Are We Teaching What They Want? A Comparative Study of What AM Employers Want versus What AM Frameworks Require

Dr. Faye R. Jones, Florida State University

Faye R. Jones is a Senior Research Associate at Florida State University's College of Communication & Information. Her research interests include STEM student outcomes and the exploration of student pathways through institutional research.

Dr. Marcia A. Mardis, Florida A&M University/Florida State University

Marcia A. Mardis is a Professor and Associate Dean at Florida State University's College of Communication & Information and Associate Director of the Information Institute. Author of numerous publication and recipient of over two decades of federally funded research grants, Dr. Mardis' work focuses on professional identity creation, educational text and data mining, and technician education improvement.

Divya Pahuja, Florida State University

Divya Pahuja is a graduate research assistant at the School of Information at Florida State University. Her research interests include the use of text mining techniques and data analytics to explore gaps in educational pathways and healthcare industries.

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Abstract

In this research paper, we compare Florida's AM employer demands and academic requirements to state mandated AM curriculum guidelines. Florida is an AM leader, producing intermediate and finished products ranging from plastics to tortillas to motor vehicles. In total, Florida is home to over 20,000 AM companies employing over 320,000 workers. Florida is also geographically diverse, being simultaneously one of the most urban and one of the most rural highly populous states in the country. To characterize Florida's AM employment needs, we analyzed 108 job postings from Florida employers who were seeking manufacturing and engineering technicians through publicly available job postings. Text mining was used to extract key knowledge areas (or topics) and verbs in these documents that AM employers identified in job postings and desired from their entry-level employees. We compared those topics and verbs to the ones found in the Florida Department of Education's (FLDoE) AM curriculum framework for two-year programs. We found varying levels of alignment, and, in some instances, misalignment, between employers' desired topics and competency levels and those found in FLDoE Frameworks. Our findings not only highlight the importance of industry-education partnerships to tailor preparation to employer needs, but also suggest that a deeper exploration and analysis of AM jobs is needed to further determine alignment to FLDoE frameworks. We conclude that the FLDoE framework may be used as a foundation, but not the sole source, for important AM knowledge areas, leaving opportunity for the development of an AM body of knowledge that reflects employer expectations and geographic variations.

1.0 Introduction

Manufacturing has evolved from the time that Henry Ford operated the first assembly line in 1913. The ability to make products in volume, allowed the US to dominate the world in manufacturing output, and increase its gross domestic product. In 1951, units of operation in product assembly began to be infused with technological innovations, evolving into what is now known as advanced manufacturing. Advanced technologies, systems, and processes have not only transformed the assembly line, but changed how products are built. Products can now be customized to meet the unique demands of the consumer. Automobiles, for example, were once assembled to be identical, whereas now customers are able to purchase cars online, select from a pallet of colors, and install unique features and equipment, whereby no two of the same product, make, or model are identical [1].

While both types of manufacturing remain essential to the industry, advanced manufacturing has created a need for technicians with new skillsets. Technologies such as 3D printing, the Internet of Things (IoT), nanotechnology, cloud computing, augmented reality, and next-level robotics, have made a home in advanced manufacturing, resulting in increased speed, customization, precision, and efficiency of product development [2]. New industries have emerged, and technical programs have been established to prepare these new technicians for the workforce.

In this study, we explore the alignment between what AM employers seek and what students should learn in AM programs. We focus on the growing AM industry in Florida, where urban areas maintain the highest concentration of manufacturing activities, and also in rural areas where manufacturing represents a more significant portion of the local economy. In this study, we aimed to answer the following research question:

RQ. To what extent are the knowledge items (or topics) and competency levels (or verbs) that Florida AM employers seek aligned with those mandated by the FLDoE AM curriculum frameworks?

1.0 Literature Review

1.1. Importance of Manufacturing in Florida.

Florida is ranked top 10 among the nation for manufacturing and home to 20,500 manufacturers as of the second quarter of 2018 [3]. Florida produces a wide variety of goods including food and beverage, communications equipment, aerospace products, pharmaceuticals, semiconductors, and more. Its transportation infrastructure includes over 20 airports, 15 deepwater seaports, 3,000 miles of freight rail tracks, and 2 spaceports giving the industry many options for moving and exporting products [4]. Florida ranks 45th among the 50 states in terms of the industry's contribution towards its own GDP, although it's low ranking among other states in manufacturing can be misleading. Florida is also the top travel destination in the world for tourism and relies heavily on international trade. Additionally, the latest index by the Information Technology and Innovation Foundation [5] ranked Florida as 27 among the 50 states for its manufacturing "value added", but also 1st for business churning, 10th for venture capital, and 12th for fastest growing firms, meaning that while manufacturing may not be Florida's leading industry, the state provides fertile ground for those seeking entrepreneurial opportunities [6].

Manufacturing employment in Florida is mostly concentrated in the urban southeast, central, and northeast regions of the state. The metropolitan areas of Miami-Dade, Pinellas and Orange each account for over 30,000 jobs, while Hillsborough, Broward, Duval, and Brevard contribute to over 20,000 manufacturing jobs each. These seven counties are attributed for 56.0 percent of Florida manufacturing jobs. Higher wage jobs are found in occupations that require greater training and additional certification beyond a high school diploma. While the more populated urban areas make the largest contribution to employment to Florida's economy, manufacturing plays a more significant role in the local economies of rural areas [7]. For example, "within the rural central Florida region surrounding Tallahassee, 8.4 percent of the region's employment is in manufacturing, producing 14 percent of the gross regional product, with average annual wages of $50,308 [7], p. 2." The rural south central region and rural northwest also enjoy these economic benefits, likely the result of several state initiatives and legislation.

1.2 Manufacturing Challenges

One of the top challenges for the industry is in recruiting students into what they perceive is an unattractive field. In a recent interview, an instructor from a Florida Advanced Manufacturing State College program said that "we have scholarships from the local lumber company for local high school students to take these courses and receive a degree for free, and I can never fill all of the slots they give us [8]." Similarly, the Manufacturing Leadership Council [9] announced that Americans still believed that manufacturing was vital to the country's economy, but that the vast majority "still wouldn't encourage their children to pursue manufacturing careers, and most don't believe that manufacturing jobs today are interesting, rewarding, clean, safe, stable, and secure (p. 1)." The limited entry of students into the pipeline leads not only to an unmet need for technicians in the AM industry, but also creates a shortage of experienced instructors that are highly skilled and that have obtained the experience and credentials to instruct these important technical programs.

The need for skilled AM workers was described by Powers [10], who stated that "one of our most significant challenges facing virtually every manufacturer is trying to find a reliable source of factory-ready workers that can operate sophisticated machine tools and keep automated (and increasingly robotic) factories up and running (p. 24)." As evidence, the U.S. Department of Labor [11] reported that construction and manufacturing had the highest ratio per vacancy, when comparing technician skills gaps to vacancies. In *Florida Jobs 2030*, the Florida Chamber Foundation [12] reported that the greatest projected long-term skills gaps in manufacturing were in sales representatives and maintenance and repair workers. Employability skills such as communication, critical thinking, and problem solving were underscored as important, in addition to developing productivity skills (e.g., word processing), occupation-specific skills (e.g., AutoCAD), and advanced digital skills (networking and design). These skills were specifically mentioned for the manufacturing industry because these skills are a "differentiating factor between entry-level and middle-skill jobs [11], p. 10."

1.3. Florida Efforts to Develop AM Competency

Career and Technical Education (CTE) prepares individuals for occupations important to Florida's economic development. The Florida Department of Education (FLDoE) offers several secondary and postsecondary courses, certifications, and degrees in manufacturing as a part of the CTE program. For example, middle schools offer introduction to manufacturing and fundamentals of career planning. High schools offer specific courses and programs in automation, production, electronic technology, welding, maritime repair, machining technology, and industrial machinery. Similarly community and state colleges offer 2-year degrees in engineering technology, with many offering one or multiple specialization tracks. Certifications can also be obtained in advanced manufacturing, with a focus on automation, lean manufacturing, mechatronics, and pneumatics, hydraulics, and motors for manufacturing [13].

1.4. FLDoE AM Curriculum Frameworks

The FLDoE reviews and creates curriculum frameworks to guide classroom instruction. As a CTE-designated program, these frameworks are used in secondary and postsecondary institutions to help meet Florida's economic and workforce needs. The standards are revised every 3-5 years on a rotational basis by a diverse group of experts from education, industry, and government.

A review of the FLDoE Curriculum Frameworks [13] for advanced manufacturing shows that there are seven core topics:

1. Pneumatic, hydraulic, and electromechanical components and/or systems.
2. Lean and six sigma concepts in manufacturing environments
3. Industrial automation systems
4. Industrial automation systems
5. Principles of Robotics and automated systems
6. Human machine interfaces and automated systems
7. Supply chain and operation management concepts and techniques

These topics reflect the foundational concepts for measuring instructional success in Florida's AM educational programs and for building competency.

1.5. Assessing Competencies

The *Taxonomy of Education Objectives,* developed by Bloom, Engelhart, Furst and Krathwohl (1956) serves as a scheme for classifyng educational standards, goals, and objectives. The six original categories (Knowledge, Comprehension, Applying, Analyzing, Evaluating, and Synthesizing), each with subcategories, are arranged in a cumulative framework whereby achievement of one level requires competency in the level prior [14]. The Taxonomy was later revised [15] to a two-dimentional framework of knowledge and cognitive processes. In the first dimesion, four types of *knowledge* are depicted (Factual, Conceptual, Procedures, Metacognitive) to illustrate how learning objectives (or verbs) in combination with disciplinary topics and subtopics can be structured to to attain competency in a discipline from lower to higher levels. Specifically, the four Knowledge Dimensions are defined as follows:

- Factual – the basic elements a student must know to be acquainted with a discipline or solve problems in it.
- Conceptual – the interrelationships among the basic elements within a larger structure that enable them to function together.
- Procedural – How to do something, methods of inquiry, and criteria for using skills, algorithms, techniques, and methods.
- Metacognitive – Higher-order thinking that enables understanding, analysis, and control of one's cognitive processes, usually by thinking about one's own thinking.

The second dimesion, *cognition,* refers to the process involved in going from lower order thinking to higher or critical thinking. These congitive dimensions are listed below (from lower to higher order):

- Remember – Retrieve relevant knowledge from long-term memory.
- Understand – Construct meaning from instructional messages, including oral, written and graphic communicaiton.
- Apply – Carry out or use a procedure through executing or implementing.

- Analyze – Breaking material or concepts into parts, determining how the parts relate or interrelate to one antoher or to an overal structure or purpose.
- Evaluate – Make judgements based on criteria and standards through checking or critiquing.
- Create – Put elements together to form a coherent whole; reorganize into a new pattern or structure. [15]

Both dimensions used together provide a classification scheme for joining actions (verbs) to objects (knowledge) to describe a process by which thinkers encounter and work with knowledge to achieve the desired competence in a discipline or acquire a constuct [16].   These two dimenions are the basis for the *Taxonomy Table* as illustrated in Table 1. Anderson and Krathwohl [17] also included and pre-sorted a list of verbs in their revised classification scheme to demonstration the hierarchy of verbs.

Table 1. Template of Bloom's Two-Dimensional Taxonomy Table [17]

Knowledge Dimensions	**Cognitive Dimensions**					
	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual						
Procedural						
Metacognitive						

2.0 Methods

In this study, we downloaded statewide manufacturing job postings from Employ Florida, a partnership of Career Source Florida, Inc., and the Florida Department of Economic Opportunity that manages workforce services online. We further extracted the competencies found in these job postings and compared them to the FLDoE's curriculum frameworks for Engineering Technology, with a specific focus on the advanced manufacturing educational objectives. In order to make these comparisons, we used textmining to extract the nouns (i.e., knowledge areas or topics) and verbs in these documents. The output files provided us with a general overview of the main topics and verbs found in the competencies of these documents, and whether there was congruence between what employers were asking for in job postings and what FLDoE said should be taught to become competent in the profession.

2.1. Data Collection

2.1.1. Job Postings. We performed a search of job postings on Employ Florida by selecting from pre-set search criteria: 1) *Area* – Florida, 2) *Job Source* – education institution, recruiter, state job board, corporate, government, and private job board, 3) *Keyword* – manufacturing, 4) *Job Occupation Group* – architecture and engineering, and 5) *Job Education Level* – No minimum requirement. The system returned 479 full-time and part-time manufacturing jobs using the search criteria from the period of 10/10/17 to 12/28/2018. We downloaded the job postings in PDF and reviewed each of the documents for evidence of the following: 1) that the highest required degree was an Associate's degree; or 2) that employers who desired an applicant with a Bachelor's degree would also consider a person with a 2-year degree with the appropriate experience. This filtering process generated a total number of 108 job postings for analysis in this study.

Each job posting was then converted from PDF to Text files in batches of 20 using a free online public tool called pdftotext.com. Once the job postings were in Text files, each posting went through an initial "cleaning" process. This involved the removal of text from the job postings that were irrelevant to the analysis of competencies, meaning that only competencies remained for analysis. The 108 text files were then merged into one document using command prompt.

The original PDF files were used to extract other important contextual information. Data from each of the postings, such as title, employer name, Florida region, city, fulltime or part-time, salary/hourly rate, and required degrees were entered into an Excel spreadsheet, when available. These data were important in order to extrapolate descriptive statistics to aid in our understanding of the contexts surrounding the manufacturing jobs offered during that time in Florida and to obtain descriptive details.

2.1.2. Curriculum Frameworks. We downloaded RTF files of the 2018–2019 FLDoE Curriculum Frameworks for the Advanced Manufacturing Specialization of Engineering Technology; this content is featured in Appendix A. The RTF files were also converted to text files and cleaned of text that were unrelated to competencies.

2.2 Data Analysis

2.2.1 Text Processing. Text files went through an additional review to remove section markers (e.g., "II" and "*"), to correct typos or spelling mistakes, and to transform unicode characters into a normalized code. Additionally, some words needed to be considered jointly, such as acronyms. We maintained a list of commonly used acronyms (e.g. CAD, short for computer aided design) and programmed the Python script to be able to identify these acronyms in long form whenever the acronym was found. We also compounded a few words in the text documents (e.g., data analysis was changed to DataAnalysis) so that program would read these compounded word as one unit, and not two individual words.

After cleaning the text, we performed text processing which involves several steps. To perform these steps, we developed a script using Python language that would take the cleaned text as input to return the set of nouns from the text and also the number of times that noun was found in the document (i.e., frequency). A similar, but independent script, was used to extract the verbs. The tools and libraries used in the program included NLTK, pandas and matplotlib. Table 2 below indicates the steps involved in processing the text.

Table 2. Text Processing Using Python Script

Step Number	Step Name	Description
1	Load Data	Load the data into the Python console.
2	Tokenize	Split the strings into tokens (or words). The splitting is done on the basis of white space and punctuation. For example, commas and periods are taken as separate tokens.
3	Filter out punctuation	Filter out the tokens that are not needed, such as standalone punctuation. This is done by iterating over all the tokens and only keeping those tokens that are all alphabetic.
4	Filter out stop words	Remove words such as “the, “a”, and “is” since these do not contribute to the deeper meaning of the text
5	Stemming	Stemming refers to reducing each word to its root or base. Ex: Reduce words like “programmable” and “programming” to “program.”
6	Parts of Speech (POS) tagging	Once tokens are filtered and stemmed, classify the words into their parts of speech. The words are assigned to their respective grammatical category in order to understand their role in the sentence, whereas traditional parts of speech are nouns, verbs, adverbs, conjunctions, etc.
7	Restricting	Restrict the words of choice. For example, to restrict topics then the code was writing to return all nouns and adjectives in the output. Ignore all other POS tags so that nouns and adjectives are returned. The tokes are stored into a data object list. We are basically restricting the output to only words with tags “NN” (i.e., nouns).
8	Frequency	To find the occurrence of all the topics in the document, create another type of object to store the frequency of the words and then coded a function to convert the list of words into a dictionary of word-frequency pairs. The output in this step represents each word against its frequency.
9	Visualization	We created bar charts using the matplotlib function using python code.

The steps in Table 2 illustrate the text mining process used to extract key words from job postings and the FLDoE curriculum frameworks. A sample code of these steps, using python, is depicted in Figure 1.

```python
#import nltk
import nltk
nltk.download()

#tokenization
from nltk.tokenize import word_tokenize
tokens = word_tokenize(book)

# remove all tokens that are not alphabetic
words = [word for word in tokens if word.isalpha()]
#print(words)

#Filter out stop words
from nltk.corpus import stopwords
stop_words = stopwords.words('english')
#print(stop_words)

# stemming of words
from nltk.stem.porter import PorterStemmer
porter = PorterStemmer()
stemmed_words = [porter.stem(word) for word in words]
#print(stemmed_words)
```

Figure 1. Python language script for the text mining process

As depicted in Figure 1, the code shows that a specific text file was imported (Step 1), tokenized (Step 2), filtered for punctuation (Step 3), filtered for stop words (Step 4), and stemmed (Step 5) using this script. Additionally, Figure 2 shows the resulting frequency output after tagging the words (Step 6) and restricting the output file to nouns and adjectives (Step 7). The output file, shown in Figure 2, captures only nouns and adjectives with the number of times that each word appeared in the document.

```
{'DISCIPLINES': 1, 'WORK': 1, 'PROGRAM': 3, 'REAL': 2, 'SCHEMATIC': 1, 'FUNCTION': 1, 'LASTING': 1, 'DRAWINGS': 1, 'ROLE': 1, 'SUPPLEMENTAL':
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12, 'MULTIPLE': 1, 'PROPERTIES': 1, 'INPUT': 2, 'MODE': 1, 'SCHEDULES': 1, 'STRONG': 1, 'ISSUE': 1, 'ROBOTIC': 7, 'REPAIRS': 1,
'UNDERSTANDING': 2, 'INDUSTRIAL': 9, 'MODERN': 1, 'SHEET': 1, 'USE': 1, 'MONITORING': 2, 'HARDWARE': 1, 'ADDRESS': 1, 'MAINTENANCE': 3,
'RELATIONSHIPS': 1, 'ESSENTIAL': 2, 'MACHINE': 1, 'LAYOUT': 1, 'FIELD': 2, 'PROBLEM': 1, 'TEAMS': 1, 'CODES': 1, 'SPECIAL': 1, 'SIGNALS': 1,
'INVENTORIES': 1, 'FACTORS': 1, 'PROBLEMS': 1, 'ELECTROMECHANICAL': 8, 'PRODUCT': 3, 'DISTRIBUTION': 1, 'RESOURCES': 1, 'INTERPRET': 3,
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1, 'PERSONS': 1, 'SUPPORT': 3, 'TIME': 1, 'CHAIN': 3, 'HUMAN': 2, 'FOCUS': 1, 'ENVIRONMENTAL': 1, 'WAREHOUSE': 1, 'PREPARE': 1, 'IMPORTANT':
2, 'HARNESS': 1, 'ASSURANCE': 1, 'PRINCIPLES': 3, 'ROBOTICS': 2, 'PLAN': 1, 'ACCOUNTING': 1, 'IDENTIFICATION': 1, 'UTILIZATION': 1,
'COMPONENTS': 8, 'IMPLEMENTATION': 1, 'OPERATION': 1, 'INSTALL': 1, 'PROGRESS': 1, 'CAPABILITIES': 1, 'TECHNOLOGIES': 1, 'AUTOMATION': 6,
'OCCUPATIONS': 1, 'PNEUMATIC': 11, 'DESCRIBE': 2, 'SCRAP': 1, 'AUTOMATIC': 2, 'BUSINESS': 1, 'MATERIALS': 3, 'INVENTORY': 2, 'FUNDAMENTAL': 1,
'EXPERTISE': 1, 'STUDENTS': 1, 'OPERATIONS': 7, 'VARIOUS': 2, 'STATES': 1, 'INTERFACES': 3, 'BASIC': 3, 'ROOT': 1, 'SUPPLIERS': 1,
'PROCESSING': 3, 'EFFICIENCY': 1, 'MATH': 1, 'VISION': 1, 'INCONSISTENCIES': 1, 'SPECIFIC': 1, 'MANAGEMENT': 5, 'MINOR': 1, 'CHARTS': 2,
'OPERATING': 1, 'LADDER': 1, 'DEVICE': 1, 'MANUAL': 1, 'FOOD': 1, 'TRAINING': 1, 'COMPLETION': 1, 'PASSIVE': 1, 'SOFTWARE': 2, 'SAFE': 1,
'METAL': 2, 'IMPROVEMENT': 4, 'FLOW': 4, 'TRANSPORTATION': 1, 'EMPLOYABILITY': 1, 'OCCUPATIONAL': 1, 'INDEPENDENT': 1, 'BUILDING': 1,
'MODULE': 1, 'CONDITION': 1, 'PLASTICS': 1, 'PARAMETERS': 1, 'IMPROVEMENTS': 2, 'MAINTAIN': 2, 'SOURCE': 1, 'MANUFACTURING': 2, 'FAULTS': 1,
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'SYSTEMS': 21}
```

Figure 2. Python Script Output of FLDoE AM Curriculum Framework's Topical Frequencies

In summary, the text mining process was used to extract words from both the FLDoE frameworks and job postings to make comparisons between the topics (e.g., nouns) and competency levels (or verbs) as written in each of the compiled documents.

2.1.2. Limitations

Not all of the data that should have been included on the job postings were available, which limited our full understanding about information such as salary, hourly rates, and some employer locations. The data presented in this study is limited and reflects only employers who used Employ Florida to post their manufacturing advertisements and who posted their advertisements during the selected timeframe. Additionally, to comply with the page and space limitations by the publishing source, it was also difficult to list all of the topics and nouns that were generated from text mining output files. As a result, only the most frequently mentioned topics were shared, whereas verbs were able to be shared in totality.

3.0 Results

3.1. FLDoE Topics and Verbs

3.1.1. FLDoE AM Framework Topics. In a review of over 228 nouns, we sought to validate what we already knew about the FLDoE framework topics (i.e., section 1.4, items 1-7). Nouns listed more than twice were identified, resulting in the top 30 nouns shown in Figure 3. The top three topics that occurred the most in the FLDoE frameworks were systems (n=25), production (n=20), and process and processing (n=15).

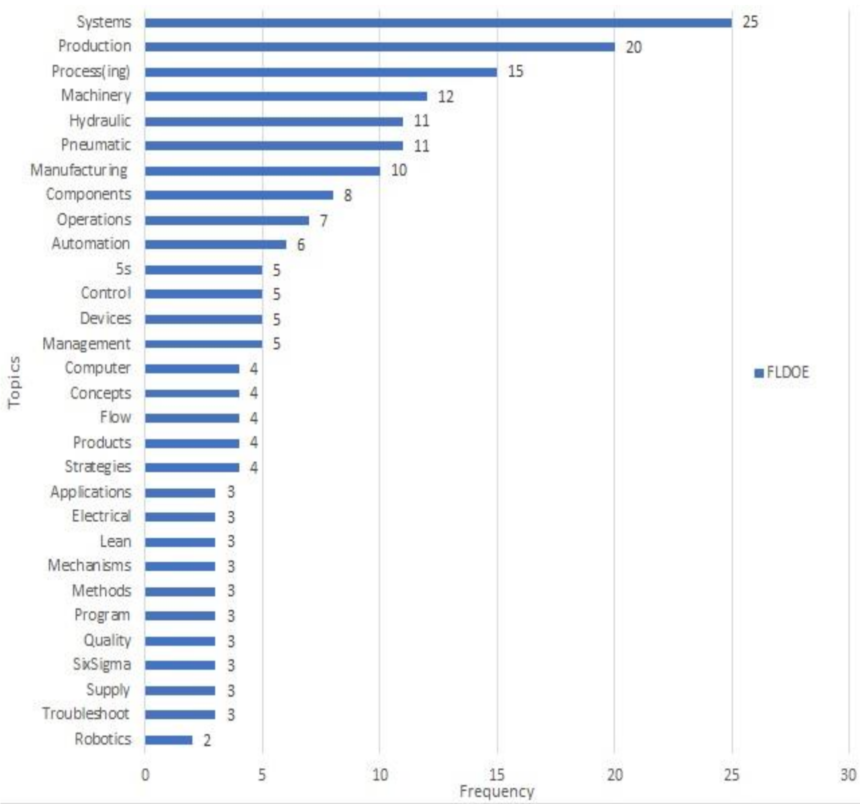

Figure 3. FLDoE Curriculum Topic Frequencies

3.1.2. FLDoE Curriculum Verbs. We also identified the verbs with the highest frequencies in the AM curriculum frameworks. The verbs in Figure 4 depict the verbs that are associated with the FLDoE AM curriculum frameworks, or those that are used to develop two-year degree-seeking students in AM. As Table 3 illustrates, 31 verbs were found in the FLDoE AM Curriculum Frameworks, and specifically in the document's list of objectives for AM technicians. The top five verbs retrieved from the frameworks were identify, apply, describe, demonstrate, and implement.

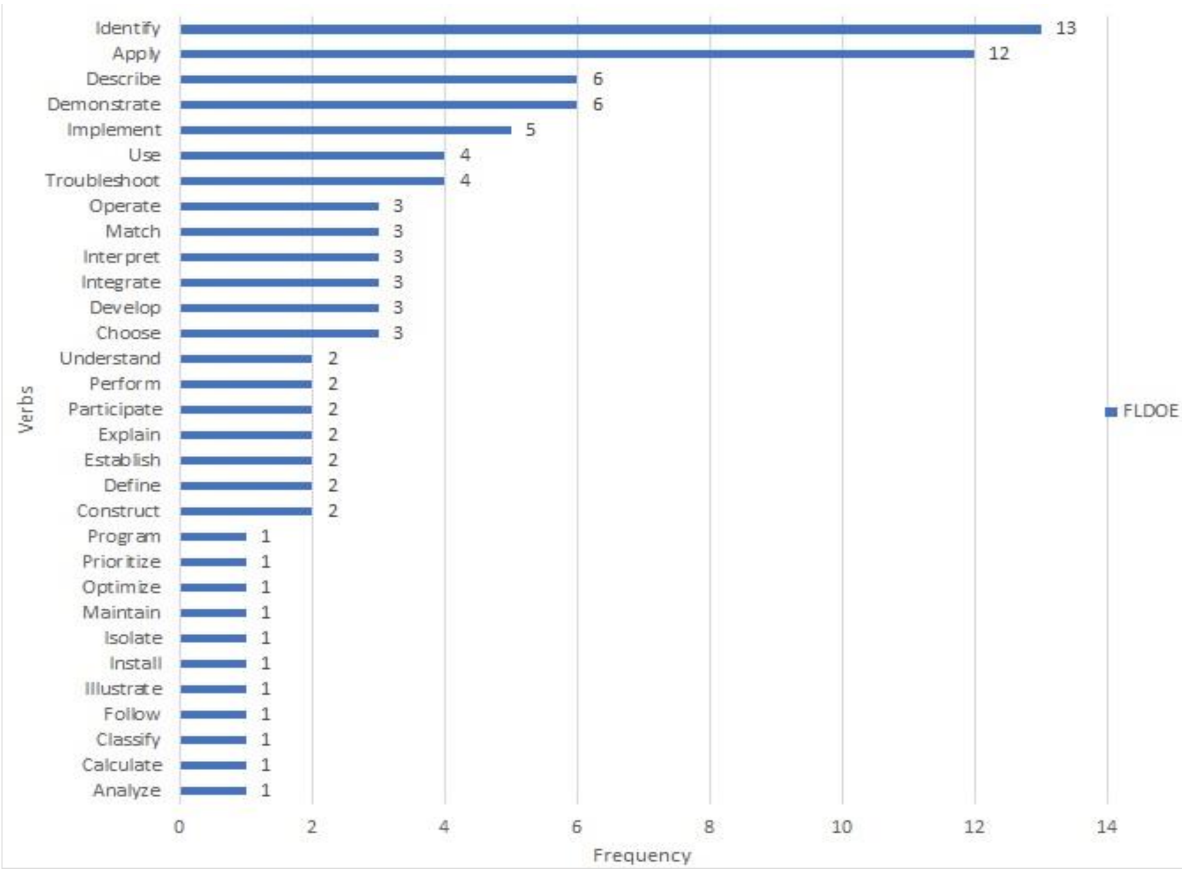

Figure 4. FLDoE Verb Frequencies

To better analyze the verbs according to their appropriate levels, all the verbs were categorized using Bloom's Two-Dimensional Taxonomy, as Table 3 shows.

Table 3. Bloom's Two-Dimensional Taxonomy of Verbs in FLDoE AM Curriculum Frameworks

Knowledge Dimensions	**Cognitive Dimensions**							
	Remember	Understand	Apply	Analyze	Evaluate	Create	n (verbs)	Know-ledge %
Factual	Define	Interpret	Use	Classify Choose			5	16.1
Conceptual		Understand Describe	Participate	Identify			4	13.0
Procedural			Operate Calculate Apply Follow Install Maintain Perform Program	Integrate Demonstrate Isolate	Trouble-shoot	Construct Develop Establish	15	48.4
Meta-cognitive		Explain Illustrate	Implement	Match Analyze	Prioritize Optimize		7	22.5
n (verbs)	1	5	11	8	3	3	31	
% Cognitive	3.2	16.1	35.5	25.8	9.7	9.7		100

As Table 3 illustrates, verbs found in the FLDoE frameworks were the highest in the "apply" and "analyze" categories of the cognitive dimension with 11 (35.5%) and 8 (25.8%) verbs in those categories, respectively. Procedural verbs were most used in the knowledge dimension with nearly half (n=15, 48.3%) of the verbs belonging to this category. Metacognitive verbs were the next highest mentioned category in the knowledge dimension, with seven (22.6%) verbs belonging to this category. The least mentioned cognitive dimensions were in the categories of remembering (n=1, 3.2%), evaluating (n=3, 9.6%), and creating (n=3, 9.6%). Factual (n=5, 16%) and conceptual (n=4, 12.9%) verbs were the two least mentioned categories in the knowledge dimension.

3.2. AM Employer Job Postings

3.2.1. Job Posting Descriptive Information. In this study, we reviewed 108 job postings representing 71 employers. The majority of postings were from employers located in Florida's urban cities (n=100, 92.6%), with only a few rural employer postings in the sample (n=5, 4.6%), and the remaining postings void of job location details (n=3, 2.8%). As can be seen in Appendix B, with the exception of the position titles, many of the job postings were missing details such as salary and hourly rate information. Of the 108 postings, the majority were full-time positions with benefits (n=65, 60.2%), followed by part-time positions (n=14, 13%), full-time positions without benefits (n=5, 4.6%), and the remaining postings (n=24, 22.2%) did not include full- or part-time details.

3.2.2. Job Posting Topics. Text mining identified a total of 341 nouns used throughout the corpus of 108 job postings. In order to present the topics that were mentioned the most, we narrowed the output to extract only the topics with more than 90 mentions which produced 25 of the highest demanded knowledge areas or topics by employers, or so we thought. Figure 5 depicts the top 25 nouns found in postings.

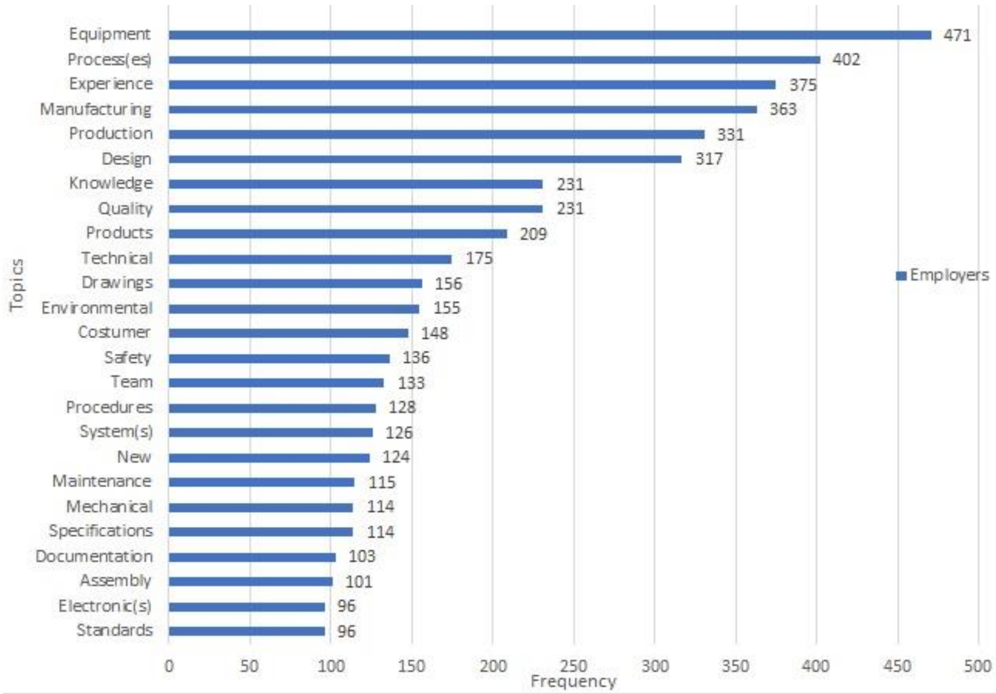

Figure 5. Job Posting Topic Frequencies

Of the 25 nouns, 22 were topical and 3 were not topically relevant. For instance, nouns such as "new," "experience," and "knowledge," were generated in the textmining output. After an initial review, without modifiers, words such as "experience" and "knowledge" were considered out of the scope of this study.

3.2.3. Job Posting Verbs. Employers mentioned 683 verbs in the 108 job postings analyzed. Of these, we extracted 28 verbs, as shown in Figure 6 that were mentioned more than 10 times.

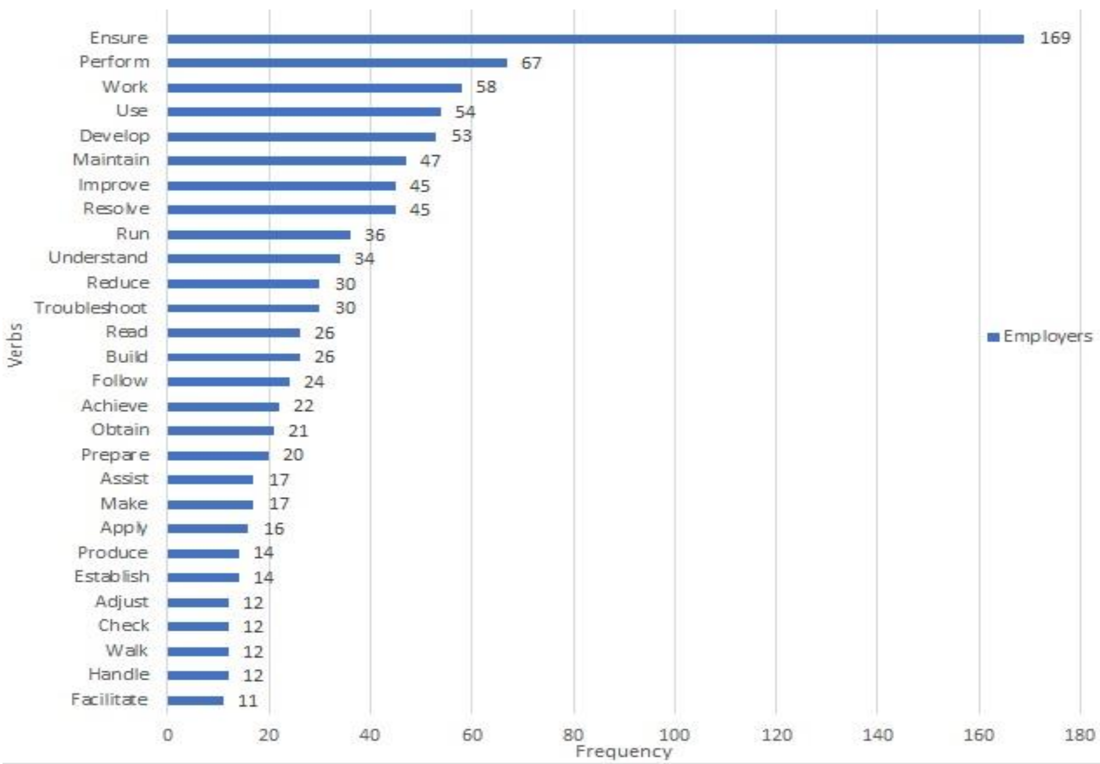

Figure 6. Job Posting Verb Frequencies

As Figure 6 shows, the top five mentioned verbs were ensure, perform, work, use, and develop. Table 5 shows the verbs found in job postings further classified and then analyzed according to Bloom's two-dimensional taxonomy.

Table 5. Bloom's Two-Dimensional Taxonomy of Verbs in Job Postings

Knowledge Dimensions	**Cognitive Dimensions**							
	Remember	Understand	Apply	Analyze	Evaluate	Create	Verbs (n)	Knowledge (%)
Factual			Use		Check		2	7.7
Conceptual		Understand Obtain					2	7.7
Procedural	Read	Assist Handle	Apply Facilitate Follow Maintain Perform Run Prepare	Reduce	Trouble- shoot	Make Produce Establis h Build Develop	17	65.4
Meta-cognitive				Achieve Adjust	Ensure Resolve	Improve	5	19.2
Verbs (n)	1	4	8	3	4	6	26	
Cognitive (%)	3.8	15.4	30.8	11.5	15.4	23.1		100

As Table 5 suggests, of the 28 verbs, we only classified 26, as two of them were related to physical requirements (e.g., walk), while others referred to abilities, such as ability to "work with" other people or "work during" certain hours or on specific shifts. The verbs found in the job postings were highest in the "apply" (n=8) and "create" (n=6) categories of the cognitive dimension, and in the "procedural" (n=17) and "metacognitive" (n=5) categories of the knowledge dimension.

3.3. Comparing the FLDoE versus Employer Topics and Verbs

3.3.1. Comparing Topics. To compare topics, and specifically to explore the extent to which FLDoE frameworks matched the competencies that employers expressed as desirable in job postings, we used the extracted list of 25 most frequently mentioned topics by employers (Figure 5) and then extracted the number of times that each of those nouns or topics were mentioned in the FLDoE Frameworks. We then converted frequencies to percentages for each of the groups to make comparisons. As shown in Figure 7, there were many similarities and differences when comparing the most frequently mentioned topics.

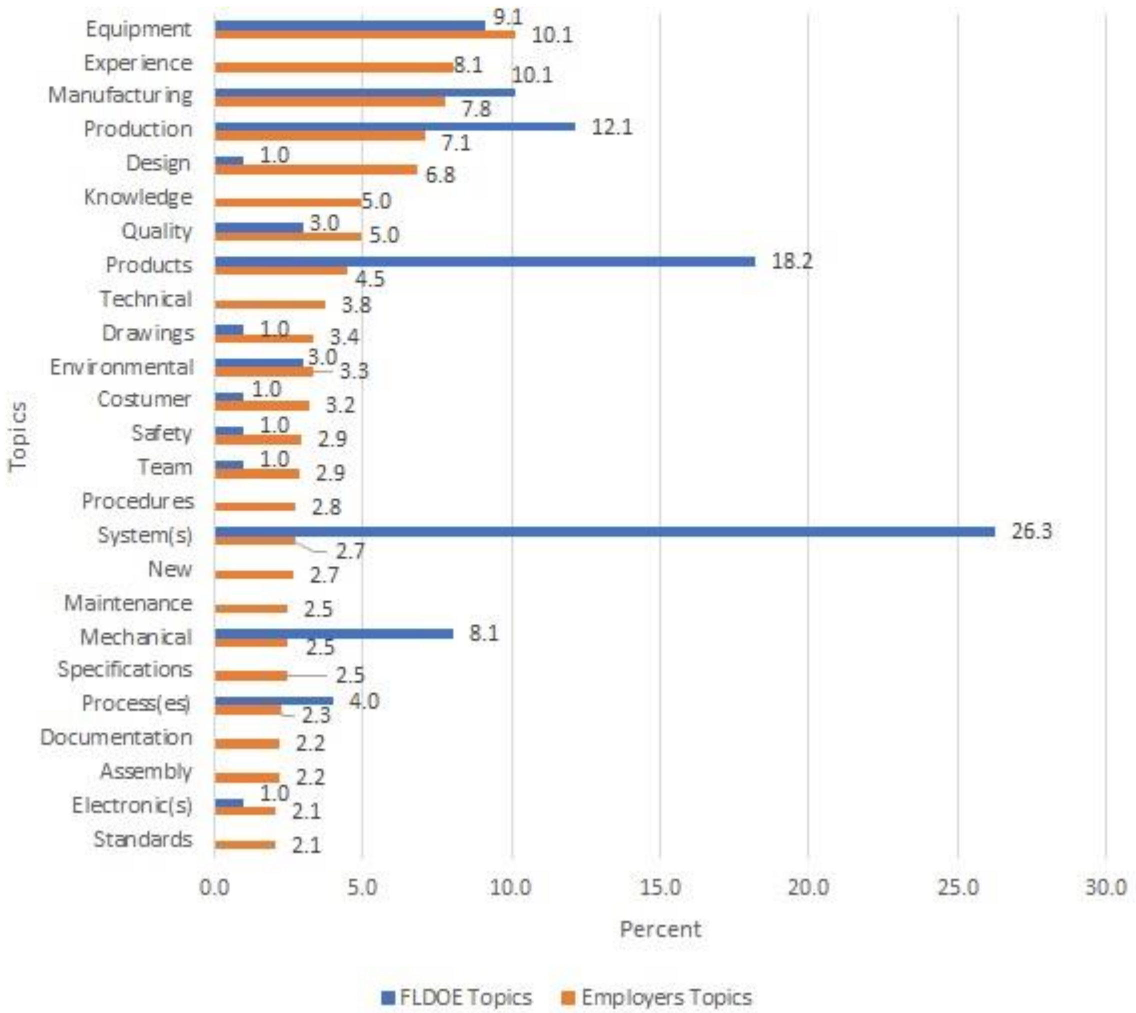

Figure 7. Comparison of Employer to FLDoE Framework Topics

In Figure 7, FLDoE frameworks were meeting or surpassing the desires of employers when the blue bars (FLDoE) where equal to or surpassed the orange (employers) bars. This was evident in areas such as production, products, systems, mechanical operations, and processes. There were also topics with "adequate" topical coverage, with adequate coverage defined as less than one percentage point deference between FLDoE and employer competencies. Areas with adequate coverage were equipment, environmental and electronics-related topics. Finally, gaps in coverage between employer job postings and FLDoE frameworks were identified there was more than one percentage point of separation between mentions. These gaps were seen in topics such as design, quality, technical topics, drawings, costumer services, safety, team concepts, procedures, concepts related to maintenance, specifications, documentation, assembly, and standards. Also, the non-topical words such as experience, new, and knowledge were never mentioned in the FLDoE frameworks.

3.3.2. Comparing Verbs. As seen in Table 6, to analyze whether there were any differences between the degree to which desired competency levels matched between FLDoE frameworks and employer job postings, we compared the percentage of verb mentions using Bloom's Two-Dimensional Taxonomy.

Table 6. Comparison of Top FLDoE and Employer Verbs

Knowledge Classification	**Knowledge Dimension**	
	Mention by Employer (%)	**Mention by FLDoE (%)**
Factual	7.7	16.1
Conceptual	7.7	13.0
Procedural	65.4	48.4
Meta-Cognitive	19.2	22.5
Total	**100**	**100**
Cognitive Classification	**Cognitive Dimension**	
	Mention by Employer (%)	**Mention by FLDoE (%)**
Remember	3.8	3.2
Understand	15.4	16.1
Apply	30.8	35.5
Analyze	11.5	25.8
Evaluate	15.4	9.7
Create	23.1	9.7
Total	**100**	**100**

In the knowledge dimension, the largest differences between FLDoE Frameworks and job postings were found in procedural knowledge, whereas employers mentioned procedural verbs (65.4%) more than FLDoE frameworks covered them (48.4%), although FLDoE frameworks (22.5%) covered slightly more meta-cognitive verbs than employers required them (19.2%) for entry level positions. Additionally, FLDoE covered factual (16.1%) and conceptual knowledge (13%) dimensions more than desired by employers, with employers mentioning factual and conceptual knowledge dimensions in job postings 7.7% of the time.

Results in the cognitive dimension revealed alignment in the classifications of remembering, understanding, and applying between FLDoE Frameworks and employers' desires of entry level AM technicians. Differences were seen in the cognitive classification of analyzing, evaluating, and creating. Specifically, the AM frameworks mentioned verbs associated with analyzing (25.8%) slightly more than double the percentage points that employer job postings (11.5%) indicated that they desired them. On the contrary, employers were more likely to desire entry-level employees with cognitive abilities in evaluating (15.4%) and creating (23.1%), compared to mentions of the AM Frameworks (each mentioned 9.7%).

4.0 Discussion

In this study, we used NLP to extract knowledge areas or topics (nouns) and verbs to compare competencies as expressed by educators and employers to answer the question: To what extent are the competencies Florida AM employers seek aligned with the competencies mandated by the FLDoE AM curriculum frameworks? Stated plainly, are educators teaching what employers want? A comparison of employer job postings and FLDoE frameworks indicates that there are areas of alignment and misalignment in both the knowledge areas (nouns) and levels of competency attainment (verbs), although the focus of this discussion will primarily describe areas of misalignment and conclude with next steps.

4.1. Areas of Misalignment

4.1.1. Gaps in Topical Coverage. Our findings identified knowledge areas or topics that FLDoE frameworks did not cover to the extent expressed by employers in job postings.

Design and drawings. Employers conveyed the need for strong mechanical design ability in new hires, and their ability to design for excellence (DFX), which included both design for manufacturing and assembly (DFMA). Other examples included the ability to create new stencil designs and familiarity with schematics and technical drawings. Employees were sought with the ability to design and implement manufacturing processes, instrumentation and equipment from laboratories through pilot planning and to appropriate manufacturing scales. This included the ability to improve designs for product realization, field services, and sales. Job postings also indicated the need to create printed circuit board design solutions for embedded computer systems, where skill with high component density, high pin count devices, and high layer count designs were the norm, as well as designing for electromagnetic capability (EMC) proficiency with respect to inter-process communication (IPC) standards.

Quality. Employers expressed quality and accuracy in building customer products as essential. The importance of quality was evident with high impact to management, assurance, controls, products, and standards. Employees with the ability to produce and carry out quality plans and supporting documentation were often mentioned. The need to ensure that quality plans are in place and used to measure and monitor key process/product characteristics and interfaces were frequently mentioned by employers.

Technical. The ability to provide technical support to streamline manufacturing processes and minimize product build-time was conveyed as valuable by employers. Employees who could provide technical guidance and support to manufacturing operators to facilitate assembly performance were also sought. Job postings indicated that technical support was also needed to help resolve production problems related to manufacturing processes, tools, and equipment. Employers also expressed the need for "technical" problem solving, and employee skills with root-cause analysis (RCA) and corrective action for manufacturing.

Customer. Employers described the importance of appropriating the time delivery of products to meet customer demands. They expressed the need for employees with not only great communication and customer service skills, but also the ability to service and test customer returns and production systems. Employers indicated that employees should be able to assist customers through the final design of a project, in addition to helping customers specify assigned products and services.

Safety. Employees should be knowledgeable about safety components in industrial and manufacturing environments and specifically have knowledge of component safety products and the relevant machine safety standards. This means that entry-level employees should be familiar with risk assessment processes, as well as have experience with machine safety products and health and safety requirements.

Team. Employers expressed that team collaboration is essential, and that employees must be able to function effectively in a team environment. Employees that can both work in teams and direct teams are highly valued. They should also have experience working in teams and be "team performers," meaning that they contribute highly to the success of a team.

Maintenance. Employees should have knowledge of preventative, corrective, and predictive maintenance, as well as be able to maintain and troubleshoot equipment (e.g., such as printed circuit boards, assembly machines, equipment, and tooling). Employees should also be able to record and track maintenance results.

Procedures. Employers desire employees with policy and procedures experience in development, production, and testing. Employees should be able to develop and maintain electrical and electro-optic procedures that focus on high complexity products that require a keen focus to develop and optimize the assembly process and associated standard work instructions (SWI).

Specifications. Employees should be able to read and follow established procedures and guidelines to manufacture the organization's products according to production specifications. Employers also indicated that employees should be able to follow predefined instructions to build high tensile capacity products to specifications. Employers expressed that entry-level employees should have knowledge about how to test assemblies based on provided specifications. This includes the ability to prepare material, proposal, equipment, and process specifications, and to interpret specifications on drawings.

Standards. Employees should be able to ensure quality work that meets or exceeds workmanship standards and improves efficiency. Some of the most commonly referred to standards included: Quality management system standards, drafting and design standards, standards of compliance, function and cost standards, international and governmental regulatory standards, International Organization for Standardization (ISO) standards, labor utilization standards, and assembly/production standards. Job postings revealed that it was also important for employees to have experience maintaining manufacturing standards up-to-date with the latest technology, as well as have experience establishing standards. Employees should also have IPC and electrostatic discharge (ESD) standards knowledge.

Documentation. Entry-level employees should know the documentation related to manufacturing activities, such as standard work instructions (SWI). They should be able to review and update process and manufacturing documentation, and identify product defects and complete appropriate documentation when defects are identified. They should be familiar with ISO, quality control, and overall equipment effectiveness (OEE) documentation. They should also be able to maintain and complete appropriate assembly, production, and test documentation. Employees should also be able to comply with paperless work instruction documentation systems.

Assembly. Employees should be able to conduct and support manufacturing operations to facilitate assembly performance. This includes the ability to work in a fast paced manufacturing and assembly environment, and be able to conduct critical assembly tasks to ensure activities meet required specifications. Types of assemblies mentioned included printed wiring board assembly, electro mechanical assembly, and the construction and maintenance of assembly figures. Knowledge and experience with assembly quality plans and solving assembly specific problems in the manufacturing process were frequently mentioned.

4.1.2. Non-Topical Areas. Non-topical words were not the focus of this study, but they did provide insight into the amount of value that AM employers place on experience. Even in entry-level positions, employers expressed the need for experience more than any other noun. As such, it would be beneficial to explore how current AM Frameworks incorporate the type and amount of experience desired by employers. Work-integrated learning activities such as internships and apprenticeships might also be considered to fulfill these employer needs.

Curriculum developers should also consider how the AM frameworks incorporate the dynamic nature of the field and prepare students to explore, operate, test and create new processes, systems, and equipment. Stated simply, frameworks and curricula may not (and probably should not) be able to change at a pace driven by employer needs, but innovative instruction can develop resiliency in students and prepare them to adapt to the newest technologies, equipment, and processes.

4.1.2. Competency Levels. Employers desire that employees possess competencies at different levels, consistent with Bloom's taxonomy [15], [16]. An analysis and comparison of verbs retrieved from FLDoE frameworks and employer job postings showed gaps in both knowledge and cognitive dimensions. In the knowledge dimension, the greatest gap between employer (65.4%) and FLDoE framework (48.4%), mentions was in the classification of procedural knowledge (a difference of 17 percentage points). Procedural knowledge involves the use of verbs that measure how something is done, methods of inquiry, and are criteria for using skills, algorithms, techniques, and methods. It should also be noted that the word "procedures" was among the most frequently mentioned nouns by employers, in which a gap was also found between employers and the AM frameworks, which serves as a secondary confirmation of this finding. As a result, the inclusion of procedural verbs that span across the cognitive dimensions (e.g., tabulate, predict, calculate, differentiate, conclude, compose, etc.) are recommended for inclusion in the AM frameworks.

Both knowledge and cognitive dimensions are hierarchical for each competency being learned and are considered as levels in competency development, meaning that attaining procedural knowledge of a specific competency means that student also understands the associated conceptual and factual categories, one and two levels the "procedural" category, respectfully. As a result, it is noteworthy that FLDoE Frameworks (22.5%) covered slightly more meta-cognitive verbs than employers required (19.2%); however, FLDoE covered factual (16.1%) and conceptual knowledge (13%) dimensions more than desired by employers, which suggests that choosing more procedural verbs when developing competencies would better meet employer needs.

In the cognitive dimension, there was evidence that employers sought employees with cognitive abilities in "evaluating" (15.4%) and "creating" (23.1%), compared to 9.7% mention of verbs related to these categories in the AM frameworks. This suggests that incorporating verbs that focus on higher cognitive processes (e.g., create and evaluate) in order to meet job posting requirements is advisable. Additionally, FLDoE frameworks mentioned verbs associated with "analyzing" (25.8%) slightly more than double the percentage points than job postings (11.5%) revealed that employers desired them. This suggests that focusing on higher cognitive processes are both achievable and warranted. Specifically, to increase competency levels at the cognitive levels recommended, the AM frameworks would need to include measurable competencies that use verbs to evaluate or make judgements (e.g., prioritize, reconstruct, support, verify, monitor, etc.) and to create (e.g., improve, invent, plan, predict, produce, generate, construct, etc.).

4.2. Next Steps

In this study, we identified the most frequently mentioned topics and verbs found in employers' job postings and compared them to AM curriculum frameworks. In this section, next steps for expanding research in this area are presented.

First, it may be valuable to explore full competency analysis in future works by joining nouns and verbs with exact match to the FLDoE frameworks by developing a more sophisticated python script for use in textmining. Additionally, while job postings are useful, they are limited by the timeframe in which they are selected, those who post jobs during the time of data collection, and the accuracy of the data they provide. Special consideration to track the location of jobs is important for generalizing results, as job postings from rural employers were underrepresented in this study. Job postings may have to be collected directly from urban employers to ensure they are adequately represented in the findings. If the postings cannot be obtained, then it might be necessary to increase rural participation by incorporating interviews or other qualitative techniques with rural employers.

A study that focuses on the differences between rural and urban employers on the needs they have of AM technicians is also recommended. This study should capture contextual factors that explore how rural employers advertise their positions. If they are not posting their jobs through Employ Florida, where are they posting their jobs? It might be that they are using word of mouth, networking, or other connections to hire future technicians.

Job postings revealed that employers seek entry-level technicians that have experience prior to employment. Additionally, the importance of resilience in the dynamic field of advanced manufacturing and development of future technicians that can adapt to new processes, systems, and equipment were mentioned repeatedly by employers. This poses an interesting question for future work in this area: How can future AM technicians be taught to problem-solve and develop the self-efficacy, motivation, and initiative needed to operate systems they haven't seen yet? Although this study did not focus on non-topical nouns, more work should be done in this area.

The creation of an AM Body of Knowledge (BOK), which combines the competencies that employers, academia, and professional organizations believe are necessary for developing AM technicians is advisable. This document could be used as the basis for making comparisons across and between various AM stakeholders. For example, a study that compares AM syllabi to an integrated BOK of all the stakeholders might be a better tool for exploring areas where experiential learning is highly desired.

Finally, another interesting application of the method used in this study would be to compare the extent to which employers are using what the FLDoE framework suggests should be taught (or the reverse of what was done in this paper). The analysis would require that the FLDoE frameworks and priorities are used as the baseline for the comparisons (instead of the employers' most frequently mentioned knowledge areas) and then explore the extent to which the FLDoE's high priority topics are mentioned by employers.

5.0 Conclusion

In this study we explored whether educators are teaching what employers desire. We found that there are areas of both alignment and misalignment in both knowledge areas and competency levels. Areas that can be addressed immediately as a result of this study include the review of the frameworks to incorporate the appropriate knowledge and cognitive levels for instruction and the workforce. Furthermore, the development of a Body of Knowledge that integrates knowledge areas and competency levels is recommended, in order to align the needs of AM stakeholders and facilitate the evaluation of AM programs, curricula, syllabi, and pathways to employment.

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Appendix A. 2018-2019 FLDoE AM Curriculum Framework

Standards		
12.0	Understand, operate, troubleshoot, and maintain pneumatic, hydraulic and electromechanical components and/or systems–The student will be able to:	
	12.01	Identify, classify and describe the function of pneumatic, hydraulic and electrical machines and components.
	12.02	Construct flow diagrams of pneumatic, hydraulic, and electromechanical systems.
	12.03	Perform basic operation maintenance of pneumatic, hydraulic and electromechanical components, devices and/or machines.
	12.04	Understand maintenance requirements.
	12.05	Troubleshoot errors, faults, and inconsistencies in pneumatic, hydraulic and electromechanical components, machines and/or systems.
	12.06	Define special applications of electromechanical, hydraulic and pneumatic machines and devices used in manufacturing and process equipment.
	12.07	Describe important limitations of electromechanical, pneumatic and hydraulic machinery.
	12.08	Operate independent pneumatic, hydraulic and electrical machines properly.
	12.09	Describe the important operating parameters of pneumatic, hydraulic and electrical machines and/systems.
	12.10	Identify and use appropriate monitoring gages for pneumatic, hydraulic, and electromechanical machines and/or systems.
	12.11	Use safe practices while operating, troubleshooting and maintaining industrial equipment.
	12.12	Apply the 5S's: Sort, Set in Order, Shine, Standardize, and Sustain.
13.0	Identify lean and six sigma concepts in manufacturing environments--The student will be able to:	
	13.01	Explain product manufacturing requirements.
	13.02	Construct process flow charts.
	13.03	Explain the role of management in production operations.
	13.04	Integrate personnel, hardware, and software capabilities for timely completion of products and product orders.
	13.05	Apply manufacturing resources planning and lean manufacturing principles to production and process planning.
	13.06	Demonstrate good examples of lean manufacturing principles of kanban, synchronized flows, perfect first-time quality, waste minimization, continuous improvement, flexibility, and building long lasting relationships with suppliers and customers.
	13.07	Implement minimization of wastes in the form of waiting time, inventory, processing, motion, over-production, transportation, and scrap.
	13.08	Apply the 5S's: Sort, Set in Order, Shine, Standardize, and Sustain.
	13.09	Use six sigma tools to identify opportunities and drive improvements.
	13.10	Apply the PDCA (plan–do–check–adjust) method in improvement activities.
	13.11	Participate in a continuous process improvement event involving multiple disciplines.
14.0	Operate industrial automation systems--The student will be able to:	
	14.01	Interpret schematic diagrams.

	14.02	Analyze ladder logic diagrams for industrial automation systems.
	14.03	Identify Programmable Logic Controller input and output module locations.
	14.04	Match wiring harness identification to program addresses for input and output modules.
	14.05	Identify active and passive states of each module.
	14.06	Interpret flow charts to match field device components with the real devices.
	14.07	Identify when a programmable controller is in run or program mode, or is in a fault condition.
	14.08	Integrate control systems and equipment with production and production support mechanisms.
	14.09	Establish routine operations involving maintenance schedules.
	14.10	Troubleshoot problems and perform minor repairs to industrial automation systems.
	14.11	Apply the 5S's: Sort, Set in Order, Shine, Standardize, and Sustain.
15.0	Troubleshoot industrial automation systems--The student will be able to:	
	15.01	Demonstrate troubleshooting techniques to identify root cause, errors and faults of a problem.
	15.02	Isolate systems for troubleshooting.
	15.03	Develop a strategy for making system improvements based on troubleshooting activities with strong focus on fail-safe methods
	15.04	Identify needed expertise to resolve complex issues.
	15.05	Participate in troubleshooting and resolution teams effectively.
	15.06	Apply the 5S's: Sort, Set in Order, Shine, Standardize, and Sustain.
16.0	Apply the principles of robotics to automated systems--The student will be able to:	
	16.01	Identify and describe the essential components of a robotic system.
	16.02	Choose appropriate robotic equipment for specific tasks.
	16.03	Describe the various axis of robotic motion.
	16.04	Describe the various methods for moving robot axis’s.
	16.05	Choose and implement appropriate sensors for robotic applications.
	16.06	Choose and install appropriate actuators for robotic applications.
	16.07	Program robotic devices for restricted movements.
	16.08	Apply the 5S's: Sort, Set in Order, Shine, Standardize, and Sustain.
17.0	Use proficiently human machine interfaces to operate automated systems--The student will be able to:	
	17.01	Match computer graphic icons to real field equipment
	17.02	Establish communication for data flow between computer and controlled equipment.
	17.03	Identify computer input and output signals and equipment destinations.
	17.04	Implement manual override appropriately.
	17.05	Perform computer-based system and/or machine troubleshooting.
	17.06	Define the essential components of an integrated HMI system.

	17.07	Apply the 5S's: Sort, Set in Order, Shine, Standardize, and Sustain.
18.0	Identify, implement, and/or interpret supply chain and operations management concepts and techniques--The student will be able to:	
	18.01	Use appropriate software for supply chain management strategies.
	18.02	Illustrate how efficiency and effectiveness are necessary attributes of good operations management.
	18.03	Apply simulations used for layout and design of production operations.
	18.04	Apply engineering economy factors in equipment justification.
	18.05	Calculate machinery utilization.
	18.06	Demonstrate warehouse throughput systems.
	18.07	Demonstrate basic principles and methods of controlling work in progress.
	18.08	Follow raw materials from their source to distribution of the product.
	18.09	Develop strategies to identify improvement opportunities, prioritize and develop an implementation plan optimize production operations.
	18.10	Demonstrate strategies to optimize raw materials and products inventories to minimize waste
	18.11	Integrate control systems and equipment with production and production support mechanisms.
	18.12	Demonstrate automatic inventory accounting related monitoring and control systems.
	18.13	Implement automatic tracking of materials and products using bar codes, machine vision and sensing, and/or infrared technologies.
	18.14	Apply the 5S's: Sort, Set in Order, Shine, Standardize, and Sustain.

Appendix B. Job Posting Details

Employer	Title	Location	Full/PT	Salary	Hourly Rate
ABM Industrial Services, Inc.	Imaging Service Engineer III, Cath Lab/IR	Hollywood	FT	Not indicated	N/A
Acara Solutions	Manufacturing Technician II	Melbourne	FT	Not indicated	Not indicated
Acara Solutions	Engineering Technician III	Melbourne	FT	Not indicated	N/A
Acara Solutions	Test Technician I	Melbourne	FT	Not indicated	N/A
Acara Solutions	Test Technician I	Melbourne	FT	Not indicated	N/A
Acara Solutions	Test Technician I	Melbourne	FT	Not indicated	N/A
Acara Solutions	Test Technician I	Melbourne	FT	Not indicated	N/A
Acara Solutions	Engineering Technical III	Melbourne	FT	Not indicated	N/A
Adams Group	Project Drafter	North Port	FT - hourly	Not indicated	17.00/hr
Advantage Staffing	Quality Control Inspector	Pensacola	FT	Not indicated	Temp
AES	Engineering Technician	Titusville	Not indicated	Not indicated	Not indicated
Aircraft Electric Motors, Inc.	Mechanical Technician	Hialeah	Not indicated	Not indicated	Not indicated
Aircraft Electric Motors, Inc.	Mechanical Technician	Hialeah	Not indicated	Not indicated	Not indicated
Airdyne Aerospace	Intermediate Liaison and Manufacturing Engineer	Brooksville	FT	Not indicated	N/A
Airdyne Aerospace	Manufacturing Engineer	Brooksville	FT	Not indicated	Not indicated
Anheuser-Busch	Technician, Utility	Jacksonville	FT	Not indicated	N/A
Applied Fiber Manufacturing	Manufacturing Technician	**Havana - NW RAO**	FT	Not indicated	N/A
Ball Metal Container	Production Technician	Not indicated	FT	Not indicated	N/A
Braun Medical, Inc.	Entry Production Technician	Daytona Beach	FT	Not indicated	N/A
Braun Medical, Inc.	Entry Production Technician	Daytona Beach	FT	Not indicated	N/A
Borden Dairy of Florida	Raw Receiver	Winter Haven	PT	N/A	13.5
Brown International Corp LLC	Electro Mechanic	Bradenton	FT	Not indicated	N/A
Canam Steel Corporation	Quality Control Manager	Jacksonville	FT	Not indicated	N/A
Chipton Ross	Manufacturing Engineering Technician	Sarasota	PT	N/A	40
Cimarron Software Services, Inc.	Technician	Titusville	FT	Not indicated	N/A

Cimarron Software Services, Inc.	Technician (TS/SSBI)	Titusville	FT	Not indicated	N/A
City of Melbourne	Electronics Technician - Water Production	Melbourne	PT	N/A	20.15 - 33.84
Creative Sign Designs	Architectural Graphics and Signage Designer	Tampa	Not indicated	Not indicated	Not indicated
Custom Manufacturing & Engineering	Manufacturing Engineer	Pinellas Park	FT	40,000-60,000	N/A
Custom Manufacturing & Engineering	Manufacturing Engineer	Pinellas Park	FT	40,000 - 60,000	N/A
CyberCoders	Manufacturing Technician	Fort Lauderdale	FT	Not indicated	N/A
CyberCoders	Process Engineer	Tampa	FT	Not indicated	Not indicated
Danaher Corporation	Production Technician	Pensacola	Not indicated	Not indicated	Not indicated
Danaher Corporation	Production Technician	Pensacola	FT	Not indicated	N/A
Elbit Systems of America	Engineering Technician (Sr. Tech)	Orlando	FT	Not indicated	N/A
Express Employment Professionals	AutoCAD Mechanical Drafter/Draftsman	Ocala	PT	Not indicated	15.00-22.00/hr
Ezell Industries	CAD Operator/Draftsman	**Perry - NC RAO**	PT	N/A	Not indicated
Ezell Industries	Engineer	**Perry - NC RAO**	FT	Not indicated	N/A
Frito Lay, Inc.	Sanitor	Orlando	FT - hourly	N/A	18.67/hr
General Dynamics Mission Systems	LCS Mission Module Sustainment Technician	Jacksonville	FT	Not indicated	N/A
General Electric	Engineering Technician	Jacksonville	Not indicated	Not indicated	Not indicated
General Electric	Manufacturing Engineering Technician	Jacksonville	Not indicated	Not indicated	Not indicated
Georgia Pacific	Manufacturing Engineer Tissue Paper Machine	Palatka	FT	Not indicated	N/A
Georgia Pacific	Electrical Technician	**Perry - NC RAO**	FT	Not indicated	N/A
Georgia Pacific	Engineering Technician	**Palatka - NC RAO**	FT	Not indicated	N/A
Grace Aerospace, LLC	Manufacturing Methods Coordinator	Jacksonville	FT	Not indicated	N/A

Industrial Lighting Products	Design Engineer	Sanford	Not indicated	Not indicated	Not indicated
IsoAid	Production Technician	Port Richey	FT	Not indicated	N/A
Jabil, Inc.	FVT Engineering Technician II	St. Petersburg	FT	Not indicated	N/A
jobs.hhstaffingservices.com	Manufacturing Technician	Sarasota	PT	N/A	10
Johnson Controls Inc./Tyco	Electronics Engineering Technician	Boca Raton	FT	Not indicated	N/A
Kelly Engineering Resources	Manufacturing Engineering Technician	Oldsmar	FT	Not indicated	Not indicated
Kelly Engineering Resources	Manufacturing Technician	Jacksonville	PT	N/A	17.00 Day/ 19.04 Night
Kelly Engineering Resources	Manufacturing Technician	Jacksonville	PT	N/A	18.00-20.00
Kelly Services, Inc.	Debug Technician	Melbourne	PT	Not indicated	17.00/hr
Kimball Electronics	ICT FCT Technician	Tampa	FT	Not indicated	N/A
Kimball Electronics	ICT FCT Technician	Tampa	FT	Not indicated	N/A
Kratos - Micro Systems	Mechanical Designer 1	Fort Walton Beach	FT	Not indicated	N/A
Kratos Technology & Training Solutions	Test Engineer	Orlando	FT	Not indicated	N/A
Leonardo DRS	Principal Manufacturing Engineer	Melbourne	FT	Not indicated	N/A
Lockheed martin Corporation	Engineering Technician	West Palm Beach	Not indicated	Not indicated	Not indicated
Lockheed Martin Corporation	Industrial Internet of Things	Orlando	Not indicated	Not indicated	Not indicated
Lockheed martin Corporation	Industrial Internet of Things	Orlando	Not indicated	Not indicated	Not indicated
Lockheed martin Corporation	Manufacturing Engineer Associate	Ocala	Not indicated	Not indicated	Not indicated
Lockheed martin Corporation	Industrial Internet of Things	Orlando	Not indicated	Not indicated	Not indicated
Lockheed martin Corporation	Manufacturing Engineering Technician	Orlando	Not indicated	Not indicated	Not indicated
Mars Company	Engineering Assistant	Ocala	FT	Not indicated	N/A
McKim & Creed, Inc.	Instrumentation & Controls Programmer	Clearwater	FT	Not indicated	N/A
Medtronic	Design Engineering Technician	Jacksonville	FT	Not indicated	N/A
Mettler-Toledo, LLC.	Field Service Technician - Industrial Weighing Products	Miami	FT	Not indicated	N/A
Noven Pharmaceuticals, Inc.	Manufacturing Engineer	Miami	Not indicated	Not indicated	Not indicated

Orion Energy Systems, Inc.	Design Engineer	Jacksonville	FT	Not indicated	N/A
Pall Corporation	Production Technician	Pensacola	FT	Not indicated	Temp
Pentair	Lean Manufacturing Talent Pool	Apopka	FT	Not indicated	N/A
Pentair	Production Technician Talent Pool	Apopka	FT	Not indicated	N/A
Pentair	EH&S Talent Pool	Apopka	FT	Not indicated	N/A
PepsiCo	Fleet Technician	Orlando	FT - hourly	N/A	22.50-26.40
Posted Aises.org	Controls Engineer/Industrial I	Orlando	Not indicated	Not indicated	Not indicated
Posted Aises.org	Manufacturing Engineering Technician	Orlando	Not indicated	Not indicated	Not indicated
Posted aises.org	Manufacturing Engineering Technician	Orlando	Not indicated	Not indicated	Not indicated
Posted aises.org	Electronic Component Engineer	Cape Canaveral	Not indicated	Not indicated	Not indicated
Posted aises.org	System Integration & Test Engineer	Orlando	FT	Not indicated	N/A
Posted societyofwomenengineers.swe.org	Manufacturing Technician	Orlando	FT	Not indicated	N/A
Posted www.isa.org	Manufacturing Engineering Technician	Ocala	Not indicated	Not indicated	Not indicated
Pro Image Solutions	Engineer	Apopka	Not indicated	Not indicated	Not indicated
Publix	Industrial Operations Technician	Lakeland	FT	5,200/mo	X
Radco, A Twining Company	Auditor/Quality Control	Tampa	FT	Not indicated	N/A
Remedy Intelligent Staffing	Production Technician	Not indicated	PT	N/A	12.00 - 12.50
Renesas Electronics America, Inc.	Fab Technician	Palm Bay	PT	N/A	13
Rockwell Automation, Inc.	Components Area Manager	Tampa	FT	Not indicated	N/A
Safran Electrical & Power	Production Technician	Sarasota	FT	Not indicated	N/A
Sensible Staffing (NFSA)	Manufacturing Product Associate	Davenport	PT	N/A	14.50 - 15.50
Siemens	Radiopharmaceutical Production Technician	Tampa	FT	Not indicated	N/A
Smith’s Interconnect	CAD Tech/Designer Drafter	Stuart	FT	Not indicated	N/A
Space Exploration Technologies Corp	Integration Specialist (Dragon Ground Operations)	Cape Canaveral	FT	Not indicated	N/A
Spacelabs Healthcare, Inc.	Field Service Engineer	Jacksonville	FT	Not indicated	N/A
STS Technical Services	Project Designer	Melbourne	FT	Not indicated	N/A

The Staffing Resource Group, Inc.	Scientific Manufacturing Technician	Winter Park	PT	N/A	14
TRC Staffing Services	Production Technician	Merritt Island	FT - hourly	Not indicated	15.00/hr
TriMech Services	Manufacturing Technician	Clearwater	Not indicated	Not indicated	Not indicated
Veterans Florida	CAD Designer	Tallahassee	FT	45,000-57,000	N/A
Violet Defense Technology	Manufacturing Technician	Orlando	Not indicated	Not indicated	Not indicated
X - Suppressed	Manufacturing Production Technician	Not indicated	FT - hourly	Not indicated	12
X - Suppressed	Quality Control Technician	Not indicated	FT	Not indicated	N/A
X - Suppressed	Bonding Technician	Panama City	FT	Not indicated	N/A
X - Suppressed	Senior Tooling Engineer	Panama City	FT	Not indicated	N/A
X - Suppressed	Manufacturing Technician II	Fort Myers	PT	N/A	18.00-20.00
X - Suppressed	Production Technician	Pensacola	Not indicated	Not indicated	Not indicated