Scenario-based Assessment of Learning Experiences

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Abstract – Learning assessment continues to challenge instructors in higher education. Particularly challenging is finding assessment methods that provide insights into both how well a particular learning activity performs, and what can be done to enhance its effectiveness. This paper presents a method for assessing the learning that derives from course-related experiences, both in and out of the classroom. The method uses students’ self-reported learning scenarios as the focal unit of analysis. Students are asked to write two scenarios each semester. One scenario describes a valuable learning experience, and the other a situation where they felt a course-related learning activity was not effective. Results from use of the method suggest it may be a generally effective tool for both assessment and design/re-design of learning activity. Effectiveness of the method is supported by evidence from an object-oriented design and programming course over four semesters.

Index Terms – Learning assessment, scenario-based methods, learning activities.

INTRODUCTION

Innovation in education is driven by designing and implementing new learning activities. Activities are designed by an individual instructor or course committee and carried out by students working alone or in teams and include in-class work or assignments to be done outside of class. A significant challenge is development of methods and techniques for assessing the effectiveness of these innovations as a function of the quality of student learning. In order to understand whether a particular learning activity is better, rather than merely different, requires assessment techniques to help tease out the effects of the innovations we try in the classroom. Assessment techniques should provide instructors with an understanding of the learning effects of an innovation; they should help guide evolution and re-design of learning activities; and they should be cost-effective and time-efficient to employ.

Whatever their perceived value, time spent on assessment subtracts from term and course schedules that are often already overly ambitious in terms of the number of learning objectives instructors set and the number of concepts students must learn to achieve these objectives. Time spent on assessment should therefore be justified by the value of what instructors (and students) learn about a course and its activities and how they are performing in relation to planned learning outcomes. Every course, every instructor, and every section of students is different. A challenge to any proposed assessment technique is that it be prescriptive enough to pick up and use “off-the-shelf” with relatively little effort while at the same time allowing sufficient flexibility to account for these differences and for the different assessment goal of individual instructors.

To be truly useful for instructors, rather than only for administrators and other external assessors, learning assessment techniques should be formative as well as summative [1]. That is, they should tell an instructor not only how well a course is going, but also how it can be improved. An item on a summative, end-of-course evaluation of instructional activities does not provide information sufficient for an instructor to make changes such that those activities better promote and facilitate learning.

Instructors also need to know how well activities in a course engage students in learning and achieving the goals that the instructor sets for them. To do this requires assessment techniques that provide information situated in specific instances of students’ engagement with these activities. Students play a critical role in evaluating learning activities, given that they are the individuals who use the activities to learn. Knowledge about how they engage with an activity and, importantly, their attitudes towards a particular activity, both provide knowledge about the effectiveness of an activity and how it can be improved.

In this paper, we report on the use of a novel technique for evaluating the effectiveness of learning activities. The technique is derived from fields outside of education, in particular, from scenario-based thinking [2], scenario-based design [3], and scenario-based evaluation [4]. Our central conjecture is that the unique attributes of scenarios may help students to more actively reflect on the factors they think of as facilitators and barriers to their learning, and to effectively communicate the results of this reflection to instructors. Beyond the value this information plays as a knowledge base for instructors trying to improve course activities, we also believe that asking students to reflect on these factors may help them become better learners.

ASSESSING LEARNING EXPERIENCES

Effective course activity assessment is critical to the design and improvement of learning experiences. Commonly used student evaluations of teaching (SETs) are relatively impoverished with respect to these goals. SET information primarily concerns teacher attributes and ignores learning
outcomes [5]. The information does not indicate which activities did or didn’t work in the course or the relative quality of various assignments. For example, the common item, “rate the effectiveness of instructional activities,” does not indicate what activities are being rated – all of them, most of them, the early ones, the late ones, the failures, or the successes. Student evaluations ask for global judgments requiring students to aggregate many different experiences of learning into a few responses to general questions. Also at most institutions a common assessment form is used for all courses ignoring instructors’ different pedagogical goals and methods. Such assessment methods provide little guidance on how a course or its learning activities can be re-designed or otherwise revised to be more effective [6]. Instructors may know that something needs to change, but exactly what to change often remains a mystery.

Despite more than 40 years of research the validity of SETs remains doubtful [7, 8]. While experts are in conflict about the ability of SETs to identify the best teachers, they do agree that the instruments do not in themselves help instructors improve practices [9]. For improvement of teaching practices we need assessment that as Cerbin puts it, “reveals how students learn – how they interpret and make sense of the subject, where the stumble, what they do when they do not understand the material, how they respond to different instructional practices” [10]. Assessment methods should be situated in specific instances of students’ engagement with learning activities [11, 12]. Students’ self-reports can play a critical role in evaluating learning activities, given that they use the activities to learn.

In this paper, our interest is discovering new ways to assess, understand, and respond to the learning experiences of undergraduate students in standard, semester-length courses in information sciences and technology (IST). In particular, we are interested in going beyond summative assessments that provide only surface-level understanding of student attitudes towards the activities in which they participate. We are seeking new ways to think about assessment. Hargreaves [13], for example, in her survey of teachers in England, found that assessment can mean many different things including:

1. Monitoring pupils’ performance against targets or objectives
2. Using assessment to inform next steps in teaching and learning
3. Teachers giving feedback for improvement
4. (Teachers) learning about children’s learning
5. Children taking some control of their own learning and assessment
6. Turning assessment into a learning event

We find the scope of these diverse meanings appealing, and suggest that especially points 2, and 4 through 6 are more constructive and useful objectives than those represented in most current assessment methods. Hargreaves’ work is directed against what she perceives as dominant educational policies focused on assessment-as-measurement at the expense of assessment-as-inquiry. She argues that this prioritization is misled by an understanding of learning as obtaining objectives rather than learning as the construction of knowledge.

In this paper, we subscribe to Hargreaves’ view of assessment as inquiry. We are most interested in formative assessment, understanding the effects and outcomes of learning activities and how they can be improved, rather than an evaluative scorecard of what happened in the past. Though such measurements may be a necessity for policy makers and administrators, we argue that they do little to assist the individual instructor in better understanding their students and the effects, both positive and negative, of the activities they design and assign in their courses.

Learning Assessment in Software Design and Development

In a survey looking at the kinds of assessments tools used most often and found most effective in computer science programs, Sanders and McCartney [14] found that of the 12 methods for which responses were elicited, senior exit surveys, alumni surveys, and external advisory panels are the most commonly used methods of assessment. Of these external advisory panels received the highest overall ranking. Overall, however, the survey’s results suggest widespread dissatisfaction with the assessment methods commonly employed by accredited computer science programs. Other methods surveyed included: employer surveys, various written and oral exams, and student portfolio evaluations.

Some researchers have focused on finding ways to assess the specific meta-cognitive skills involved in designing and developing object-oriented software [15]. This work attempts to identify some key skills germane to object-oriented programming and object-oriented design in practice. Among the skills they identify are analogical thinking, decomposition, and others. The article, however, describes a planned assessment only, and no results are provided from an actual implementation.

SCENARIO-BASED METHODS

Scenario-based methods for analysis, design, and evaluation emerged from the work of Herman Kahn at the Rand Corporation during the Cold War [2]. Scenarios were used to help manage the complexity associated with global thermonuclear warfare; they were seen as a significant aid to making the new and the changing dynamics of Cold War relations more tractable. In particular, they helped to ground analysis in the concrete details of situations that might otherwise give rise to more abstract thinking. According to Kahn, scenarios “…force the analyst to deal with details and dynamics that he might easily avoid treating if he restricted himself to abstract considerations.” Scenarios help to ensure completeness and coverage of the problem space, and facilitate grounded, multi-dimensional, multi-level thinking.

More recently, scenario-based methods have been used for design of complex information systems and technologies.
Scenarios are seen as a critical bridge between the inherent messiness of complex human social activity and the formalisms required to capture and represent designs for engineered systems. They help maintain a focus on the real work being done by users and other stakeholders on systems design projects.

Scenario-based design methods have been adapted as an approach to evaluation of complex, distributed information systems [4]. As with scenario-based design methods, scenario-based evaluation is an effective means to use real-world situations as the basis for structured analysis of the causal forces behind phenomena of interest. People generally find scenarios easy to identify and discuss, as they make up the patterns of their everyday life. The use of scenarios as the basis for evaluative discussions is effective because the technique links more general statements to actual activity.

**SCENARIO-BASED ASSESSMENT OF LEARNING EXPERIENCES**

In our course on object-oriented design and software applications, we have found a number of barriers to effectively understanding student experiences with the learning activities they work on as part of the course. Our college uses student rating of teacher effectiveness (SRTE) as its primary means of assessing student satisfaction with a course and its instructor. These SRTEs provide very little insight into the specifics of what went wrong and what went right over the course of a semester, and provide no support for understanding and improving the specific learning experiences of the students in a class.

Development of the method described here was motivated by our desire to understand student perceptions of learning activity effectiveness, in their own words, and relative to the specific activities in which they engaged. We wanted to understand what makes some learning activities effective and others ineffective, to understand the why underlying students’ perceptions of their experience with a particular assignment. Further, we sought to understand more about the context in which learning activities occur, both within and outside of the classroom. Finally and importantly, we wanted an assessment method that would inform design and re-design of more effective learning activities.

**SCENARIO WRITING ASSIGNMENT & ANALYSIS**

Students in a third-year object-oriented design and programming course were given an assignment to write two scenarios related to course activities and their learning experiences while engaged on these activities. The assignment was given about three-quarters of the way through the semester. Students had already worked with scenario-based methods as part of the course core-curriculum.

The scenario-writing assignment was described as follows.

1. One course scenario (an in-class discussion or activity, or an out-of-class activity or assignment) which you feel was an effective learning opportunity.
2. One course scenario (an in-class discussion or activity, or an out-of-class activity or assignment) where you feel the activity was ineffective as a learning opportunity.
3. For each, make sure you include why the activity was effective or ineffective.

Each scenario was required to be one page in length, and to follow a specific format with specific components.

**Scenario Title** – short description of the scenario.

**Actor** – Usually you the student.

**Setting** – a description of the context in which the scenario takes place (e.g., in class or outside of class).

**Scenario Goal** – the objective of the interaction with the application being designed.

**Scenario Narrative** – a detailed account of the activity.

**Claims Analysis** – statements of why the scenario is effective or ineffective as a learning opportunity.

This format and set of scenario components was derived from [3] and made use of ideas from scenario-based evaluation [4] as well as scenario-based design. Students were given double credit for the assignment, and were asked to be thoughtful and honest in order to receive full credit.

**REPRESENTATIVE RESULTS & DISCUSSION**

A total of 92 scenarios were collected from 46 students. Per the assignment there were 46 positive and 46 negative scenarios. The scenario texts were analyzed using the grounded theory approach [17]. The focus of the analysis reported in this paper is on what students identified as the most significant facilitators of (positive scenarios) and barriers to (negative scenarios) effective learning activities. This section provides a representative sample of some of the most significant factors that appear to affect learning effectiveness. The most significant five factors are given for identified Learning Facilitators and Learning Barriers.

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>LEARNING FACILITATORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td>Facilitator</td>
</tr>
<tr>
<td>34</td>
<td>Collaboration opportunities</td>
</tr>
<tr>
<td>33</td>
<td>Coaching</td>
</tr>
<tr>
<td>18</td>
<td>Opportunities for practice</td>
</tr>
<tr>
<td>12</td>
<td>Activity sequence success</td>
</tr>
<tr>
<td>12</td>
<td>Effective demonstration</td>
</tr>
</tbody>
</table>

The following provide descriptions of the codes, and selected examples are given italics.
Collaboration opportunities

This factor refers to activities that involve group or team project work in or out of the classroom. Students appear to benefit and enjoy the multiple perspectives and diversity of ideas that are brought together in these activities. Especially important to them are opportunities for collaborative work in class. Some examples from the student scenarios:

“This is also an effective method for learning because it allows for those who do not understand the assignment as well the opportunity to learn from their peers as well as from the professor.”

“This scenario was effective because it gave all of the students a chance to participate and give ideas without having to worry about getting a bad grade for the wrong answer.”

“I would imagine that most jobs involving design would be set up in teams, this type of learning helps improve the ability to work in groups and gives the student more perspective.”

Coaching

Coaching refers to activities that are carried out in a problem-based learning environment with the instructor and teaching assistants circulating to prompt and direct individual students or project groups on work related to project deliverables. Included in this factor are displays of expert performance, demonstrated techniques for reaching solutions and partly completed examples that act as scaffolds for student learning.

“By having a meeting with the professor the student was able to offer ideas and get an immediate response. This allowed the professor to continue to challenge the student in the same fashion as problem-based learning with[out] the long turnaround time associated with grading.”

“We went over the assignment step-by-step as a class and everyone participated. It ended up taking a good portion of the class but I learned a lot from it.”

“Generally, it’s always better to begin to work on assignments in class and have the instructors and TAs there to answer any questions we may have.”

Opportunities for practice

Students are increasingly resistant to the idea that they learn from activities involving rote memorization. Especially in classes such as this on object-oriented design, they recognize the importance of doing, of opportunities to reinforce their understanding of concepts introduced in lectures or from assigned readings.

“This was a very good learning experience because we were forced to work through a problem by ourselves as homework, but the next day in-class review the problem together.”

“By allowing the students to have time to work on new concepts, the “hands-on” experience helps engrain the material and [is] more effective.”

Activity sequence success

This factor marked student quotes that referred to the importance of activity sequence as a facilitator of learning. Some of the issues identified were directly related to the use of problem-based learning, but others pointed to more subtle aspects of sequencing, such as the need for concept-demonstration-practice when being exposed to new topics.

“This scenario was a very effective learning opportunity because it allowed us to get a feel for the class diagram while we were still in class.”

“There are three advantages in using this method. The student gains a conceptual idea of inheritance. Implementation of inheritance is shown and the student gains better knowledge on implementing the example. Code is also explained to the student and they can ask questions about any parts they do not understand.”

Effective demonstration

Many of the problem-solving techniques introduced in this object-oriented design course are inherently messy and do not have fixed algorithmic sequences. Demonstrations of a particular technique appear to be one way to introduce students to methods that can be applied.

“The interactive class lectures which involved student/teacher discussions were effective learning strategies, because I was able to watch the diagramming process and study an example which helped me learn the concept much better than just lectures and readings from the text.”

“During the lesson another student had an alternative to the way we were designing the diagram. We made changes to the diagram to represent the students. In doing this I could see pros and cons of each solution and it really solidified my understanding of the concepts.”

TABLE 2 LEARNING BARRIERS

<table>
<thead>
<tr>
<th>Count</th>
<th>Facilitator</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>Insufficient bootstrapping knowledge</td>
</tr>
<tr>
<td>25</td>
<td>Activity sequence problems</td>
</tr>
<tr>
<td>22</td>
<td>Course materials</td>
</tr>
<tr>
<td>16</td>
<td>Relevance conflict</td>
</tr>
<tr>
<td>15</td>
<td>Bad examples</td>
</tr>
</tbody>
</table>

Insufficient bootstrapping knowledge

This factor describes cases where students identified lack of initial ‘bootstrapping’ knowledge as an impediment to learning. Again this factor may relate closely to the use of PBL on the course. Students are often given assignments with little or no introduction beyond any assigned readings. They are in effect asked to struggle with solving the problem before any in-class discussion takes place.

“This situation is very common, at least once per week, however the same problem is encountered with every occurrence - students not understanding enough about the
Interestingly this code represents the inverse of the high-density, positive factor Activity sequence success. This version, however, suggests that lack of appropriate activity sequencing can have just as significant a negative impact as the positive version has on learning success.

“I turned the program in before it was working correctly, because I had to study for the quiz. I was expecting a class lecture on the vectors the next day, but we were given a work day instead. I wasn’t too happy with this, since I was still confused about the assignment and wanted to learn how to use vectors correctly. I realize the value of using vectors and they will be utilized in our final project.”

“What I am proposing and offering is that the homework for the specific topic be assigned after the material has been introduced, demonstrated as a case in point, questions fielded, and discussed.”

Course materials

This learning barrier represents student-identified issues with some of the more routine aspects of the course design, such as the book chosen, the software development environment used, and other supporting materials.

Upgrading to a newer book and using a common application for the programming both in the book and in the classroom would be a much more effective way to develop the programming aspect of a class which is based mostly on the design of programs as opposed to their actual coding.

Relevance conflict

This category refers to cases where students appeared sensitive to the relevance of material covered and activities assigned in the class. Object-oriented design is an applied discipline and because many students already have experience developing software in real-world contexts (e.g., on internships) they are critical of situations where the applicability of their work does not directly map to problem solving scenarios in the field.

“This type of event is a bad test of true understanding and aptitude because it is essentially a situation that a programmer would never find him or herself in.”

“The CRC cards themselves are fairly easy and quick to fill out so the homework wasn’t too hard, but I found the CRC cards themselves to be a useless instrument in our actual car dealership domain’s software design. As we moved on to other activities and made other diagrams, I found that the CRC cards were never looked at or referred to again in the future design discussions.”

Bad examples

Students are sensitive to the relevance and quality of examples that are presented in class. Completeness and correctness of examples are among the attributes that appear to detract from the learning experience.

“We rarely ever get the diagram finished in the time allotted and that hurts the learning process because the students never see a finished diagram to help them when they are creating their own diagrams.”

“The student refers to the … book for correct syntax and format of the code. As the student continues through the code they run into constant problems with errors and the examples in [the book] prove to be ineffective because they are very simple when compared to the scope of the homework assignment.”

DISCUSSION

Scenario-based evaluation appears to be an effective means of helping instructors to reflect upon their course, class, and assignment designs from the perspective of a course user. By focusing on concrete scenarios rather than the broader abstraction of the course as a whole, instructors are better able to address these specifics through course design interventions and other innovations.

Our analysis of the scenario data helped identify a number of errors in course activity design. These ranged from ‘meta-errors’ such as activities out of sequence in the overall context of the course and its goals to more microscopic problems such as the use of an inappropriate or misleading example to demonstrate some point. The rationale given for why some activities did not work well often provided guidance of how the activity could be tailored to better fit student requirements.

One pervasive and useful theme in discussions of negative learning activities involved students identifying where they felt they possessed insufficient ‘bootstrapping’ knowledge to successfully complete the activity. By bootstrapping knowledge we mean the conceptual knowledge required to engage effectively with a problem. Because the course under study employs a form of problem-based learning, it, like other PBL courses, is often criticized by students who feel they are being given problems without the conceptual tools to solve them without becoming frustrated. Likewise, because this assessment approach provides the instructor or evaluator with some causal information about the source of student frustration, it supports discriminating between more routine complaints that are germane to PBL and cases where upon reflection, and with the help of the students’ detailed accounts, instructors can see that the students truly did lack the conceptual background to engage in the task.

The level of detail provided in SBA is again a key benefit of the method in terms of its ability to highlight where students have either not learned a foundation concept...
or learned it incorrectly. The detailed accounts help differentiate between cases where a topic was not covered in sufficient detail or not covered at all, for example, due to on-the-fly changes to topic coverage such as those brought about by emergent time pressures.

We found that one of the key strengths of the method is its ability to identify opportunities for change, for re-design, evolution, and elimination of course activities. Student accounts coupled with activity design insights and experience of the instructor represent a powerful knowledge base for facilitating understanding and action to make courses better. Identified activities that students enjoy, that are effective learning experiences, and that fit within the constraints of the course structure act as exemplars that instructors use as models for other activities derived from their basic structure. The detailed accounts provided by claims analysis also help to identify the underlying causal mechanisms that make an activity enjoyable and effective. These mechanisms are often more general, and therefore transferable to a wide variety of learning contexts.

As a result of students’ self-reported scenarios and claims analyses, a range of changes were made to the design of course activities. As a simple example, substantially more time was allocated for in-class collaborative and group work. This was in response to student claims that collaboration opportunities are among the most important learning facilitators. We continue to seek ways to incorporate changes that leverage the knowledge we have gained from employing the method.

As both a formative and summative method, scenario-based assessment (SBA) should tell us not only what to do going forward, but also how effective activities have been in helping to achieve the aims of the course. The ultimate aim of a course, or any learning activity for that matter, is, of course, to learn. As discussed above, one of the strengths of the method is in its ability to help identify the causal factors that lead to positive and negative learning experiences. A positive learning experience should help a student see how concepts and skills are combined to solve problems they are likely to face in their chosen field. A learning experience reported as negative can still be positive in terms of its educational outcome, but not always. The detail provided in SBA accounts allows instructors to differentiate between experiences reported as negative, but central to instructor objectives, and those that simply detract from student morale and their attitudes towards a course.

Standardized SETs have the advantage that their results are comparable across heterogeneous courses and instructors. This standardization comes at a cost however, because the level of abstraction required to be standard makes them ineffective for helping to explicate what is going wrong or right and what can be done to correct or enhance it.

Course assessment can go beyond coarse-grained measures of learning outcomes. Time spent on assessment is valuable. The greatest possible value should be obtained for time spent on design assessment methods, collecting and analyzing data, and interpreting and reporting results. In particular, assessment methods should provide measures of the effectiveness of different techniques and activities, they should help instructors and evaluators to understand where things are going well, so that successful techniques can be used to their fullest potential, and they should suggest course and activity designs to address the issues they identify.

CONCLUSION

We found that the use of scenario-based activity assessment was effective in bringing to light both the breadth and depth of information regarding student perceptions of effective and ineffective learning activities. Because the scenario-writing task asked for both positive and negative scenarios, the method helped identify successful activities and activity types to be continued, extended, replicated, and evolved, while at the same time eliminating or changing activities widely perceived as ineffective.

There are fundamental differences between the objectives of assessment as measurements and assessment as inquiry. In this paper, we have argued that for individual instructors and communities of instructors in the same field, scenario-based methods of learning experiences may provide better material for understanding the students they teach and coach, understanding the context of learning, and understanding how activities can be designed and re-designed to be more effective.

The research and techniques reported here are concerned with gauging student perceptions of specific learning activities. As such they are most likely not appropriate for evaluation of large-scale curricular innovations or even of a single course in aggregate. The particular value of these techniques, we believe, lies in their capability as an approach to understanding the effects, outcomes, and psychological consequences of learning activities, and for identifying how these activities can be improved to provide more effective learning.

REFERENCES


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