Assessing the Alignment of Objectives, Instructional Activities, and Assessments in a Biomedical Informatics Curriculum

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Abstract: The objective of this research was to assess the alignment of course learning objectives, instructional activities, and course assessments in a Biomedical Informatics curriculum. Each syllabi in the curriculum was reviewed and scored according to a validated rubric. Disagreements among reviewers adjudicated by consensus. Only low and moderate levels of alignment were identified. The results indicated the needs and goals of courses could be more effectively met with faculty investment in syllabi redesign and clarification to achieve course objectives. Root causes included word choice in learning objective statement as well as lack of consideration of instructional scaffolding by the course developer.

Keywords. curriculum, alignment, taxonomy, learning objectives

1. Introduction

A notable assumption in the educational development of any academic field is the variability of faculty knowledge of teaching and learning theory, curriculum development techniques, and instructional design principles. This assumption has traditionally been grounded in the notion that faculty at institutions of higher education are primarily trained as researchers in their scientific fields of study. The curricula of scientific fields such as Biomedical Informatics do not include formal coursework in teaching and learning theory, curriculum design techniques, or instructional design principles. However, there is a significant expectation that faculty serve as the primary developers of courses and the curriculum in which the courses compose. As the nature of faculty work, this charge does not offer a systematic avenue for formal faculty preparation in ensuring that the needs and goals of students will be met. This charge is heavily grounded in the idea that the needs and goals of the learners extend beyond the teacher-centered approach to teaching and learning that is heavily associated with traditional pedagogical practices. This significant reliance on pedagogical practices presents a significant concern for designing a biomedical informatics curriculum to meet the goals and needs of adult learners.

Both instructional designers and faculty must partner to build and maintain curricula [1]. This collaboration will ensure the technical components of educational development are used to provide learning standards and expectations that are traditionally found in academically rigorous, programs of study. Therefore, the primary research question examined the alignment of course learning objectives, instructional activities, and course
assessments within the 28 courses in the biomedical informatics’ graduate program curriculum.

2. Background

2.1. Biomedical Informatics Graduate Education at UAMS

With no degree programs to represent the full spectrum of biomedical informatics, the University of Arkansas for Medical Sciences (UAMS) broadened the range of the state’s training opportunities by developing a 15 credit hour graduate certificate, a 36 credit hour Professional Master’s degree, a 36 credit hour Master of Science degree, and a 55 credit hour Doctorate of Philosophy in Biomedical Informatics. The newly expanded program includes four tracks: Translational Bioinformatics, Imaging Informatics, Clinical Informatics, and Clinical Research Informatics. This included the development of 28 new courses designed to reflect the competencies of both practitioners and scholars in the domains of the biomedical informatics spectrum. The development of the syllabi for the courses was facilitated by the Department of Biomedical Informatics’ Curriculum Committee. Given the significant value of the Department’s faculty as content experts in their respective fields and not as instructional designers, there was a significant need to integrate instructional design expertise to examine the degree to which the courses were designed to meet the objectives articulated in each syllabus through the use of instructional activities and assessments.

2.2. Fink’s Taxonomy of Significant Learning

As the conceptual framework for the instrument used in this study, Fink’s Taxonomy of Significant Learning is widely viewed as an evolutionary stage of Bloom’s Revised Taxonomy in the context of examining how learning occurs. Fink’s Taxonomy is grounded in the notion that a change must occur in the student before learning occurs [2]. This is reflected in the significant emphasis of the Fink’s Taxonomy on blending the cognitive and affective domains. This emphasis is a distinguishing feature of Fink’s taxonomy and significantly represents the rationale for its categorization as an evolutionary stage of Bloom’s Revised Taxonomy. Additionally, the nature of the Fink’s Taxonomy is relational while the nature of Bloom’s Revised Taxonomy is hierarchical. The relational nature of the Fink’s Taxonomy is evident in the six learning dimensions of the taxonomy. The six learning dimensions of the Fink’s Taxonomy include Foundational Knowledge, Application, Integration, Human Dimension, Caring, and Learning How to Learn. These dimensions represent the various realms and ideas of how a student’s affective activities work in a collaborative manner to produce significant learning.

In the context of the UAMS biomedical informatics graduate curriculum, the foundational knowledge dimension represented the element of developing students who have a comprehensive understanding of biomedical informatics concepts to support a student’s ability to remember and explain the intricacies of the concepts. The application dimension allows faculty and instructional designers to examine the kinds of critical, practical, and creative thinking as well as skills that students should be able to do [2]. As an interdisciplinary field, biomedical informatics education could substantial benefit from utilizing the integration dimension’s focus on a student’s ability to make connections
within and beyond the ideas, people, and concepts of biomedical informatics [2]. In addition, the human dimension examines what students should learn about themselves and their interactions with others in the biomedical informatics profession such as ethical, civil, and cultural principles [2]. The caring dimension of the taxonomy examines changes that occur within a student such as feelings and interests in the development of computational tools used to improve human health. As the final dimension of the taxonomy, the value of a student’s ability to learn how to learn aligns with nature of adult learning which is heavily grounded in intentionally and reflectively, self-directing one’s own learning [2]. Developing or expanding any biomedical informatics graduate program presents an enormous challenge for faculty and instructional designers. Each of these six dimensions offered a guided approach to assessing a curriculum to ensure that its design would effectively train students to develop and apply computational tools to biomedical data. Additionally, the literature substantiated a need to provide assurance that the curriculum and its embedded competencies are designed to prepare students for roles in the biomedical informatics workforce [3]. An assessment using these six dimensions provided an adequate level of assurance.

2.3 Alignment of Syllabi Components

The examination of alignment offered a significant distinction between a course’s intended design and its actual design. The basis of the concept of alignment is described by academic fields in various ways. To some scholars and practitioners its basis is considered to be the process phase of training and development [4]. To other scholars and practitioners, it is referred to as the ADDIE model of instructional design [5]. Regardless of how the alignment process is referred to, the process offered a systematic process for creating, organizing, and assessing instruction. This systematic process contains five steps which include (1) analyzing the learning needs of the biomedical informatics students (2) designing measurable learning objectives based on the identified needs (3) developing instructional activities to meet the learning objectives that were developed based on the identified needs of the students (4) implementing the instructional activities and (5) evaluating the instructional activities based on their ability to yield the outcomes noted by the learning objectives [5]. Each step of the design process is dependent on its preceding step [5]. This sequential process of steps represents the concept of alignment. Therefore, the most significant benefit offered by the concept of alignment is its ability to ensure that a course’s learning objectives are being met by the instructional activities and assessments of a course.

3. Methods

3.1. Objective

The objective of this study was to examine course alignment within the developing biomedical informatics graduate curriculum to understand the extent to which courses were capable of achieving learning objectives.
3.2 Study Design

A validated syllabi rubric was used to review and score the instructional design components of 28 graduate-level courses in the UAMS Biomedical Informatics graduate curriculum using three rounds of review to gain agreement on how each of the 15 components of the rubric should be scored. This study did not involve human subjects. Course syllabi served as the primary data source for the instructional designers’ scoring. The data provided by the scoring of the syllabi was analyzed univariately. Syllabi were previously designed by 15 faculty in the Department of Biomedical Informatics using a standard syllabi template. The template included elements that are traditionally found in syllabi such as a list of learning objectives, instructional activities, a description of course assessments, and etc. Thus, the template used to create the initial syllabi provided an adequate amount of information for assessing the alignment learning objectives, instructional activities, and course assessments.

3.3 Instrumentation

The syllabi review rubric served as the instrument for assessing the measurability of the learning objectives and their alignment with the instructional activities and course assessments. The rubric focused on identifying the presence of five categories that supported the examination of alignment. These five categories were (1) the presentation of measurable learning objectives and longer-ranging goals, (2) instructional activities, (3) assessment activities, (4) a fully articulated course schedule, and (5) the overall learning environment. These five categories represented the Fink model’s taxonomical structure for classifying the 16 components of the syllabi rubric. Palmer et al. provided ample examples for what should be considered as evidence of the 16 components. These examples offered a structured process for identifying evidence of components in the syllabi and scoring the level of evidence in each syllabus. For example, component 2 of the rubric is designed to assess the measurability of the learning objectives in the syllabus. Palmer et al. provided background information on interpreting the measurability of a learning objective including a notation of the difference between a learning goal and a learning objective. Each of the 16 components were categorized according to Palmer et al.’s work as highly important, moderately important, or less important. In terms of the scoring of the 16 components, the strength of evidence found in the syllabi is reflected on an ordinal scale of measurement using rating of strong evidence, moderate evidence, and low evidence.

3.4 Data Collection and Analysis

Data was collected using three rounds of review. Consensus adjudication was used for its ability to provide agreement among the expert opinions of the instructional designers and the frequency of its historical use in healthcare. The use of the technique sought to gain agreement among the instructional designers for scoring each of the 15 of the 16 components of the syllabi rubric for each of the 28 courses in the curriculum. Data was not collected on the third component of the syllabi rubric because of its difficulty associated with assessing the item without content knowledge of the curriculum. The faculty subsequently assessed the third component of the rubric independently of this study. The scoring of the syllabi was conducted over a 90-day period. The first round of
the consensus technique was used as a method of allowing each instructional designer to score each syllabi independently of the other instructional designers. A significant element first round’s design was to allow for independent interpretation of the syllabi scoring rubric with subsequent rounds eliminating the variation in the interpretation of the rubric through consensus. The instructional designers were charged with providing qualitative feedback on the level of evidence found on each of the 15 components of rubric in each syllabus. Second and third rounds of review were used to facilitate robust discussion and clarification on the rubric’s scoring system, the instructional design principles being scored, and the amount of evidence of the 15 components in the rubric.

4. Results

4.1. Findings

The mean, as a descriptive statistic, was calculated on all of the components of the syllabi rubric for the courses. Component #14 specifically assessed the alignment of objectives, instructional activities, and assessments. Scores for Component #14 in each course was averaged and produced a mean score of 1.64. Table 1 provides means for all of the components of the rubric.

<table>
<thead>
<tr>
<th>Component Number</th>
<th>Syllabi Component</th>
<th>Mean</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Learning goals encompass full range of Fink’s dimensions of significant learning</td>
<td>1.18</td>
</tr>
<tr>
<td>2</td>
<td>Course level learning objectives are clearly articulated and use specific action verbs</td>
<td>1.86</td>
</tr>
<tr>
<td>4</td>
<td>Objectives and assessments are aligned.</td>
<td>1.64</td>
</tr>
<tr>
<td>5</td>
<td>Major summative assessment activities are clearly defined</td>
<td>1.60</td>
</tr>
<tr>
<td>6</td>
<td>Plans for frequent formative assessment with immediate feedback</td>
<td>1.61</td>
</tr>
<tr>
<td>7</td>
<td>Assessments are adequately paced and scaffolded</td>
<td>1.75</td>
</tr>
<tr>
<td>8</td>
<td>Grading information is included but separate from assessment; it is aligned with objectives</td>
<td>1.71</td>
</tr>
<tr>
<td>9</td>
<td>Course schedule is fully articulated and logically sequenced</td>
<td>1.79</td>
</tr>
<tr>
<td>10</td>
<td>Tone is positive, respectful, inviting</td>
<td>1.46</td>
</tr>
<tr>
<td>11</td>
<td>Fosters positive motivation, describes value of course, promotes content as a vehicle for learning</td>
<td>1.25</td>
</tr>
<tr>
<td>12</td>
<td>Communicates high expectations, projects confidence of success</td>
<td>1.25</td>
</tr>
<tr>
<td>13</td>
<td>Syllabus is well organized, easy to navigate, requires interaction</td>
<td>2.07</td>
</tr>
<tr>
<td>14</td>
<td>Classroom activities, assessments, and objectives are aligned</td>
<td>1.64</td>
</tr>
<tr>
<td>15</td>
<td>Learning activities are derived from evidence-based practices</td>
<td>1.86</td>
</tr>
<tr>
<td>16</td>
<td>Learning activities likely to actively engage students</td>
<td>1.75</td>
</tr>
</tbody>
</table>
4.2. Discussion

The mean score provided an overall reflection of the curriculum’s alignment. The overall mean score on the components ranged from 3 (strong evidence) to 1 (low evidence). The mean score of 1.64 produced by Component #14 indicated a moderate level of alignment between objectives, instructional activities, and assessments. The moderate evidence reflected by the mean of 1.64 suggested a significant need to redesign the syllabi to increase the strength of the learning objectives, instructional activities, and course assessments. Standardized syllabi templates and other aids could support increases in alignment. The results indicated a lack of evidence to support a declaration that alignment existed within the courses of the biomedical informatics curriculum. The moderate evidence found in the reviews were highly reflected by the means of the 15 components noted in Table 1. With increased evidence of alignment, a declaration could have been made that the instructional activities and assessments were designed to carry out the learning objectives of the courses.

4.3. Limitations

A limitation of the study involved the number of instructional designers who conducted the reviews of the syllabi. The ideal number of formally trained, instructional designers scoring the syllabi could have been more. However, institutional resources limited the amount of investments in this internal approach to increasing the alignment. Only three of the institution’s instructional designers were both formally trained and available to invest time in performing the syllabi reviews. Given the nature of the consensus technique’s ability to account for variance in solicited opinions, there is high confidence that the rigorous discussions of the technical elements of the rubric and the rubric’s systematic design adequately reflected the amount of evidence found in each syllabus. The components of the syllabi could have also been more clearly articulated by course directors to ensure adequate evidence of alignment between the learning objectives, instructional activities, and assessments.

5. Conclusions

The results of this study emphasized the technical importance of integrating instructional design principles into the development of curricula in biomedical informatics. More specifically, instructional designers are formally trained, professionals who seek to guide the development of instruction to meet the needs and goals of students. Their expertise will complement the acquisition of the dynamic, knowledge bases that exists within biomedical scientists and educators.

References

