee (EM) and Nonemployee (NEM) models of student-preceptor work relationships could be used to describe the impact of students on site productivity. Sites appear to have a combination of both EM and NEM activities. The overall impact of training on site productivity is based on the balance of student activities that fit the EM, providing a positive impact on productivity and other activities that fit the NEM, implying a potential for negative effects\textsuperscript{(7)}. Characteristics of student activities that determined if the EM or NEM model described student impact on a site were level of supervision and level of necessity. Level of participation indicated the potential magnitude of the impact.

The consequences of clerkship placements, that is, the impact that sites have on student learning experiences should also be determined. A school should know what a clerkship reimbursement fee is purchasing. Site-specific factors that affect the learning process need to be identified and measured. Preferably, the measures will be independent of the learner, since placements are frequently negotiated for a clerkship program and not an individual student.

Information used to negotiate and promote optimal placements should consider the impact of clerkship placements from both the site and school perspectives and provide guidance for evaluation, revision and negotiation.

METHODS

**Background.** Theory served as the basis for the development of the site impact and learning opportunity algorithms.

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\textsuperscript{2}Presented in part (i.e., the Learning Opportunity Algorithm) as a poster session at the 98th AACP Annual Meeting, July 15, 1997, Indianapolis IN.
Theories by Kolb and Bandura were used to guide the development of the learning opportunity algorithm. Kolb described learning from experience as a four-stage cycle consisting of a concrete experience, reflective observation, abstract conceptualization and active experimentation. The concrete experience stage requires learners to be aware of both an event or action and its consequence. To learn from the events occurring in a clerkship, students must reflect upon the meaning of the concrete experiences and form a personal understanding or theory about it. Students can then test their understanding by actively experimenting and observing the subsequent results. Kolb’s work builds on earlier work by Dewey and Lewin(8).

Understanding the connection between an action and its outcome does not provide the student with information about how well they can perform the action. The student needs to understand both the connection between an action and effect as well as how well they can perform that action. The social cognitive theory developed by Bandura describes self-efficacy, the effect of one’s perception of prior performance success on subsequent behavior (9). This theory provided guidance for considering how students will develop a sense of their ability to perform the actions of a pharmacist. The theories by Kolb and Bandura were used to identify characteristics of clerkship placements that affect a site’s ability to provide students with an opportunity to complete the four stages of Kolb’s cycle and receive feedback on their ability to perform certain activities.

The Nonemployee (NEM) and Employee Models (EM) of the student-preceptor relationship served as the conceptual basis for the site impact algorithm. These two models described the effect of dependent and independent student-to-preceptor relationships on the output produced by a preceptor(6). The unit of analysis (student activity) and its characteristics (level of supervision, necessity, and participation) served as the starting point for the development of the site impact algorithm (7). A student activity was defined as a single function or group of functions that are performed most easily and efficiently by one person.

Participants. Algorithm development was an iterative process that used data from students and preceptors participating in The University of Arizona clerkship program during the 1996-1997 academic year. Fifteen preceptors, three in each of the five required rotations (i.e., community, institutional, ambulatory care, drug information, and adult acute care) were conveniently selected to maximize representation of different sites, locations, facility sizes, and distances from the school. All sites were in Arizona.

The study design was approved by the university human subjects committee. Preceptors from 15 sites were contacted and asked to participate in telephone interviews in mid-January, 1997, for the purpose of obtaining site-specific lists of student activities. This information was used to develop student and preceptor questionnaires for each site.

Questionnaire Development. All student and preceptor questionnaires contained three sections: *(i)* demographic, *(ii)* general clerkship experience, and *(iii)* site-specific activity items. Demographic questions inquired about respondents’ previous experience as a preceptor or intern. The general clerkship experience questions covered aspects of the placement that would affect a student across a variety of activities, such as site facilities, acceptance by the staff, presence of other students, and difficulties encountered because of the placement. The site-specific activity section was divided into direct patient care *(i.e.,* prospective and anticipatory actions taken for a specific patient), indirect patient care *(i.e.,* retrospective reviews or policy development that affects patients in particular populations) and educational activities *(i.e.,* learning is primary goal).

Questions in the site-specific activity section of the student and preceptor instruments focused on different aspects of the clerkship experience. The students were asked about aspects of the experiential learning cycle, variety of experiences, role models, and performance feedback for each activity, while the preceptors were asked about the supervision and necessity of each student activity. The length of the questionnaires varied according to the number of activities at each site. Respondents were encouraged to respond to the questions as well as comment on the instrument’s format and wording.

Responses to the demographic and general clerkship experience questions were used to describe the individual sites and experiences. The responses to the site-specific activity questions were used to test and refine the order of elements in the algorithms.

Data Collection. Packets containing a questionnaire, cover letter, five dollar incentive, and self-addressed, stamped return envelopes were mailed or delivered to the practice sites just prior to the final week of the sixth rotation in early February 1997. Follow-up consisted of one telephone call to nonrespondents approximately two weeks after the initial delivery and mailing of the questionnaires. The initial format developed for the estimation method was a series of worksheets best described as “tables of specifications.” In May 1997, the worksheet versions were tested for ease-of-use and ability to provide useful information. Copies were distributed to administrative personnel at two local sites, a hospital and a managed care organization. After the participants used the instrument, the principal investigator interviewed the individuals to obtain feedback on the quality of the instrument format and information.

Algorithm Development. The initial method developed in the study, a series of tables of specifications, provided a comprehensive means for analyzing each activity. The tables, however, did not organize the activities into easily identifiable categories. Feedback from the administrative reviewers resulted in the development of algorithms that provide estimates that could be completed quickly and interpreted easily by others.

While theory guided the selection of characteristics capable of categorizing activities as negative or positive influences, it did not provide guidance for the actual structure of the algorithms. The site-specific activity data were used to test which characteristics were necessary to determine category status and the order in which those characteristics should appear in the algorithms. During the development process, two groups of characteristics were distinguished: those that defined the direction of impact (positive or negative) and those that defined the magnitude of impact.

Data Analysis. Demographic data were analyzed with descriptive statistics, including means, standard deviations, medians, and percentages. Calculations were conducted by hand and with Systat for Windows, Version 5. Data from the
Interviews and questionnaires were used to test instruments and estimation methods. This study assumed that the responses from participants were true and complete and that the practice sites in Arizona were representative of U.S. clerkship sites.

RESULTS

Participants. Fourteen of the 15 preceptors selected for the telephone interviews participated. All 14 preceptors and 14 of the 17 students (three preceptors had two students) responded to the written questionnaires for an overall participation rate of 90 percent (28 out of 31). After an estimation method was developed, three reviewers evaluated the first version of the instrument. These individuals were two clinical directors from a local managed care organization and one supervisor from a local hospital.

Preceptor experience with the clerkship program ranged from one to 20.5 years, with an average (SD) of 8.1 (5.4) years. The average (SD) time preceptors had been at the current practice site was 8.1 (6.2) years. Six of the 14 preceptors (43 percent) indicated they could accept two students at a time, although during the sixth rotation when the data were collected, only three sites had two students present. Seven of the preceptors (50 percent) take students from other schools of pharmacy or degree programs (e.g., nurse practitioner).

Ten of the 11 female and four of the six male students receiving the questionnaires returned a completed instrument. The student sample was reflective of the gender ratio of the class (36 females: 19 males). The age of the students ranged from 23 to 45 years with an average (SD) of 28.2 (7.2) years and a median age of 24.5 years.

Thirteen of the 14 student respondents had prior work or intern experience, with seven reporting experience at more than one site or type of practice. All but one student (92.9 percent) indicated a willingness to serve as a preceptor in the future, once their practice was established.

Practice Sites. Thirteen of the fourteen sites had at least one student-preceptor pair participating, resulting in two community, three institutional, three ambulatory care, three drug information, and two adult acute care sites. Five practice sites were located in metropolitan areas with populations less than 100,000, and nine sites were located in larger metropolitan areas (populations >500,000). All sites were located within the state of Arizona and affiliated with The University of Arizona clerkship program. One site offered three rotations (drug information, community practice, and adult acute care) although each clerkship was conducted independently of the others.

Algorithm Development. Two algorithms were produced, one represented the school perspective (learning opportunity) and the other represented the site perspective (site productivity). Both algorithms placed student activities into rank-ordered categories and used additional characteristics of the student activities to consider the magnitude of the impacts. The site productivity impact algorithm categorized student activities by potential for positive or negative effects on site productivity. The learning opportunity algorithm categorized the student activities by level of completeness of the learning opportunities offered by the site.

To use the algorithms, a list of activities for a placement site is generated, then the algorithms are used to categorize each activity. The result is a list of activities with a learning opportunity category and site productivity impact category assigned to each activity. The results of the two algorithms could be used to describe a clerkship placement since a common unit of analysis, the student activity, was used in both algorithms.

Site Productivity Impact Algorithm. Figure 1 shows the Site Productivity Impact Algorithm developed to estimate the relative effect of various student activities on site productivity. The algorithm divides activities into categories ranging from a high potential for a positive impact on productivity (A) to a low potential for a negative impact on productivity (H).

The four characteristics of student activities used in the algorithm are level of supervision required for a fully trained student (i.e., student is oriented to clerkship activity), the length of time spent training the student compared to the length of time the student participates in the activity (i.e., the training time to participation time ratio), the number of personnel who may serve as a supervisor, and the necessity of the activity to the function of the site.

Level of supervision was chosen as the first step in the algorithm because it was found to be the primary factor in determining whether impact would be positive or negative(7). All student activities were assumed to be directly supervised during the initial orientation and training period. Preceptors were asked to describe the level of supervision required for each student activity after the initial orientation and training period was completed.

The algorithm used three levels of supervision: direct, indirect, and independent. Direct supervision was defined as the direct observation of a student performing an activity to ensure a successful completion of the activity. Any student activity that required direct observation during at least part of the activity fit this definition. Indirect supervision was defined as reviewing or inspecting the product of a student activity. Independent activities were defined as activities students could perform at the same level of supervision as a licensed practitioner.

In Figure 1, the algorithm paths labeled “G” and “H” represent a greater potential for a negative impact. Activities that require direct supervision throughout the clerkship
will be categorized in this part of the algorithm. The need for direct supervision will cause the greatest decrease in the flexibility of the workload (i.e., ability to shift work activities among the personnel) by requiring two individuals to participate in one activity at the same time.

The negative effects may be moderated by sharing the supervisory responsibility. Activities that may be directly supervised by various personnel at the site will have a lower potential for a negative impact. When the supervisory responsibility is shared, the personnel at the site has the opportunity to shift this part of their workload to the least busy individual or shift other duties away from the person who is designated as a supervisor. This moderating effect is seen in the distinction between an activity that fits the “G” category and one that fits the “H” category.

The algorithm required an additional “training time” step for student activities that could be performed independently or with indirect supervision (i.e., product review) once the student was oriented and fully trained. This step accounts for the two distinct supervision phases found in these activities; an initial, directly supervised training phase and a subsequent, more independent participation phase. During the initial orientation and training phase, a student has the same potentially negative effects on productivity as those caused by students performing directly supervised activities. When the training phase is completed, the student would be in a more independent phase and the effect on productivity would become more positive. The loss of site productivity experienced during the initial training period of an activity should be offset or recaptured by the subsequent contributions made when the student performs the activity with little or no supervision. It is the balance of these two effects that is considered by the algorithm in this step.

To represent the balance of the training and participation time, the algorithm uses a ratio of time-to-train over time-to-participate. The ratio compares the directly supervised training time to the total time the student is expected to participate in an activity. The time-to-participate part of the ratio may vary and is not necessarily the same as the length of the clerkship itself. When the ratio of training time to participation time is less than 0.5, an overall positive effect is expected. When the ratio exceeds 0.5, it means the student requires more than half of the total time just for training and there is a potential for an overall negative impact on site productivity.

For activities that are performed independently, the algorithm places them into either category “A” or “B” depending on the training-time to participation-time ratio (See Figure 1). For activities that require a review of the student’s work (i.e., indirect supervision), the algorithm uses the number of site personnel allowed to review the product in assigning a category. As training time to participation time ratio decreases and the number of personnel allowed to review a student’s work decreases, the category shifts from “C” to “F.”

The last step in the algorithm considers the necessity of the student activity to the functioning of the site. This is applied to activities in all categories, “A” to “H.” Activities that were necessary to site function would have to be performed by site personnel if the student was not present. Students able to perform necessary activities would increase the time available to staff members to pursue other activities, potentially increasing productivity of the site. Conversely, when the student activity was not necessary (i.e., optional or educational only), then the activities that required high levels of supervision had the potential to create a negative impact on productivity by involving site personnel in non-essential activities. While the category designation of an activity is not changed by this determination, the information will be useful in evaluating the impact of an activity.

Additional Site Impact Considerations. The site impact algorithm provided information about the potential positive or negative effects of an activity on site productivity. Estimating the magnitude of the potential impact required a consideration of the frequency of the activity and a determination of which site personnel may be needed to perform the activity if students were no longer present.

For activities that were highly supervised, the source of restriction affecting the students’ independence was considered. If the activity was associated with dispensing, the most likely sources of restriction were state and federal laws that were not negotiable. If the source of restriction was site policy or liability concerns, there was a slight potential for a change to a less supervised status. Activity performance restricted due to school or preceptor preference or limitations of the facilities and supplies are sources of restriction that may be negotiable.

Learning Opportunity Algorithm. Figure 2 shows the algorithm developed to determine the learning opportunity provided by various student activities at a site. It incorporates Kolb’s and Bandura’s concepts at several steps. The algorithm emphasizes the need to connect actions to outcomes and provide information about ability to perform actions in the clerkship learning environment. Student activities categorized as “A” are optimal opportunities to learn, whereas those in the “G” category lack those characteristics.

The first distinction made by the algorithm shown in Figure 2 is the level of student involvement in the activity. The algorithm recognizes that a student may learn from actively participating (Level I), directly observing other participants (Level II) or indirectly experiencing an activity or event through recorded information (Level III). Because the purpose of clerkships is to provide students with an
opportunity to learn from experience, activities that are designated Level I are preferred.

Figure 2 shows that all activities, regardless of level of involvement, are routed to a common second step (Knows Outcome of Activity). This step is based on Kolb’s definition of a complete concrete learning experience as one that includes both an action or event and its outcome. To learn from any activity, the student must be aware of it. To answer “Yes” to this step of the algorithm, an activity must provide the student with an opportunity to gather information (i.e., know) about an event and its results.

If an activity does not provide information about both the event and its outcome, the algorithm will categorize the activity as either “E” or “F” depending on whether the student receives performance information (See Figure 2; Performance is Evaluated). Student activities that are focused on process and performance will tend to fall into these categories. These activities may still offer students an opportunity to learn about their ability to perform based on feedback from others.

Activities that provide complete experience information will be ranked higher (“A” to “D”). Student activities that provide an opportunity for a complete experience may be further examined in the third step of the algorithm in Figure 2 (Learning Cycle is Completed) to determine if they provide the other steps of the experiential learning cycle which Kolb described as reflective observation, abstract conceptualization and active experimentation (8).

The “Learning Cycle is Completed” step in the algorithm differs from the previous step in that it considers and accounts for internal learning processes in Kolb’s model(8). Proxy measures were used to determine whether opportunities for reflective observation and abstract conceptualization were present. Evidence of dialogue and types of discussion topics were chosen as the proxy measures based on Wildemeersch’s observation that learning is basically an act of communication(10). This step also includes the opportunity for students to actively experiment or test their understanding. This part of the experiential learning cycle was measured by asking students how they decided to perform a repeated activity. Activities that appear to provide an opportunity for students to complete the entire learning cycle were ranked higher (“A” and “B”) than those that lacked one or more steps (“C” and “D”).

Unlike previous steps in the algorithm that decided whether students have an opportunity to learn about activities, the “performance evaluated” step determines whether students have an opportunity to learn about themselves and their ability. Bandura’s social cognitive theory provided the basis for adding this step(9). Performance feedback was added as a separate type of learning opportunity for students, because a student may successfully perform an activity without ever knowing the outcomes that resulted from it. Likewise, a student may understand the relationships between actions and outcomes without demonstrating an ability to successfully perform the activity. This step represents efforts to measure the ability-based outcome of a clerkship experience. The “performance evaluated” step further categorizes activities based on whether students receive performance feedback for an activity (compare “A” to “B” in Figure 2).

Activities that offer optimal learning opportunities actively involve the student (Level I) and fit the “A” category. Such activities offer students an opportunity to actively participate in an activity that offers a complete concrete experience, complete learning cycle, and performance feedback.

### Additional Learning Opportunity Considerations

After activities are categorized by the algorithm, one could determine whether an activity lets the student provide direct patient care. Student involvement in the care of patients is one of the recommended clerkship goals in the ACPE accreditation standards(1). Activities may also be reviewed to determine the variety and depth of experiences offered to the students.

Variety of a clerkship placement could be determined by considering the type of patients (e.g., age group), type of illness (e.g. chronic or acute), type of therapy, manner of the direct patient encounters (e.g., face-to-face, chart review), location of the practice site (e.g., outpatient clinic, institution), and role models present during an activity. Variety could also be determined by the type of skills used to perform activities at the site (e.g., problem-solving, communication, team participation, applied pharmacokinetics).

Depth of the learning experience was addressed in part by the algorithm when the completeness of the experiential learning cycle was determined. Additional factors that tend to promote deeper learning is dialogue between a student and a preceptor(10). Indications that students have an opportunity to explore topics in depth through dialogue might be found in the existence of an open, positive relationship between the student and the preceptor (e.g., open line of communication, positive perception of the relationship), accessibility of the preceptor, regularly scheduled preceptor-student meetings, and the availability of sufficient meeting space.

Depth of learning could be further established by determining if students have an opportunity to perform the same

### Table I. Results of algorithm estimates of impact and learning opportunity for student activities offered in a composite ambulatory care clerkship site

<table>
<thead>
<tr>
<th>Student activity description</th>
<th>Site impact</th>
<th>Learning opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Round with the medical team</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>2. Use the computer system</td>
<td>A</td>
<td>F</td>
</tr>
<tr>
<td>3. Give inservice to nursing staff</td>
<td>A</td>
<td>E</td>
</tr>
<tr>
<td>4. Complete assigned readings</td>
<td>F</td>
<td>(A)</td>
</tr>
<tr>
<td>5. Visit and observe other</td>
<td>F</td>
<td>D</td>
</tr>
<tr>
<td>6. Answer drug information</td>
<td>C</td>
<td>E</td>
</tr>
<tr>
<td>7. Outpatient medication counseling</td>
<td>G</td>
<td>E</td>
</tr>
<tr>
<td>8. Evaluate orders for medications</td>
<td>G</td>
<td>B</td>
</tr>
<tr>
<td>9. Monitor drug therapy</td>
<td>G</td>
<td>B</td>
</tr>
<tr>
<td>10. Participate in the patient clinic visits</td>
<td>H</td>
<td>F</td>
</tr>
<tr>
<td>11. Develop and conduct a drug utilization review</td>
<td>H</td>
<td>A</td>
</tr>
</tbody>
</table>

*Created from responses received from individual ambulatory care sites to maintain confidentiality. Activities described in Appendix A.

*Category determined by activity characteristics: level of supervision, training-to-participation time and number of supervisors. Parentheses indicate activities that are “not necessary.”

*Category determined by activity characteristics: level of involvement, use of outcome information, completeness of learning cycle, and provision of performance evaluation.
activity with similar patients (i.e., repetition) or perform the same activity during different clerkship placement (i.e., duplication). Both should contribute to learning opportunity by allowing the student to test their understanding of the situation (i.e., active experimentation) and reinforce their performance self-efficacy.

Other potential sources of restriction for participating in activities could also be explored. Sources of restriction include insufficient supplies or facilities, legal and policy restrictions, and school or preceptor preference. Some of these restrictions will not be amenable to change.

Example. Table I shows the results of the two algorithms’ categorization of student activities offered at a composite ambulatory care site based on the description of the activities (see Appendix A). The composite site includes an ambulatory care site that was associated with a hospital and another one that had ties to a long term care facility. As a result, some of the activities available to students were not limited to ambulatory care activities.

From the practice site perspective, five activities show potential to negatively impact site productivity (Site Impact Categories “G” and “H”). These activities should be further investigated to determine if they may be revised. The activities are medication counseling, medication order evaluation, therapeutic drug monitoring, participating in patient clinic visits, and developing and conducting a drug utilization review (DUR).

The medication counseling and order evaluation activities are both necessary professional activities that would be performed by pharmacists if the students were not present. At this time, both activities are supervised by the preceptor which prevents the preceptor from doing other activities at the same time. The activities occur frequently, on a daily basis, and would have to be performed by someone else if the students were not at the site. The supervision remains high even though the students have been fully trained.

Several changes may reduce the potential for negative impact on productivity. The level of supervision required for these activities depends on state laws implementing OBRA ‘90 mandates. If the state laws consider the clerkship student a substitute for the pharmacist then the negative impact may be decreased by making the activities more independent.

If the level of supervision cannot be changed, then increasing the number of supervisors, scheduling the activity when the workload is lighter or spending fewer hours a day participating in the activity should help reduce any negative effects. Before changes are made, however, a school should consider the activities from the learning opportunity perspective.

Therapeutic drug monitoring and participating in patient clinic visits are also necessary, professional, direct patient care activities. It appears that the preceptor and the student focused on the same patient at the same time for these activities. Therapeutic drug monitoring could potentially be changed to a more independent activity with the student and preceptor working side-by-side, but considering different patients. The students could independently monitor, interview, and assess patients, then submit therapy plans to the preceptor or another pharmacist for review. Clinic visits may also be arranged to allow a student to actively participate with the preceptor by preparing and conducting part of the case load. These activities may be restricted because of policy or preference by the site or school. Liability concerns or the belief that a preceptor must be present during the activity to ensure its completion may be reasons such policies or preferences exist. Increasing the number and type of supervisors will help decrease the impact of the activities. For clinic activities that require supervision by a licensed professional, the student may be able to participate with different disciplines, such as medicine and nursing.

The development and conduct of a DUR was placed in the “H” category. This activity provides indirect patient care. This activity is not restricted by law and could be performed more independently. This is a complex, involved activity that occurs infrequently. The magnitude of this activity’s impact is probably less than the other activities in this category. This activity should be explored to determine the reason for the high level of supervision. A student could work quite independently on this activity and submit work for review at various stages of the project.

The learning opportunity algorithm which represents the school perspective, identified three activities in the “F” category. These activities are using the computer system, completing assigned readings, and participating in patient clinic visits. Discussion could improve opportunity to learn with the assigned readings and computer use. The clinic activity has the potential to become an optimal learning opportunity. Students could actively provide patient care through preparing, interviewing, assessing, and monitoring patient progress in subsequent clinic visits. Cases could be the source of discussion topics and student performance could be evaluated for the various steps.

DISCUSSION
The most important finding of the study was a unit of analysis (i.e., student clerkship activity) that could be used to estimate both student training impact on site productivity and quality of the learning experience. Characteristics of the student activities used in the site impact algorithm reflected effects on flexibility of the workload and necessity. The learning opportunity algorithm used activity characteristics that indicated student awareness of experiences and the completeness of the experience.

The algorithms may be used to determine the rank-order category of each type of student activity. The result of this estimation method is a list of student activities and their ranked category. Unlike methods that produce a summary measure such as a specific dollar value, the list provides sufficient information to allow a site or school to identify and potentially revise activities that are most likely to cause a negative impact or a poor learning experience. Using summary information, such as a dollar amount, may cause site administrators to eliminate an entire clerkship when elimination of one or two activities would be sufficient.

The algorithms developed in this study were designed to represent the site perspective (site impact algorithm) and the school or learner perspective (learning opportunity). Both perspectives should be considered when negotiating clerkship placements. Using the same unit of analysis (student activity) allows both parties to discuss their perspectives on a shared consideration. By analyzing a clerkship placement one activity at a time, sites and schools can identify potential problems. The information is sufficient to guide revision or justify deletion of the activity from the clerkship.
The preceptors’ perspective was not considered as a separate issue in this study. Preceptors were considered to be representatives of the schools regardless of the source of their salary because the presence of students conferred the “preceptor” title on them. The importance of preceptors has been recognized by the number of schools providing rewards for their efforts(11,12). Preceptors appear to play an important role in obtaining and retaining sites(2). The results of the algorithms may provide preceptors with information they can use to request additional supplies, facilities, or support for their clerkship students from both schools and practice sites.

The learning opportunity algorithm developed in this study emphasizes the use of activity outcomes as part of the learning experience (See Figure 2, “Knows outcome of activity” step). Kolb’s description of experiential learning says that a person needs to know about an event and its outcomes to ultimately learn about that experience(8). By assessing whether clerkship activities provide a student with outcomes information, schools and sites may come to view activities as more than just something to be performed. It is also possible that including outcomes as part of the clerkship activities will teach students the skills needed to consider, collect, and use outcomes in practice. Pharmacy graduates will be entering a healthcare environment where having access to and using information about outcomes, especially patient outcomes, will be an important skill.

The ability to perform activities and demonstrate that important skills have been learned has been an important topic in pharmacy clerkship education research(13). This student assessment approach may be affecting how we think about and evaluate the experiential component of our curricula. Perhaps a performance focus was the impetus behind developing the traditional four week placements found in medicine and pharmacy. Learning to perform an activity may require less time at a site than waiting to see the results. The learning opportunity algorithm was designed to balance the use of activity outcomes, dialogue to promote learning, and performance feedback in the site evaluation process. Students will need both information about their ability to perform activities and the outcomes produced to continue learning throughout their professional lives.

The estimation methods for learning opportunity are not intended to be a replacement for student evaluation. Schools should continue to assess the individual learner. The estimation methods described in this manuscript are intended for planning and evaluating clerkship sites. The learning opportunity algorithm was developed to emphasize the opportunity to learn. How a student chooses to use the opportunity is not within the control of the school or site.

The method used to rank order activities should be generalizable to many sites and schools. The use of theory should promote the generalizability of the estimation method; whereas, empirical findings may be confounded by the effect of students on the measures of impact(6,7).

An earlier study that focused on the development of a method for estimating impact assumed that students continuously perform all activities during a placement(7). This assumption led to the conclusion that students should be fully trained in about four weeks based on estimates from research in the physical and occupational therapy fields(14,15). The assumption could be misleading for activities that required a very short training time. Changing this measure to a ratio of time spent in training to time spent participating in an activity should provide a more accurate portrayal of the impact of training.

Activities that require supervision during the initial orientation and training phase may produce negative impacts on site productivity. That impact becomes more positive as students complete the “training” phase and become more independent. One potential use for the training time to participation time ratio may be to determine the optimal length of time (duration) needed for a clerkship. By considering how long should a clerkship placement should last based on the training time needed for the activities, sites may be able to determine how long a placement should be to minimize training costs. Sites concerned about lost productivity during four week placements may decide that a longer placement (e.g., eight weeks) may allow them to recover from losses during the initial training phase.

Schools may find that a longer placement allows the student to experience activities in more depth through additional dialogue with the preceptor and other practitioners, use more outcomes information in learning, and gain more confidence by successfully completing activities. A longer placement may also decrease the variety of sites and role models to which a student is exposed. The question is how does a clerkship experience for a student that uses four sites compare to an experience that uses eight or 10 sites. Schools need to decide how to balance depth and variety of experiences.

**SUMMARY**

Two algorithms were developed to estimate impact of a student activity on site productivity and learning opportunity. A determination of the effects of an activity on workload flexibility and the necessity of the activity to the site can be used to identify student activities most likely to adversely affect productivity. The effects of an activity on the completeness of an experience and student awareness of an experience can be used to identify activities that provide a less than optimal learning opportunity. Both algorithms share the same unit of analysis, allowing schools and sites to discuss and negotiate clerkship placements in common terms.


**References**


(8) Kolb, D.A., Experiential Learning: Experience as the Source of
APPENDIX A. DESCRIPTION OF STUDENT ACTIVITIES AT THE COMPOSITE AMBULATORY CARE SITE

1. Round with the medical team:
Student acts as pharmacy representative for the team and participates in patient rounds by reviewing orders, lab results, and notes, and discussing patient care and outcomes with the team. Rounds are later discussed with the preceptor. The student receives performance feedback. Training time is short. Not a required pharmacist work activity.

2. Use the computer system:
Student gains access to pharmacy and lab databases and may access the system as needed to provide patient care. Pharmacists help the student if asked, but otherwise offer no feedback. Training time is short.

3. Give inservice to nursing staff:
Student prepares an inservice for nursing staff. Preceptor available and will help if asked. Student will receive a performance evaluation for presentation. No training required.

4. Complete assigned readings:
Student receives a series of articles to be read when there are no other activities. Topics in the articles are not discussed. No training required. Not a required pharmacist work activity.

5. Visit and observe other departments:
Student observes activities and outcomes of patient care in other departments. Performance is not evaluated, discussion is limited to the personnel in the department. No training required. Not a required pharmacist work activity.

6. Answer drug information questions:
Student prepares responses to questions and receives feedback on format from preceptor when the response is reviewed, but does not know outcomes of this activity. Training time is minimal to none.

7. Outpatient medication counseling:
Student is supervised during the session by one of several pharmacists. Student receives feedback on counseling but does not know outcome (patient outcome) of this activity. Training time is minimal to none.

8. Evaluate orders for medications:
Student is supervised during the process by one of several pharmacists. Student has opportunity to observe actions and outcomes associated with the activity and to discuss what is seen. The performance is not evaluated for this joint effort.

9. Monitor drug therapy:
Student works with one of several pharmacists on monitoring tasks. Actions and outcomes associated with monitoring are known and discussed. Performance is not evaluated for this joint effort.

10. Participate in the patient clinic visits:
Student observes the preceptor during the clinic sessions. There are no discussions of cases.

11. Develop and conduct a drug utilization review (DUR):
Student works with the preceptor during this activity. Actions and outcomes associated with the DUR are known and discussed. The student receives performance feedback.