ON-LINE ASSISTANT FOR WRITING COURSE OBJECTIVES

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Abstract *- The Instructional Objective Writing Assistant (IOWA) is a simple online knowledge-based system that serves to help instructors write good course objectives. Instructional objectives are important for a number of different reasons and yet objectives are often not written, written incorrectly, or incompletely written. Instructors can use IOWA to solve the problems of absent, incorrect and incomplete objectives. Most objectives are incorrect in that they are usually written in a form that cannot be observed or measured, thus making it impossible to determine whether or not the objectives have been met. The IOWA web site contains instructions and suggestions on how to write objectives that are observable and measurable. A set of objectives is incomplete if it doesn't include objectives for all levels of thinking or if the objectives are focused on levels of thinking that are not appropriate for the course. The knowledge-based system, which is written in Java and posted as an applet on the IOWA web site, can help to correct this problem. The program asks the instructor questions about the course for which objectives are to be written and then returns a graph, based on the input of the instructor, that shows which levels of cognition should be focused on when writing objectives. The instructor then uses this graph, along with the suggestions, instructions, hints and examples provided on the rest of the web site, to write objectives that are correct and complete. This paper will present the motivation for creating IOWA, the knowledge upon which IOWA is based, how IOWA works, and initial results from the use of IOWA.*

Instructional Objectives

An instructional objective is a statement of skills, activities or accomplishments that an instructor would like the students to be able to demonstrate at the end of the instructional period in question (module, lecture, course, etc.). Many professors use the words objective and goal interchangeably and sometimes an objective is defined as a goal that the instructor wants the students to achieve. There is, however, a distinction between the terms goal and objective. A goal is a general statement of desired outcomes whereas an objective is a statement that details the circumstances and situations in which the goal will be achieved [1]. Furthermore, an objective should state precisely what the student would be doing when demonstrating mastery of the objective [2]. Thus, an objective should be an action that the student can actually perform and that the instructor can observe. If the action is performed appropriately, then the objective has been met.

For illustration, consider the following examples, noting the differences between the two:

Example 1: At the end of this course in Engineering Graphics, the student will know how to use a computer-aided-design software package.

Example 2: At the end of this course in Engineering Graphics, the student will be able to draw a multi-view representation of a solid object using a computer-aided-design software package.

The second example is more effective because the objective is clear and specific. The second objective is an activity that can actually be observed and assessed. A professor can hand the student a solid object and ask the student to draw a multi-view representation of the object using a specific piece of software. If the student can perform the task, the objective is met. On the other hand, it is impossible to determine whether or not the first objective has been achieved. Whose standards of 'knowledge' must the student live up to in order to prove that he/she does in fact 'know how to use a computer-aided-design software package?' The first example is more of a broad statement of what is expected of the students and thus is a goal rather than an objective.

Purpose of Objectives

There are many important reasons for writing appropriate instructional objectives. Some of these purposes for writing objectives are discussed below.

Effective education is a process that begins with determining what the student needs to know and then stating these needs in terms of objectives [3]. Developing a set of properly written objectives is one of the most important elements of course design [4]. One reason that objectives are important, then, is that they streamline course planning. If accurate and appropriate objectives are written, course lectures can be organized according to these objectives, thus serving to accomplish the objectives. Writing objectives also can assure that all major topics are covered completely and efficiently. Writing objectives can also aid in course planning by identifying unnecessary material, which the instructor can then remove from the course plan.

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Well-written objectives not only help instructors get organized but they can also help students organize their efforts as well [2]. If students are unaware of what exactly is expected of them, they may have difficulty proving that learning has occurred [3]. A well-written set of objectives can be used by students to know what is expected of them. Students can use the objectives to track their own learning and assure themselves that what they are learning is what the instructor intends for them to learn.

A third reason for writing objectives is to facilitate assessment. Assessment tools, whether they be tests, quizzes, homework assignments, group projects, or in-class activities, are easier to construct if appropriate objectives have been written. As can be seen in the computer-aided-design example given above, when objectives are written correctly, they are very easy to assess. If an objective describes what a student would be doing when demonstrating mastery of the objective, then assessing the objective merely consists of observing whether or not the student meets the description given in the objective.

Yet another reason for writing objectives is to enhance communication between colleagues [5]. Professors can know what incoming students are able to accomplish by reading the objectives from courses that the students have previously taken. Also, curriculum planning committees and accreditation boards can know what to expect from a particular course by reading the objectives [5].

There are many reasons for writing a clear set of objectives. The four main reasons for writing objectives are that they help streamline course design, they help students know what to expect from the class and what topics the instructor thinks are important, they provide assessment parameters, and they enhance communication between colleagues.

Common Errors

Despite the fact that most professors would agree with the reasons given above for writing objectives, many courses are developed and taught with either a nonexistent, incorrect, or incomplete set of objectives. These three problems are very common in courses at many universities.

Absent Objectives

The absence of objectives can affect both students and instructors. Well-written objectives provide a coherent and logical structure to a course [6]. Just like a thesis in an essay provides a structure that informs the reader where that paper is going, the structure that objectives provide to a course can help both the student and the instructor know where the class is headed. Without objectives, it is easy for a professor to wander off on different topics. Similarly, without a defined structure, students may have trouble drawing relationships between different course topics. Objectives provide the structure that ties these topics together.

Despite the positive returns that come from writing objectives, many instructors do not write them. A survey of engineering faculty at eight different universities in the southeast concerning teaching habits was performed and one of the questions in the survey asked instructors how often they wrote objectives for the courses that they taught [7]. The results of the survey showed that only 39% of the instructors who responded to the survey wrote objectives for all their courses and that 19% of the instructors had never written objectives at all [7]. The report goes on to say that these numbers may be unrealistically positive due to the nature of the survey. The reason for this is that the survey was voluntary and that professors who already held teaching as a high priority were more likely to respond to a survey about teaching habits than a professor who is more focused on research [7]. If, however, these numbers are correct then 61% of instructors either do not write objectives at all or do not write them for all of their courses. This is clearly a problem that could be corrected for the benefit of teachers and students alike.

Incorrect Objectives

An objective is incorrectly written if it is not observable or measurable. It is impossible to determine if an objective has been met if the objective cannot be directly observed or measured [2,3,4,5,6]. Such objectives are usually not written, however, because most objectives written by professors show a preoccupation with topics rather than with skill and abilities [8].

It is fairly easy to find objectives that are focused on topics rather than skills and abilities. Consider some of the following examples, which are actual objectives taken from courses in an undergraduate civil engineering curriculum:

Example 1, from a legal aspects in engineering course: The objective of the course is to introduce students to the contractual, legal and ethical issues that they may encounter in professional practice.

Example 2, from a steel design course: The objective of the course is to develop an understanding of structural steel theory and design.

Example 3, from an advanced fluid mechanics course: The objective of this course is to round out your understanding of engineering fluid mechanics.

The first example gives a good course description, or goal statement, but is not an objective that can be assessed directly. The second example is even more ambiguous. Worse yet is the final example. How is an instructor to know whether or not the student's understanding of fluid mechanics has been 'rounded out?' And how is 'rounded out' defined. How can students know for themselves if their understandings have been 'rounded out?' It is impossible

for an instructor to determine whether or not these examples of objective have been met. Also, because these objectives are so broad, they cannot provide the coherent and logical structure mentioned above. Objectives written this poorly defeat the whole purpose for writing objectives and might as well be not written at all. Writing objectives incorrectly is another common error that needs to be corrected.

Incomplete Objectives

A set of objectives is incomplete if the objectives do not emphasize all levels of thinking, or if the objectives focus on inappropriate levels of thinking. The most popular method of classifying objectives or assessment materials by levels of thinking is to use Bloom's Taxonomy. The cognitive domain of Bloom's Taxonomy classifies objectives, tasks, and assessment tools according to six levels of cognition that are required to accomplish the objective, task, or assessment.

There are six levels of thinking in the cognitive domain of the taxonomy: knowledge, comprehension, application, analysis, synthesis, and evaluation [9]. Knowledge is generally defined as rote memorization, recognition, or recall of information. Comprehension is the ability to understand the meaning behind the information. Application is the proper use of the information. Analysis is the ability to break down the information into related parts. Synthesis is the combination of the parts of information to make a new and different whole. And finally, evaluation is the ability to make a judgement on the information.

It is important that in order for all levels of cognition to be addressed that objectives are written for all levels of Bloom's Taxonomy. Most instructors, however, only require students to use the lower three levels of thinking in courses, even if the course is supposed to be an advanced course [5,6,9]. Writing objectives to cover all levels of thinking can help the instructor structure the course so that students can develop critical skills for all the levels.

While most courses should include at least one objective from each level of thinking, different courses should require different types of thinking from the students. For example an introduction to concrete materials course should require, in general, different skills than an advanced concrete design course. The introductory course may include objectives from all levels but focus more on objectives that require students to identify (knowledge level) properties and composition of concrete. The design course, conversely, should have objectives that focus on higher level thinking skills, such as an objective that requires students to evaluate (evaluation level) which type of member would be more appropriate for a particular design.

In addition to not writing objectives for all levels of thinking, incompleteness of objectives can occur if there is not a match, as explained above, between the nature of the class and the focus of the stated objectives. For instance, if a class that is mainly factual in nature has objectives written that focus on the higher level thinking skills then there exists an incompatibility between what the students are given and what is expected of the students. Similarly if a course requires students to use high level thinking skills but only addresses lower level skills in objectives there is again an incompatibility. Instructors should determine the levels of thinking that the students should be using and write the objectives that focus on those levels of thinking. Incompleteness of objectives is a problem that if corrected would increase the quality of any course.

Motivation for IOWA

This project started as an attempt to assess the impact of technology in the engineering classroom, but the authors found that no leaming could be assessed if objectives were not written properly. Thus, before any assessment could be accomplished, the problems of objectives must be addressed. The problems that were mentioned above, absence, incorrectness and incompleteness of objectives, motivated the creation of the Instructional Objective Writing Assistant (IOWA). In order to correct the problems just described, the project should fulfill a few specific tasks.

A tool that could educate instructors on the importance and benefits of writing objectives could serve to correct the problem of nonexistent objectives. The problem of absent objectives usually stems simply from a lack of information. Engineering instructors generally have received little formal instruction into the field of educational theory and thus may not know how important or beneficial educational tools such as objectives are. A tool that could present this information to instructors in a simple and succinct manner could do much good.

The simple presentation of information could also solve the problem of incorrect objectives. Many professors write objectives incorrectly simply because they don't know that a good objective should be clear, specific, and observable. Presenting this information to engineering instructors would allow professors to see the problem and thus correct it.

To solve the problem of incompatibility or incompleteness of objectives, a dual function tool is needed. The first function is similar to the one mentioned in the previous paragraph, simply the presentation of information with which an instructor may not be aware; namely that of Bloom's Taxonomy. However, even after learning about the nature of the Taxonomy, some professors may not know which levels of thinking are appropriate for a particular class that they are teaching. The need, then, arises for personal interaction with these professors to help them look at the class they are teaching and determine which levels of thinking should be focused on when writing objectives and assessment tools. One-on-one human interaction to accomplish this task would not be cost effective and perhaps not even be possible. A knowledge-based tool, however, could accomplish this task of interaction. This interaction is the second function that a tool should be able to accomplish in order to solve the problem of incomplete objectives.

Thus, if a single tool were developed to solve all three problems, it would need to not only instruct but interact. The instructive part of the tool would present critical information on the importance of objectives, how to write correct objectives, and how Bloom's Taxonomy could be used to write complete objectives. The interactive part of the tool would be used to help the professor determine which levels of Bloom's Taxonomy should be focused on while writing objectives. In addition to these characteristics, the tool must be easy to access and require little time investment on the part of the professor or else it would not be used.

Creation of IOWA

The tool entitled IOWA was created to instruct, interact, and be easily accessible. The accessibility concern was solved through use of the Internet. Currently, the best way to distribute information in a timely manner and to a large audience is to deliver it via the Internet. In this age, the information age, most professors at institutions of higher education have access to the World Wide Web. Information, to instruct, as well as a program, to interact, could be posted on a web site and made available to a large audience. Publishing the tool on the web fulfills the need for this project to be accessible nearly everywhere and at any time. This decision led to the creation of the IOWA web site.

To meet the instructional need, IOWA must present information on the importance of objectives, Bloom's Taxonomy, and how to write objectives correctly. To present this information, a number of web pages were created and published on the IOWA site. After the welcoming page, is a page that defines objectives, thus differentiating between correct and incorrect objectives. Following this is a page that concisely lists the importance of objectives and explains why objectives should be written. Next is a page that explains how to write objectives, talking briefly about Bloom's Taxonomy and how the Taxonomy can help. There is also a page that talks more extensively about Bloom's Taxonomy and gives examples of an objective, an in-class activity, and an assessment tool for each level of the Taxonomy. The various pages of the site fulfill the need for the presentation of information pertaining to objectives. These static pages instruct and are easily accessible, but a dynamic portion was added to the site so that interaction could take place.

In order for IOWA to interact, an intelligent assistant has been posted on the IOWA web site also. This program, entitled The Assistant, is the heart of the web site and is what differentiates this site from other sites about course objectives and Bloom's Taxonomy. An intelligent assistant is a knowledge-based system that assists a human in making decisions [10]. The Assistant is programmed to help professors decide which levels of thinking are appropriate for a particular class. The details of The Assistant are the topic of the next section.

The Assistant

The Assistant aides a professor in writing objectives by asking the professor questions about a specific class and then reporting which levels of Bloom's Taxonomy should be emphasized most in the class.

The Assistant is a Java applet that is posted on the IOWA web site. The applet has a graphical user interface that includes a large canvas where instructions and results are given, a small text area, and group of buttons, as can be seen in figure 1. The text area is where the program prints questions that are being asked of the user. When a question appears, the buttons that are possible answers to that question are made available and the user chooses one of the available buttons to answer the question. The buttons that are available will be highlighted so that the user can clearly determine which buttons are to be used for which questions.

The user is asked questions that are to be answered for a specific class. The questions should be answered for a single class only, not for a group or series of classes, thus allowing the information and results that the program returns to be more specific. The first group of questions deal with the levels of Bloom's Taxonomy and how they relate to the class. These questions are meant to determine the relationship between the professor's view of the class content and Bloom's Taxonomy. Action verbs that are typically used to write objectives for specific levels of the Taxonomy were used to formulate the questions. For instance, 'define' is often an action verb used in writing objectives for the Knowledge level of the taxonomy. Thus, a question used to determine how much of the class consists of Knowledge level content included the word 'definitions'. The question is as follows; "to what extent does the course content involve definitions with which the students must become familiar?" This was done so that the professor could answer questions about the relevance of each level of the Taxonomy in the class without having any previous knowledge of the Taxonomy. Multiple questions are asked for each level to cover any error that might arise. If the user misreads the question or if the question is hard to understand, thus causing the user to answer in a way that may not be accurate for the class, then the other questions are supposed to make up for such error.

From the answers to this first group of questions, a simple graph is formed. Possible answers to the first group of questions are high, medium, and low. These fuzzy terms were chosen because they better represent human reasoning than numerical ratings do [11]. To accommodate the fuzzy terms, some fuzzy logic is used to analyze the input and obtain a relative level of emphasis (RLE) for each level of the Taxonomy. What the RLEs represent is how important each level should be, in relation to each other, when writing objectives. Each RLE has no meaning when standing alone. The RLE is only significant when compared with other RLEs because the RLEs show how important each level is only in relation to the other levels. These RLEs form a bar

graph that shows the importance of each level of Bloom's Taxonomy as compared to the other levels. Before the graph is displayed to the user, however, a second group of questions is asked. The answers to these questions serve to skew the graph and it is not until all the skews have been applied that the graph is drawn.

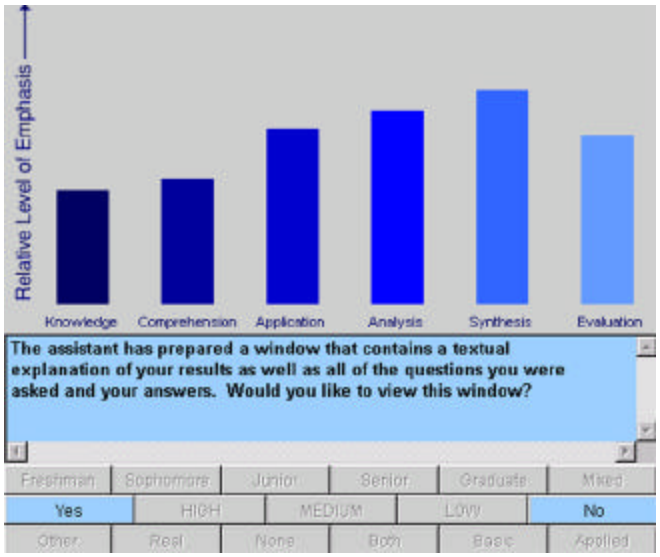

Figure 1. Graphical User Interface of and Results from The Assistant for Concrete Design Course

There are four questions that help to skew the graph. These questions are meant to further flesh out the relationship between class content and the levels of Bloom's Taxonomy by determining more characteristics of the course. For instance, a graduate level course should probably not have content, objectives and assignments that mainly cover the Knowledge level of the Taxonomy. Thus, one question asks what year in school are the students. Another asks what type of situations the information from the class is intended to transfer to (i.e. real world, other classes, neither, or both). Another question asks whether the information presented in class is considered by the professor to be basic or applied. The final question asks whether or not the class is in a series of classes and if it is in a series it asks where the class fits in the series. The answers to these questions serve to skew the graph in one direction or the other. Answering basic, for example, to the type of information question will multiply RLEs that correspond to the first three levels by factors greater than one, whereas the higher levels, analysis, synthesis, and evaluation, will have RLEs that are multiplied by consecutively decreasing factors of less than one.

Once all of the RLEs have been multiplied by the various skewing factors that result from answers to the final questions, a bar graph is returned to the user. This bar graph, shown in figure 1, shows the user how each level relates to the other levels of the taxonomy.

Textual results can also be given to the user. If the user wishes, a window can be opened that describes the graph in words. These textual results provide the user with even more input on how to use Bloom's Taxonomy in his/her class and how to write objectives, activities and assessment tools that are appropriate for the class. In addition to a textual explanation of the results, copies of all the questions asked by the program and answers given by the user are given in this window.

The instructor can then use these results to write objectives that are appropriate for the class in question. The instructor must remember to use the information on the rest of the site also to insure that objectives are written to be correct and complete.

Initial Results

Though more testing is required, some results have been obtained from the use of IOWA and The Assistant. The assistant was initially used by instructors who were not familiar with Bloom's Taxonomy to determine if the results that The Assistant returned were the results that should be expected. The results showed that The Assistant returned anticipated results.

Figure 1, for example, shows a graph resulting from the input of an instructor who teaches a senior-level concrete design course at Georgia Tech. In this course, a student is expected to use most of the information they have learned from previous courses to design members and simple structures. The synthesis level of Bloom's Taxonomy is defined as the combination of informational parts to form a new whole, which is exactly what most professors expect of students in a design class. The other high-level thinking skills scored high also, which is to be expected. Students will be required in this class to judge between different members or designs thus requiring them to use the evaluation level of cognition. Students must also perform many calculations to reach a design decision, thus requiring them to use application skills. Analysis, with respect to Bloom's Taxonomy, is the ability to break down information into component parts and see the relationships between the parts. The importance of these analysis abilities in a concrete design course may not be readily apparent and may even vary from instructor to instructor depending upon what is expected of the students. The low scores on knowledge and comprehension are expected for a course such as this one where simple skills such as memorization are not required.

In addition to merely using The Assistant in a single class to determine appropriateness of results, it was also used by different instructors who taught the same class to see if the results were similar. Figure 2 shows a graph resulting from input of a different instructor who also teaches the senior-level concrete design course at Georgia Tech.

Comparison of the two graphs shows that with the exception of the analysis level, the curves are very similar. Ignoring analysis, the second graph has the same, yet more dramatic, shape as the first, again scoring highest on synthesis as expected. The major difference between the two is obviously the analysis score. However, as mentioned before, the necessity for students to use analysis skills, as defined by Bloom [9], in a concrete class is not readily apparent and may differ between instructors. This difference is not disturbing. The similarities between the other levels, however, are expected because how these levels are used in this class can be better predicted than that of analysis.

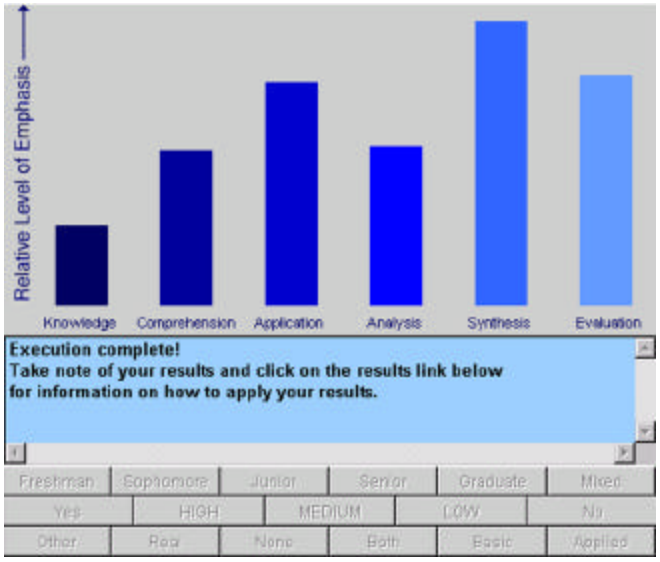

Figure 2. Results from The Assistant for Concrete Design Course

One excellent point brought about by the difference between the two figures is that this tool could be used to facilitate discussion between colleagues about a particular course. Professors who have differing opinions on a course could use the results from The Assistant to initiate a discussion. The Assistant could also facilitate discussion between professors and students about different course opinions. The main use of The Assistant, however, is to help professors write objectives that are appropriate for a given class. Preliminary results show that the Assistant fulfills this task. Larger-scale studies will be performed in the future to further test this conclusion.

Summary

Despite the many benefits that come from writing and using course objectives, many engineering courses are being taught with nonexistent, incorrect, or incomplete sets of objectives. In an attempt to correct this problem, a web site was created which provides instructors with information on how to write objectives that are complete and correct. There is also an intelligent assistant on the web site, which can help the instructors decide which levels of cognition should be focused on while drafting objectives. In preliminary studies, the intelligent assistant provides expected results. The IOWA web site can be found at http://epitome.ce.gatech.edu/iowa/.

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