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Weekly Self-rating of Proficiency with Course Learning Objectives: Gaining Insight into Undergraduate Students' Perceptions of their Learning

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Abstract

Quizzes, mid-term examinations, and homework are common ways educators assess students' understanding and abilities with course content. While these formative assessments provide more insight when they are tightly aligned to the course learning objectives, they still do not reveal students' perceptions of their learning progress and challenges throughout the semester. Though some common problems may be revealed through in-class dialogue, even in smaller courses, it can be difficult to precisely assess the problems students perceive they are having. By using students' self-rating of their proficiency with course learning objectives (as a component of self-reflection), instructors can gain deeper insight into students' perceptions of their learning and make timely instructional adjustments. This study aims to examine twenty-eight undergraduate agricultural and biological engineering students' self-ratings of their proficiency level with learning objectives following weekly assignments in a process engineering course. These responses, in conjunction with results from the learning-objective based grading of students' work by the teaching assistant were analyzed to determine patterns in students' learning needs as the semester progressed. Examples of inferences about students' struggles that the instructor drew from the results of students' self-ratings and actions that the instructor made or plans to take are discussed.

I. Introduction

University instructors write course learning objectives, and they may even use these as a guide to designing their instruction as per backward design [1], but they rarely use them as the basis for regularly identifying students' learning challenges and needs. Learning Objectives (LOs) are written statements that describe specific competency in knowledge, skills, and abilities (KSAs) that students are expected to demonstrate [2] in a course. They are typically introduced to students at the start of a class session, unit, or assignment to frame the intended learning. After which, they are seldom referred to again [3], but herein lies an incredibly missed opportunity.

Clearly articulated LOs can be used as the basis for assessment, particularly in criterion-referenced assessment strategies like Standards Based Grading (SBG) [4], also referred to as Specifications Grading. In this assessment strategy, the LOs become the assessed items in rubrics. Each LO in the rubric is used to assess a student's demonstrated level of proficiency as seen through their work on a course artifact (e.g., homework, presentation). The use of LOs as the basis for assessment in this way makes assessment more transparent and fairer to students since there is a clear link between stated intended learning and what is assessed [5]. Examples of the use of SBG in engineering have been presented by numerous authors e.g., [6]– [9]. Further, the benefits of consistently using LO-based rubrics have also been discussed as a means of generating actionable assessment data and providing evidence of students' challenges and needs that can be acted on in the short term (e.g., immediately in class) or in the long-term (e.g., redesign of course materials) [10].

Unbeknownst to many instructors, LOs can also be used regularly to discover students' learning challenges and needs through students' self-assessment of their proficiency level with course LOs, thus allowing instructors access students' perceptions of their learning and learning challenges [11]. This access to students' perceptions of their learning can mitigate the problems associated with late awareness of students' learning needs and difficulty in identifying specific students with learning challenges prior to critical exams. When instructors are not able to identify students' challenges and needs, unaddressed learning needs tend to fester and can affect students' abilities to understand and apply course contents within and outside of the classroom, leading to low performance in the course and frustration for both the students and instructor.

The purpose of this work is to demonstrate how LOs self-assessment by students can be integrated into an agricultural and biological engineering course. Further, this work will show how the results can be harnessed by instructors to improve students' learning experience. More specifically, in this study, students' weekly self-assessments of their proficiency with the LOs were evaluated in conjunction with the results of the LO-based grading of students' work, to identify patterns in students' proficiency levels and their learning needs across the course. These patterns are discussed from an instructor's perspective to make meaning in terms of instructional actions.

II. Background

Learning Objectives (LOs) are the foundation for developing a course curriculum [1], [12]. As they provide the detail for achievement of course outcomes (the broader statements of student learning that appear on syllabi), the importance of specific, measurable, achievable, realistic, and time-bounded (SMART [13], [14]) LOs to students' achievement of course outcomes in a degree program cannot be overstated. Since ABET identified student outcomes, in areas such as problem solving (Outcome 1), communication (Outcomes 3), and technical knowledge and skills (Outcomes 1, 2, and 6), as being important for the professional practice of engineering [15], engineering programs have focused on the alignment of course LOs, curriculum (e.g., class activities, tasks, projects), and assessment to achieve the various educational outcomes necessary for professional practice.

Two weaknesses of the alignment between the LOs and their assessment is that instructors rarely use LOs as a basis for student assessment, and students are rarely asked to use them as the basis of self-assessment of their abilities. When explicitly using LOs for assessment, instructors are better able to ascertain the extent to which students are achieving the LOs [3], [16], [17]. When students are asked to reflect on their abilities by referring explicitly to the LOs, their attention is drawn to what they should be learning and how they are learning, which not only builds students' reflexive capacity but also reveals to instructors' information about their students' perceptions of their learning. In this study, these two ways of using LOs are brought together to provide instructors with ways of accessing information about students' learning.

When considering using LOs as the basis for student reflection, the theory of self-regulation has bearing. According to Zimmerman [18], self-regulation consists of three phases: 1) forethought, 2) performance, and 3) self-reflection. During the forethought phase, students, driven by self-motivation, set goals and make plans to achieve them. Goals are standards against which students compare their performance. In the performance phase, students carry out actions according to their plans and take ownership of their learning. During the self-reflection phase, students evaluate their performance in comparison to the standard, they identify causes for success or failure, and they either make corrections (adaptive response) to increase their self-satisfaction and motivation [19] or they avoid learning opportunities (defensive response) and reduce the efficacy of self-regulated learning [20]. At the heart of the phases of self-regulation are the standards that students use to formulate their goals and evaluate their performance. These standards can be students' interpretation of the course LOs which then serve to anchor or center students' reflections and learning. There have been a limited number of studies in which LOs have served as the anchor for reflection [11], [21].

This present work examines part of the self-reflection process undertaken by junior and senior agricultural and biological engineering students in which they self-assessed their proficiency with course LOs related to weekly assignments. Comparison to the LO-based grading of students' proficiencies as demonstrated through the assignment work are also made. The focus of this work is on the inferences that instructors might make about their students' learning from their weekly self-ratings of LOs that assessed their problem-solving, communication, and technical abilities. This study proposes a novel assessment technique, which asserts that students' self-assessment of their abilities with the course learning objectives is instrumental in helping instructors understand students' challenges and needs.

III. Research Questions

The following research questions are addressed in this study:

1. What insights about students' learning needs can be gained from students' weekly self-assessments of their proficiency with course learning objectives (LOs) ?
2. What can instructors infer from the patterns in students' proficiency with the course LOs for the purpose of instructional improvement?

IV. Methods

A. Setting and Participations

This study was conducted in an introduction to process engineering course offered in Spring 2021 by a department of agriculture and biological engineering at a midwestern research intensive (R1) university in the United States. The participants in this study were junior and senior level engineering students from two department majors who took this course as either an elective or a required course. The total number of students enrolled in this course was (N=28) with a male to female ratio of 3:1.

This course was delivered as a flipped class that met twice weekly for 75 minutes via zoom web conferencing due to the COVID- 19 pandemic; class time was predominantly used to launch assignments and project work. This course consisted of four units distributed across twelve training assignments. The units were Conservation of Mass (CM). Fluid Flow (FF), Fan Selection (FS), and Thermal Preservation (TP) (Table 1). As shown in Table 1, trainings were denoted by two digits, the first digit represents the course unit while the second digit represents the training number for the course unit. For example, 1.1 connotes the first training for the conservation of mass unit, while 4.2 connotes the second training for thermal preservation unit.

Table 1. Trainings assigned to each course unit

Weeks	Unit	Training
1-3	Conservation of Mass	1.1 - 1.3
4-7	Fluid Flow & Pumps	2.1 - 2.4
8-10	Fans Selection	3.1 - 3.3
11-12	Thermal Preservation	4.1 - 4.2

At the beginning of the semester, the syllabus, course outcomes, and a comprehensive list of LOs were presented to the students. The LOs were named with suffix identifiers that represented the course unit or sub-units, and sequential numbers that indicated the main LOs and sub-LOs. For example, the LOs related to problem-solving methods and computational tool used the “PS” suffix, while the LOs for technical skills used “FF” for the conservation of mass and fluid flow units. “FA” and “TP” prefixes stood for fan selection unit and thermal processing unit, respectively. For this study, only data associated with the “PS” and “FF” LOs were examined.

B. Intervention

Each week, the instructor assigned a training which consisted of one or two authentic problems related to the course unit focus for the week, along with eight to fourteen LOs for the unit. After submission of their work on the problems, students compared their work to a solution key, making notations on the nature of errors or opportunities for improvement and what needs to change. Then the students performed a reflection activity as part of each assignment. This activity consisted of two parts, students’ self-ratings of their proficiency level with each unit LO and a written reflection in response to prompts that asked them to consider their plans to improve on any LOs they perceived they could not demonstrate during the assignment, also what helped and hindered their learning of each LO. Only students’ LO self-ratings were examined in this study; their written reflections were examined in [22] and [23].

The LO self-rating activity was administered following each training to students as a Graded Survey via Canvas, the university's learning management system. For each LO, students were required to choose one of five phrases that best described how they perceived their proficiency level with the stated LO (Figure 1).

PS 01.03 Draw a sketch that clearly represents the problem being solved

- I can do this on my own without referring to resources
- I can do this on my own if I refer to some resources
- I need more practice with this
- I need someone to help me understand and do this
- I am not sure what this means (I am very lost)

Figure 1: A sample of LO reflection prompt and self-rating options

For each LO, the desired LO proficiency level is described. For example, to demonstrate proficiency with LO PS 01.03 (i.e., draw a sketch that clearly represents the problem being solved), a student must clearly label problem components and ascribe their appropriate unit. Course resources such as recordings of class videos, PowerPoint slides, Microsoft Excel templates for the assignments, course FAQs, grading rubrics, and solution keys were made readily accessible to students throughout the semester via Canvas. Grading for problem-solving and communication was done by a graduate teaching assistant (GTA) who was trained and mentored by the instructor. A standard-based grading rubric [10] guided the GTA's assessment of students' performance level in line with the LOs. Feedback from the GTA was available for students to use to improve their work on subsequent assignments.

C. Data Collection

Students' perceptions of their ability with the course LOs were obtained from their responses to the weekly reflections. More specifically, the data collected were the students' LO self-ratings associated with all twelve training reflections. As the details of the unit changed on a weekly basis, the LOs featured in the reflections were accordingly updated, with some LOs being removed, some new LOs added, and others being retained or brought back from earlier reflections as warranted by week's class instruction or activity required in the training. For instance, the LO PS 01.00 (i.e., employ a robust problem-solving process that clearly documents engineering work) was repeated across two Fluid Flow, three Fan Selection, and two Thermal Preservation trainings.

Twelve reflection activities were collected as Graded Surveys in Canvas. This enabled the students' LO self-ratings to be downloaded from Canvas as a CSV document. The current Canvas capabilities allow for easy viewing of the results of each LO self-rating in a histogram format through the Survey Statistics option. In the CSV format, the data collected were students' ID (later de-identified), date-time stamp for their self-ratings submission, the LOs covered in the reflection activity for a specific training, and students' LO self-ratings in text format. The CSV files were converted to Microsoft Excel editable format for data analysis.

In addition, students' performance on select LOs was collected from the rubrics used by the GTA to grade the trainings. Rubrics were used to assess only those LOs common to all trainings (e.g., overall problem-solving skills and communication of problem results). Outcomes were constructed in Canvas for each instance a LO was used, and these Outcomes were used to build an LO-based rubrics. This allowed students' performance on each LO for each training to be downloaded from the Learning Mastery version of the gradebook in Canvas. This is an error prone process, resulting in some manual verification of the data being necessary to ensure proper recording of the LO performance data. LOs were assessed on a five-point scale of Proficient, Developing, Emerging, Insufficient Evidence, and No Attempt as described in [10].

D. Data Analysis

Quantitative data analysis consisted of determining for each LO self-assessed in each training, the percentage of students with self-ratings at each of the five LO proficiency levels (Table 2). Similarly, when LOs were explicitly graded by the GTA, the percentage of students at each of the five LO performance levels was determined (Table 3). It should be noted that the GTA's grading on any assignment was often for a fewer number of students because not all students submitted their assignments for grading. Students who did not submit their assignments were allowed to review the solution key and submit a reflection on their learning. The frequency of the LO-self ratings and LO-based grading data was then represented graphically using color schemes shown in Table 2 and 3.

Table 2. LO self-rating options denoting different proficiency levels

LO Self-Rating Options	Short Version	Color Code
I can do this on my own without referring to resources	Without Resources	
I can do this on my own if I refer to some resources	With Resources	
I need more practice with this	More Practice	
I need someone to help me understand and do this	Need Help	
I am not sure what this means (I am very lost)	Lost	

Table 3. LO-based grading proficiency levels

LO Performance Level	Color Code
Proficient (>80% of proficiency items demonstrated)	
Developing (70-80% of proficiency items demonstrate)	
Emerging (50–60% of proficiency items demonstrate)	
Insufficient Evidence (< 50% of proficiency items demonstrate)	
No Attempt (on this element of the training)	

V. Results & Implication for Instruction

The students' weekly self-ratings of their proficiency levels with course LOs and the GTA's assessment of those LOs (where appropriate) are presented below. Three KSA categories are discussed below: problem-solving skills, communication of results skills, and select technical knowledge and skills associated with the Fluid Flow (FF) unit.

A. Problem-Solving Skills

The LOs related to problem solving skills are explicated with their proficiency expectations in Table 4. Note that PS 01.02 is missing from the PS sequence as it was not used in the reflections. The trainings in which these LOs were self-rated by the students are also listed.

Figure 2(a-g) shows how students self-rated their proficiency level with the LOs that accessed their problem-solving skills (PS 01.01-01.08). These detailed problem-solving LOs featured in all CM and two FF trainings. Due to the escalation of the number of technical LOs being introduced and demonstrated in each training making the reflections quite long, only the generic PS 01.00 was self-assessed in the reflections starting with training FF 2.3 (Figure 2(h)) and continuing through the FS and TP trainings. Across the PS LO series, an instructor would note that students generally feel that they could demonstrate these skills on their own or while using resources. There are, however, some notable exceptions where students were calling for more practice. In Training 1.1, students expressed difficulty with checking their answers to CM problems (PS 01.08). The instructor, noting this issue at the time and discussed this topic more in class. This seemed to have helped, as students expressed an increasingly less need for practice and help with this LO in the subsequent CM training.

Table 4. Problem-Solving LOs and corresponding trainings

LO No.	LO Description	Trainings
PS 01.00	Employ a robust problem-solving process that clearly documents engineering work	2.3, 2.4, 3.1, 3.2, 3.3, 4.1, 4.2
PS 01.01	Write a clear problem description • Sufficient context is provided to understand the nature of the problem • The goal indicates the result(s) that are being sought	1.1, 1.2, 1.3, 2.1, 2.2
PS 01.03	Draw a sketch that clearly represents the problem being solved • Components (e.g., processes, streams, forces) are clearly labeled as appropriate for the problem • When appropriate, units are included	1.1, 1.2, 1.3, 2.1, 2.2
PS 01.04	Identify and declare all knowns with units • The list of knowns is complete • Clear descriptors are provided for each known • Correct units are included on each known • Variable names match any sketch provided	1.1, 1.2, 1.3, 2.2
PS 01.05	Identify unknowns with units • The list of unknowns is complete • Clear descriptors are provided for each unknown • Correct units are included on each unknown • Variable names match any sketch provided	1.1, 1.2, 1.3, 2.1, 2.2
PS 01.06	Solve a problem symbolically to completion and in a manner that facilitates subsequent computational tool use • All equations needed to solve the problem are identified • Symbolic equations are solved "by hand" for all unknowns" • Order that the equations need to be used is clear	1.1, 1.2, 1.3, 2.1, 2.2
PS 01.07	Follow a plan outlined in a symbolic solution to compute all unknowns • Knowns are plugged into equations • Equations are employed in order as planned • All unknowns are found • Compute values are marked with descriptors and units	1.1, 1.2, 1.3, 2.1, 2.2
PS 01.08	Check solutions using one or more quantitative or qualitative methods • Quantitative checks are completed when possible • Qualitative checks (e.g., relative magnitude of results, units, comparison to other sources, personal experience) are completed when quantitative checks cannot or are not supplied	1.1, 1.2, 1.3, 2.1, 2.2

Further, students' self-assessment of their problem-solving skills was lower for Training 1.2, particularly for sketching (PS 01.03), identifying knowns (PS 01.04), identifying unknowns (PS 01.05), symbolically representation of the solution of the problem (PS 01.06), and following the symbolic plan to do computations (PS 01.07). This training introduced significantly more complex mass balance problems that perhaps tested students' abilities on these fronts in ways Training 1.1 and Training 1.3 did not. Students' struggle with problem-solving process skills on Training 1.2 was also confirmed in the LO grading (Figure 3). The instructor had to reassess the content of Training 1.2 to determine whether it was too much for one week.

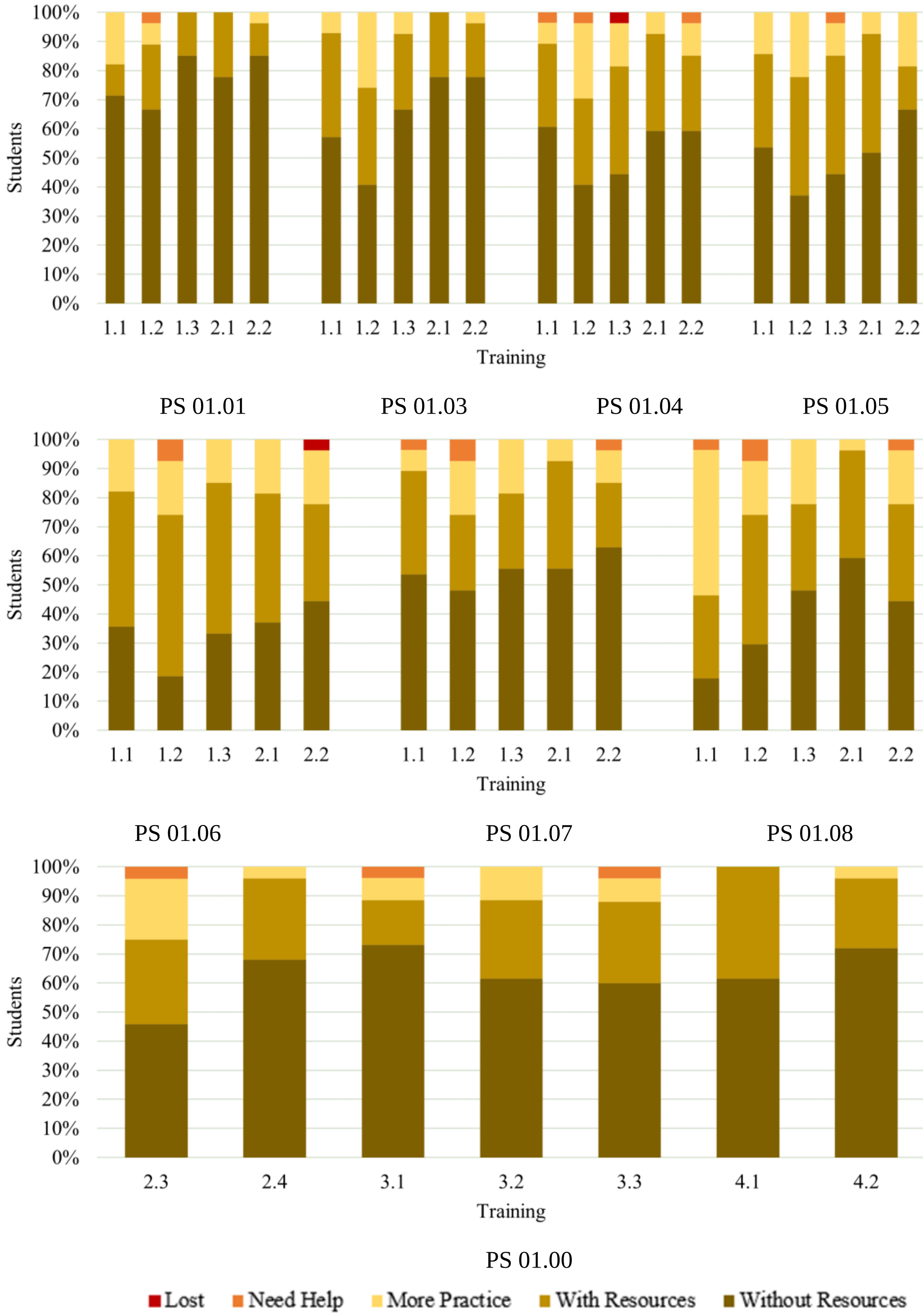


Figure 2. Students' LO self-ratings for problem-solving

The switch from having the students self-assess the skills that make up problem-solving (PS 01.01 to 01.08) to the more generic problem-solving skill LO (PS 01.00) was practical but less informative. Results from students' self-rating of PS 01.00 are parallel to those of the GTA's grading in Figure 3. There is an increase in students' perception of proficiency from Training 2.3 to 2.4 and a general increase in proficiency from Training 3.3 to Training 4.2. For Trainings 3.1 and 3.2 there was a difference between students' perception of their abilities with problem solving and the GTA's assessment of their abilities. The instructor was left not knowing what the students were or were not attending to regarding their problem-solving abilities captured in the grading of the higher-level LO (PS 01.00).

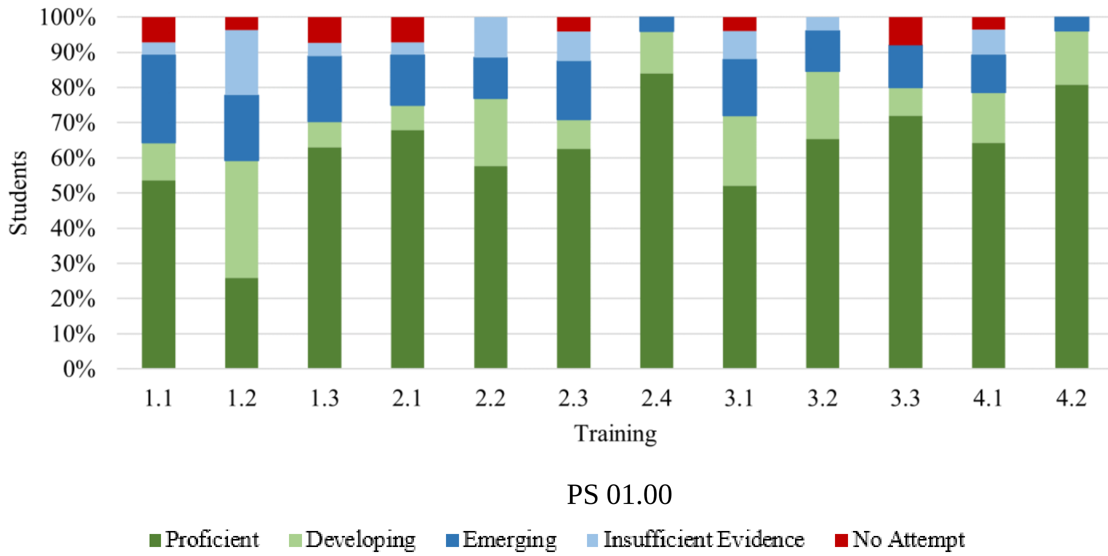


Figure 3. Instructor's grading of students' proficiency with PS 01.00

B. Communication Skills

Communication skills described the ability of students to convey the results of training problems in clear statements (for single value results) or in clear, well-defined, and labeled technical plots. The LOs and the proficiency indicators are listed in Table 5.

As shown in Figure 4, students indicated increasing levels of proficiency with both communication LOs across trainings. It was noted that students' perceptions of their proficiency dropped for Training 3.1. The instructor attributed this to students' perception that the FS unit was a significant change in topic from the FF unit. The problems being solved and the presentation in Training 3.1 may not have been perceived as building on the FF. The instructor may need to clarify this in future semesters.

Table 5. Communication LOs and their corresponding trainings

LO No.	LO Description	Trainings
PS 02.01	Format results that are single values or a collection of values in manner suitable for technical presentation • Text descriptors are provided • Units are provided • Significant figures are appropriate	1.1, 1.2, 2.2, 2.3, 2.4, 3.1, 4.1, 4.2
PS 02.02	Format plots for technical presentation • Title (below the plot) must provide sufficient context to understand the plot • x-axis label has a description with units • y-axis label has a description with units • Axis markers should have managed significant figures • A grid is supplied if values are to be read from the plot • Line markers are appropriately used in the context of the problem When multiple lines are on the plot, distinctive line colors, styles, and markers must be used, and a legend must be provided	2.3, 2.4, 3.1, 3.2, 3.3, 4.1, 4.2

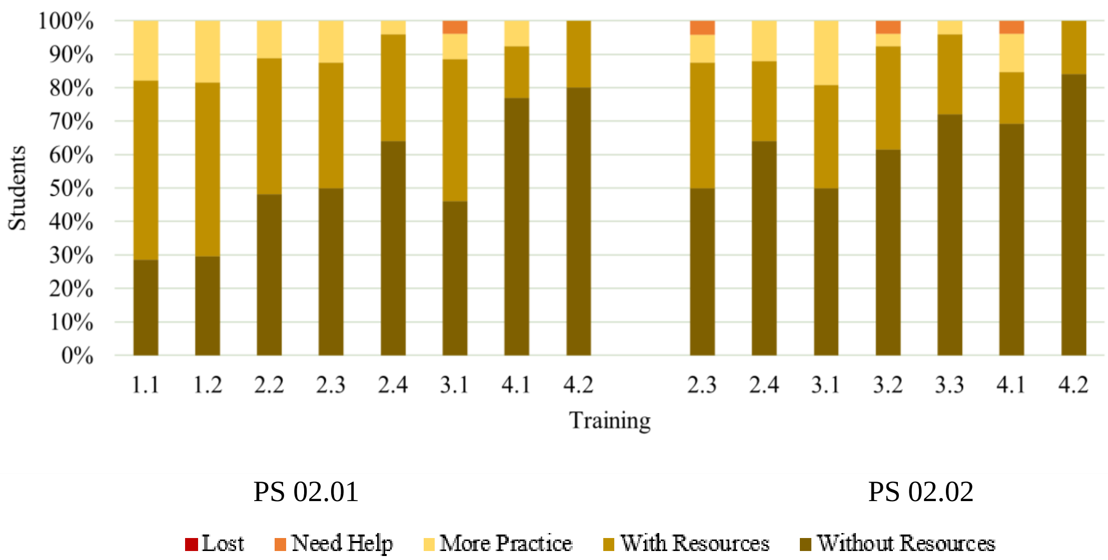


Figure 4. Students' self-rating of their proficiency level in communication

In Figure 5, the GTA's assessment of the communication LOs may be seen. The degree to which there are scores of No Attempt would indicate a greater need for help than the students are expressing. However, the students may be expressing their perception of their skills with communicating results whether or not they worked the problems to the point that they could demonstrate that proficiency. For the presentation of single values (PS 02.01), the trend expressed by the students and the GTA's grading of the LO is similar. There was a trend towards greater proficiency as the semester continued. For the presentation of plots, the comparison is a bit more murky. The GTA's grading indicates that students' demonstrated proficiency is lower during the FS (third) unit.

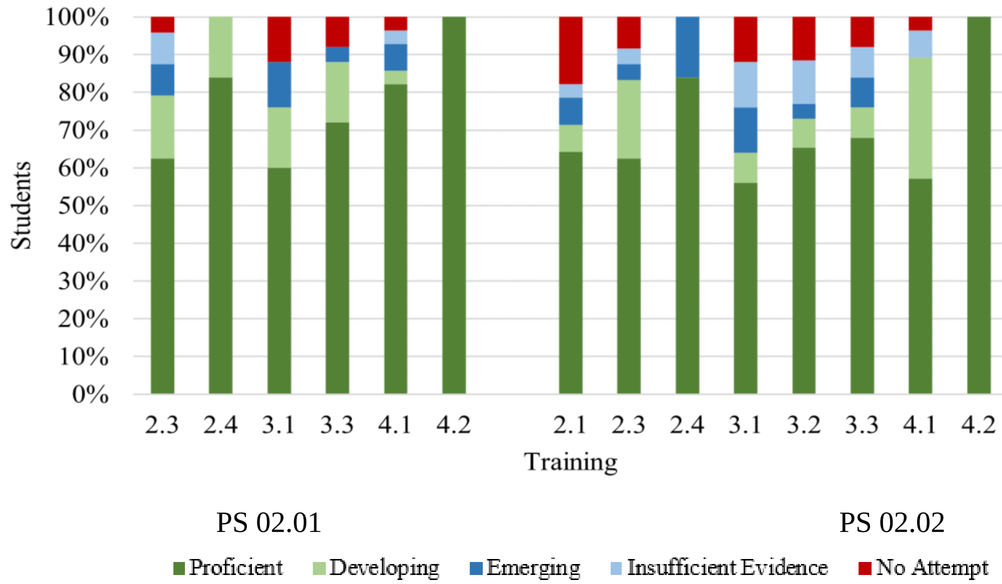


Figure 5. Instructor's grading of students' proficiency with PS 02.01 and PS 02.02

C. Technical Skills

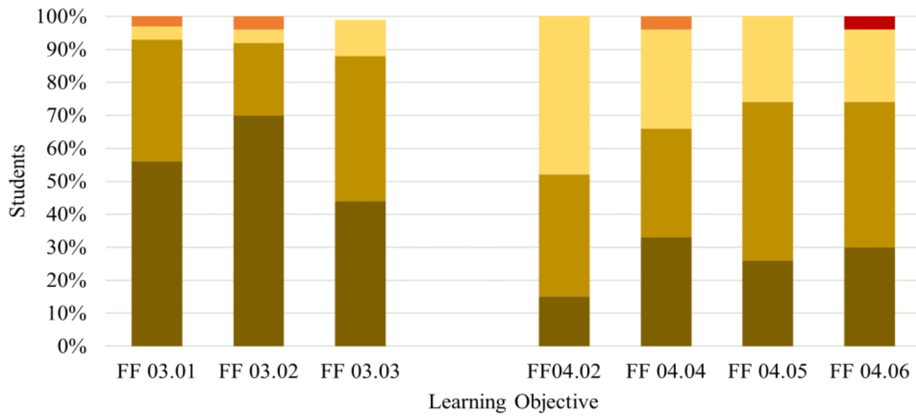
Students' perceptions of their proficiency in understanding concepts and performing computations were provided through their self-ratings of the technical LOs. This section focuses on Trainings 2.2 and 2.3 to discuss the results for select FF LOs (Table 6) for which students indicated a higher-than-average need for more practice, need for help, or feeling of being lost. Again, for the technical skills, the instructor was reliant on the students' self-assessments as there was no GTA or instructor assessment of these LOs for the trainings.

In Figure 6, what is most apparent about this group of LOs is that students' perceptions of their abilities did not overly change from Training 2.2 to 2.3. The differences from Training 2.2 to 2.3 are subtle. For LO FF 03.01 (computing Reynold's number of Newtonian fluids), there is a decrease in perceived proficiency. The instructor may interpret this as students' not improving in their learning of how to perform this computation despite more practice. Yet for LO FF 03.04 (Reynold's number of non-Newtonian fluids), which was an LO first introduced in Training 2.3, the students' perception indicates greater confidence in their abilities. The instructor had to wonder if the students were convoluting the two computations, as the latter is more difficult to compute.

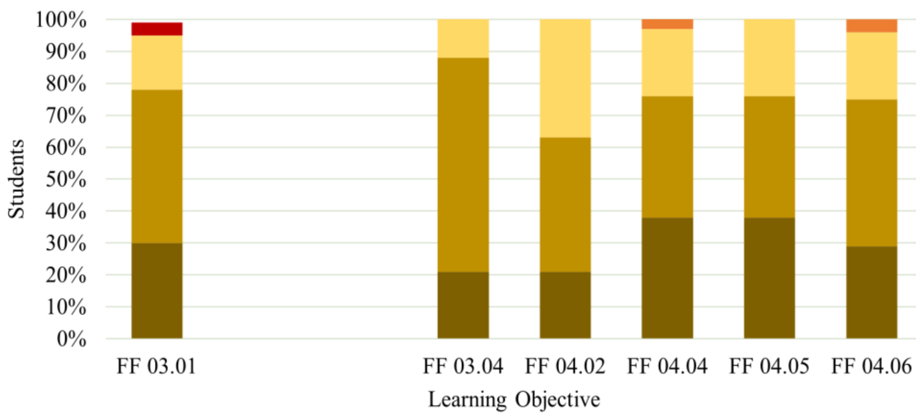
The LO FF 04.02 (mechanical energy balance) did show some increase in students' perception of their proficiency from Training 2.2. to 2.3. However, the continued need for more practice is clear. The instructor might consider either bringing examples into class or making other problems available to ensure more practice. Similar considerations may need to be given for LOs 04.04-04.05 where up to 32% of the students indicated that they needed help or more practice.

Table 6. Select FF technical LOs

LO No	LO Description
FF 03.01	Compute the Reynolds number for Newtonian fluids flowing in pipes • Correctly use the Reynolds number formula to obtain a dimensionless number • Perform computations in SI or English units
FF 03.02	Classify fluid flow using the Reynolds number for Newtonian fluids flowing in pipes • Classify fluid flow as laminar, turbulent, or transitional
FF03.03	Discuss the impact of changing system characteristics and fluid properties on the Reynolds number • Discuss the impact of changing: pipe diameter, velocity, fluid density, fluid viscosity
FF 03.04	Compute the Reynolds number for non-Newtonian fluids flowing in pipes • Correctly use the Reynolds number equation to obtain a dimensionless number • Perform computations in SI or English units
FF 03.05	Classify fluid flow using the Reynolds number for non-Newtonian fluids flowing in pipes • Classify fluid flow as laminar, turbulent, or transitional
FF 04.02	Use the general mechanical energy equation to determine unknown system parameters • Recognize that general mechanical energy equation is a special case of the overall energy balance equation (i.e., isothermal, and only considers flow work part of enthalpy) • Perform balance between two points in a system • Perform balance for Newtonian and non-Newtonian incompressible fluids • Perform computations in SI or English units
FF 04.04	Discuss the impact of changing system characteristics and fluid properties on fluid head or a mechanical energy balance between two points in a system • Discuss the impact of changing: pipe diameter, velocity, height (relative to a datum), pressure, fluid density, fluid viscosity, fittings
FF 04.05	Compute head losses due to friction in a length of straight pipe for Newtonian incompressible fluids • Compute head losses due to friction in straight pipes when flow is laminar • Compute head losses due to friction in straight pipes when flow is turbulent • Compute relative roughness • Read a Moody Diagram • Perform computations in SI or English units
FF 04.06	Compute head losses due to friction associated with a fitting for Newtonian incompressible fluids • Compute head losses due to friction in sudden expansions, sudden contractions, fittings, perform computations in SI or English units



Training 2.2



Training 2.3

Figure 6. Students' LO self-ratings for select Fluid Flow LOs

VI. Discussion

For instructors, developing LO lists and having students use them as the basis for reflection on their learning progress can serve multiple functions in effective teaching. Some of these functions are noted below.

Save time to plan, develop, and align course syllabus to learning objectives. Developing an effective curriculum is an iterative and lengthy process; it may take years for instructors to achieve a satisfactory curriculum for courses that they teach. Sometimes instructors proceed with this process intuitively and with little evidence. Following an initial investment to develop SMART (Specific, Measurable, Achievable, Result-oriented, and Time-bound) learning objectives [13], [14] and an assessment strategy that uses the LOs, instructors can generate the evidence to identify weaknesses more easily and precisely in the curriculum and consider ways to improve.

Early identification of learning needs. As indicated by the LO self-rating results in this study, students have different learning needs at different times. Identifying learning needs early is crucial to ensuring student success [24]. Students' LO self-assessment can be used to drive a simple fix (e.g., revisit of a topic) to comprehensive modifications (e.g., revised course materials) that can help cater to diverse learning needs.

Effective communication of expectations. SMART LOs set a common set of expectations to which instructors and students can refer and use as a basis for improvement. Having documented and regularly used LOs provides for improved communication between students and instructors about students' learning as it provides a common language on what is being learned [25]- [27].

Student input beyond course evaluations. Many universities administer Student Evaluations of Teaching (SETs), which allow students to submit feedback on their instructors. This feedback focuses on the overall quality and impact of instructors' teaching and may provide ideas for general instruction improvement [28], [29]. Such feedback is limited in its ability to help instructors understand specifics about students' learning, particularly during the semester. Students' LO self-assessments, as exemplified in this paper, allow instructors to determine the strengths and weaknesses in their courses as it pertains to students' achievement of intended course learning objectives.

VII. Limitations

There is always a concern that students' self-assessments may be unreliable due to bias [28]. In this study, this was reflected by students overrating or underrating their proficiency levels as compared to the GTA's grade. The discrepancies were more pronounced during the first and second weeks of a new course unit. As the weeks advanced students' ratings more closely matched those of the GTA. Students' learning from the feedback from past assignments may be responsible for the reduction in the gap between students' ratings and the GTA's grading.

The discrepancies between students' LO self-ratings and the GTA grading may also have been due to social desirability of responses, selective recall, or misinterpretation of what is being assessed. One way the social desirability issue was attempted to be mitigated was by making it clear to students in lectures and in the assignments' instructions that the self-assessments are to be used by them as a guide for identifying things they needed to work on. The focus of their responses had no bearing on their course grade. Further, having well-articulated expectations for proficiency is one step towards reducing misinterpretation. To address selective recall, the LO list was readily available to students on Canvas, the extent to which they had this list open when self-assessing their proficiency is unknown. It may be better in the future to put the reflection prompt and LO list side by side.

In addition, although students completed both LO self-ratings and written reflections, this paper considered only the self-ratings. Instructors may find more specific evidence for curricular change in the written reflections. Lastly, not all the students who participated in self-rating activity for a specific week submitted their assignment. Since these students' performance was not considered in the GTA's LO-grading, the result for the GTA's grading may not be representative of the actual performance levels of the class. Yet, an instructor will need to know the performance levels of the whole class as evidence to drive changes in instruction.

VIII. Conclusion

Learning objectives (LOs) were used as the basis for assessment and student reflection in a junior and senior level agricultural and biological engineering course. It was shown that students' LO self-ratings can provide insight into their learning successes and struggles. This paper contributes to the study of assessment strategies by exploring the meanings about students' learning that can be inferred from integrating students' weekly self-ratings of their proficiency levels with the course learning objectives. The findings support the use of LO self-ratings for early identification of students' learning needs and describe how the LO self-rating results may direct instructors to improve their teaching and the students' learning experience.

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