Critical Skills for Game Developers:
An Analysis of Skills Sought by Industry

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ABSTRACT

With electronic gaming on the rise, several major universities involved in game development research have implemented curricula specifically for future game developers. Gaming curricula are now being offered in smaller universities, colleges, and other educational institutions, with other departments wondering if they should follow suit and what content should be covered. For this quantitative research, the author performed a content analysis on posted job advertisements for game developer positions, to determine qualities the gaming industry desires when seeking game developer employees,. A categorization of qualities was performed after reviewing each job ad and five categories for qualifications were developed: Experience, Education, Interpersonal & Personal Abilities, Technical Skills, and Supporting Knowledge and a frequency distribution of the qualities in each ad was performed. The results show that there are education and experience levels, skills, abilities, and knowledge that are clearly sought by industry and certain qualities are sought with more frequency than others.

Categories and Subject Descriptors

K.3.2 [**Computers and Education**]: Computers and Information
Science Education – *Curriculum.*
K.8.0 [**Personal Computing**]: General – *Games.*
D.1.m [**Software**]: Programming Techniques – *Miscellaneous*

General Terms

Design, Experimentation, Theory, Languages, Management

Keywords

Game curriculum, Game concentration, Skills, Game Industry, Required skills, Game developer, Software developer, Game Education

1. INTRODUCTION

With electronic gaming on the rise, several major universities involved in game development research have implemented

curricula specifically for future developers. These schools, such as University of Southern California, Carnegie Mellon University, University of Denver, Northwestern University, University of North Texas and others, are at the forefront of research with dedicated gaming labs and have existing relationships with the gaming industry. As its popularity grows, gaming curricula are now being offered in smaller universities, colleges, and other educational institutions, with other departments wondering if they should follow suit. Departments are considering the pros and cons of adding such a program, and what a game developer (or related) curriculum would entail. [30][21]

Several areas need to be considered in determining whether a game development curriculum would be an appropriate addition, including identification of required developer skills, a review of curricula at existing programs at major universities, ease of integration of such a program into existing curriculum framework, resources, demand for such a program both regionally and nationally, and student recruitment. Special consideration must also be given to the placement of students into industry positions.

In order to build a holistic program whose graduates are recognized as quality candidates for employment, the current skills and competencies of graduates that are needed by industry should be weighed with these other curriculum issues. Trauth, Farewell, and Lee [26] and others have previously shown that an "expectation gap" exists between what is taught in academic settings and what industry sees as employable skills [11][10]. Researchers have identified current skill sets in their respective fields by performing content analysis on job advertisements listed either through newspaper advertisements, online advertisements, or both [11][25][5]. Those identified skills have then been reviewed and incorporated into their curriculum.

The purpose of this paper is to determine what skills are currently in demand by gaming industry professionals of game developer hires by performing a content analysis of current online job advertisements. Specifically, the questions considered are two-fold:

> 1) What developer skills and competencies does the gaming industry desire when seeking game developer hires?

> 2) Are certain developer skills and competencies sought more than others?

With little existing research in this field, this research benefits those in academia who are in the process of or are considering implementing a game concentration or degree program at their

college or university. Additionally, industry may benefit by having a pool of graduates with skills that more closely meet their needs.

2. LITERATURE REVIEW

Research indicates that there is an expectation gap between industry and academia, and that this gap can have an effect on recruitment and hiring of graduates from programs [26][15][9]. Industry input is an important part of curriculum development and this input can be garnered in several noted ways. Very few universities have game programs, but the number of institutions seeking to implement programs continues to grow. Their input from industry is limited. Content analysis has been recognized as a standardized way of collecting current job skills sought by industry. This analysis process has been done by researchers to gather insight into skills sought by industry and to account for these skills somewhere in their curriculum.

This section reviews each of these four areas and provides the background for conducting a content analysis of advertisements for game developers.

2.1 Expectation Gap

The expectation gap is a term used to describe the gap between what industry expects of its new hires and what academic institutions require of its graduates. Trauth, Farwell, and Lee [26] explore the need to constantly and methodically reevaluate the skills required by industry and examine those needs against the skills and knowledge of Information Systems (IS) graduates. In their multi-phase study, the researchers use a combination of surveys, meetings, and focus group sessions to identify whether there is a gap between the expectations in industry and university educators. The concluding phase surveyed 131 professionals and professors to rank their perceptions of skills needed for their graduates before entering the IS profession.

The researchers concluded that the expectation gap exists and that educators understand the gap exists, but change within academia comes very slowly. They also noted that faculty are not directly paid for curriculum development and there is a long lead-time to publish research results that might lead to minimizing the gap, both of which may be contributing factors to the gap. The authors also consider the conflicting messages companies may send to professors and students about required skill sets.

Gallivan, Truex, and Kvansky [11] viewed the expectation gap as the difference "…between employers' demands and skills provided by academic programs," though their research is focused on the recruitment gap routed in job advertisements. (p. 1) Their 13-year trend study provides a systematic review of major research performed to identify IT skills, including ad content analysis, Delphi studies, and surveys. The recruitment gap they found involves the listing of technical skills more than soft-skills, since they note that it may be easier to screen for them.

In research by Eskandari et al. [10] results of a survey of both Industrial Engineering professionals and faculty gathered desired characteristics of undergraduates upon completion of their program. This was followed by a modified three-round Delphi technique to obtain rankings grouped by professionals and faculty. The authors note that there are statistically significant "…differences in opinions expressed by persons in academic settings and those working in business and industry." (p. 45)

Woratschek and Lenox [29] surveyed 24 doctoral students who also hire new Information Systems (IS) graduates in their industry positions and surveyed 6 companies offering internship programs at their institution. Though the sample size was small, the comparison of expected to actual skills of graduates notes a statistical difference. They conclude that "…IS academics must be in continual communication with the industry and a partnership between the two groups is essential." (p. 7)

2.2 Industry Input in Curriculum Development

Industry input into technological degree programs has proven to be an important asset in curriculum development in order to reduce the expectation gap between academia and industry while simultaneously increasing opportunities for graduates. Rae [23] researched the connection between enterprise education and employability of graduates within the program. Rae demonstrated the rationale for this connection and how it can be used in the "…design of curricula and learning experiences within UK higher education." (p. 605) Pool and Sewell [22] develop a framework to be used to develop the employability of students. These holistic approaches towards curriculum development provide strategies and models for incorporating these models to increase graduate employability.

Clarke [6] addressed the incorporation of commercial products and training into the curriculum and looks at recent trends in Australia to incorporate corporate curriculum, like CISCO Networking Academy) into schools and how that decision evolved. Employability of students was instrumental when considering the addition of CCNA to the curriculum.

With outsourcing as a predominant issue in CS curriculum design, Hoganson [13] looked at how upper level courses and elective hours can be used to build "strategic knowledge areas" needed by industry. The strategic approach lies in building a curriculum to enhance skills at the undergraduate and graduate levels that cannot be outsourced, thereby working to increase the number of students attracted to the program.

Lee, Trauth, and Farwell's [17] research, sponsored by professionals in the Boston Society for Information Management, focused on the expectations in the IS field. Another key component of this research was to determine if these expectations might have an impact on IS curriculum design. Using forums and survey instruments, the results of the research conclude with the researchers stating that "…that industry and academia must work together more closely to face the transformation of the IS profession." (p. 334)

Ehie [9] provides another example of incorporating industry feedback into curriculum design. The researcher analyzed the current literature to define skills and competencies sought within industry that need to be considered in an MIS curriculum. After analysis, a consultant was hired to reexamine the results of the review before incorporation of the identified skills and competencies into the MIS curriculum. Then 14 businesses participated in a review of the draft curriculum and provided input into the framework.

2.3 Game Curriculum

Industry input in curriculum development has been an important tool used by academia in related IT and IS fields. The International Game Developers Association (IGDA) Curriculum Framework [14] outline for Game Programming delineates several areas of knowledge that are desired in game programming.

Though game developer is not given a separate category, the Game Production category seems to touch on a few areas that game developers may encounter, such the phases of game development and communication skills. Though the outline is provided with bulleted topics, it does not go as far as the Computing Curriculum series developed by the IEEE and ACM professional organization in providing rationale, unit hours per subject, and structuring of the curriculum.[1]

University of Southern California's Computer Science Department, a top researcher in the game development arena, offers both a BS in Computer Science (Games) and an MS in Computer Science with Specialization in Game Development. The BS major goes beyond programming and comprehensively includes about 40% of its required courses in core computer science topics, 40% in game development courses, and 20% in a mix of writing, physics, and math [27]. Carnegie Mellon University's new joint BCSA program from the Computer Science and Arts colleges complement the interdisciplinary approach taken in the Entertainment Technology program curriculum.[3] Parberry, Roden and Kazemzadeh [21] describe skills and experience usually demanded by game industry employers of their programmers. They built relevant curriculum and capstone projects using multidisciplinary teams at the University of North Texas. As research academia in the game field, all three of these institutions have the resources and reputation to build unique curriculum in well-developed niches. Though each of these institutions provides rationale for their curriculum, they do not provide a quantitative analysis of desired qualities sought by the gaming industry.

Universities with more of a teaching focus and with fewer resources are still adopting curriculum based on little quantitative evidence of industry needs. Marist College, for example, has adopted a concentration using in part the IGDA framework that incorporates Artificial Intelligence (AI), Computer Networking and Distributed Systems, C++ in a game design and programming courses, and Advanced Data Structures. [7] The author could find no quantitative evidence demonstrating that following the IGDA framework will produce graduates that will meet game industry needs.

2.4 Content Analysis of Job Advertisements
Many researchers have used quantitative, qualitative, and mixed methods to collect data in order to identify the expectation gaps and minimize it in their respective fields, including traditional surveys, multi-method studies (Delphi, interviews, surveys, and focus groups), cross-study comparisons, and content analysis of advertisements [11]. Content analysis of advertisements can serve as an indicator of employers' expectations of its new hires and is recognized by economists as a method of measuring skills in demand by employers. Within the content analysis research, the methodology used to collect data from advertisements has varied among researchers.

Todd, McKeen, and Gallupe [25] performed a literature review of IS job skills, then followed this with a quantitative analysis of job advertisements for programmers, analysts, and managers collected from two major US newspapers and two Canadian newspapers. They classified the skills into three major categories (technical, business, and systems knowledge), then subdivided those into further categories to determine frequency counts of skills.

Kittner and Papp [16] looked at both skills advertised as well as education levels requested in classified ads. Skills were mapped into categories and results were compared to a previous skills survey in order to identify changes needing to take place in the curriculum. Papp [20] reviewed 2600 ads in six major New England newspapers over a four month timeframe. Categories of skills included education levels and years of experience, where Papp analyzed curriculum impact issues, including greater emphasis on soft-skills such as interpersonal and business communications.

In another study, Case, Price and Rogers [5] performed a content analysis on 727 ads in major newspapers in the southeastern US. First, researchers created a grid of skills from classified ads taken from two newspapers. Once developed, several other major city newspapers were analyzed to see how the categorization of skills ranked according to the grid. Advertisements were analyzed to identify hard and soft IS skills and provide recommendations for curriculum. Case [4] was one of the first to compare online advertisements to those found in newspaper advertisements in the IS/IT fields. Litecky, Prabhakar and Arnett [18] perform a longitudinal perspective analyzing IT/IS job descriptions on monster.com for 35 geographic locations, concluding that employers first use technical skills to filter the candidates, then used soft-skills (non-technical) to make the final hiring decisions.

Gallivan, Truex, and Kvasny [12] performed content analysis of ads in the first issue of each quarter from ComputerWorld from 1988 to 2003. Researchers codified the desired skills, then conducting a two-stage Delphi study with 28 faculty and students to determine the coding accuracy. After it was developed, the ads were reviewed and assigned frequencies to the content codes, then the 1998 and 2003 results were compared. In the five year timeframe, there was a shift to online job sources and industry required "…an ever-increasing number and variety of skill sets from new hires." (p 80) Authors noted a 17% increase between 1988 and 1995 and an additional 20% increase between 1995 and 2001.

Content analysis of job advertisements has been performed in many IS/IT fields, as well as others. Nelson, et al [19], are developing an automated method of large-scale collection of IT/IS ads using vertical search engine output to identify IS job skills via a Latent Semantic Categorization. Listings are sent through a parser to parse out job descriptors. The researchers note that "[w]hile the use of ads has the limitations inherent with any secondary data, it has the advantages of traditionally ascribed to unobtrusive data gathering methods." (p. 168)

Though content analysis of job advertisements has been conducted in related fields, the author found no such analysis of game developer advertisements.

3. METHODOLOGY
To address the question of what developer skills and competencies the gaming industry desires when seeking game developers, the author used quantitative methods to perform a content analysis on posted job advertisements for game developer positions. The Conference Board's analysis of advertisements in 2007 [8] indicated that the Internet now produces the most job offers (38%) among various sources (including print ads) and 70% of job seekers use the Internet to find jobs, with 278,000 ads posted in the computer and mathematical occupational category. Given this trend, only online advertisement sources within the

United States were identified based on research performed in past ad analyses. The data source for these ads was restricted to those on simplyhired.com, an aggregator of job postings across the Internet.

Searches were performed against industry standard job titles for game developers identified in the UK, since the US Bureau of Labor Statistics does not classify positions for game developers [28][2]. Ads were identified using keywords derived from the job titles specified by the Sector Skills Council for Creative Media: Lead Programmer, Software Engineer, Programmer, AI Programmer, Middleware/Tools Programmer, Graphics Programmer, Gameplay Programmer, Action Scripter, Platform Designer, Information Architect, Systems Analyst, Database Designer, Engine Programmer, and Server Architect. [24]

Nine searches that capture each of the job titles were done over a one week period in late May, 2008. Game was the first keyword, followed by one of the following: programmer, engineer, action scripter, platform designer, information architect, systems analyst, database designer, and server architect. Additionally, developer was also added to the list. By including this variety of job titles, the author cast a wider net on the postings. To keep this pilot research in a manageable scope, the author chose to limit the search to those classified as full-time positions and to those posted within the last 30 days. Table 1 provides a summary of jobs found for the different searches. Of the 5291 ads returned from the searches, 721 were full-time jobs posted within the last 30 days.

Table 1. Keyword Search Results.

Complementary Keyword	# Returned from Search	Full-time & Posted within 30 days
Engineer	2043	223
Programmer	830	133
Action Scripter	3	0
Platform Designer	38	9
Information Architect	245	48
Systems Analyst	209	38
Database Designer	36	0
Server Architect	156	28
Developer	1731	242
	5291	721

Duplicate ads were identified both manually and by the simplyhired.com search engine. The manual process of identifying duplicated ads consisted of a query based on the location of the job, the company, and the job title. A manual check was performed by reviewing ad requirements to determine whether the ads were identical. Once duplicates were removed, a total of 385 unique postings remained for evaluation.

Unique postings were then reviewed to determine if they met two primary criteria: 1) the position indicated that the new hire would be directly involved in game development and 2) the position involved software development. Of the 385 unique postings, 68 ads met both criteria and were deemed relevant to this study.

After identification of all unique skills and competencies from these 68 ads, five categories for qualifications were developed: Experience, Education, Interpersonal & Personal Abilities, Technical Skills, and Supporting Knowledge. Definitions of each are as follows:

Education – Level of education as a Bachelor or Master's degree, a 2-year degree, or other education

Experience - Previous experience in the gaming industry as a game developer, engineer, game titles shipped, game design, game programming and game play experience

Interpersonal & Personal Abilities – Problem-solving skills, communication skills, interpersonal skills, work ethic, attitude/disposition, organizational/time management, and leadership skills

Supporting Knowledge – Software development processes, math, graphics, AI, networking, code development skills, databases, physics and other areas of knowledge sought in game developers

Technical Skills – Languages, software development tools and environments, development platforms, application platforms

To address the question of whether certain developer skills and competencies are more important than others, after categorization, another pass was made through all of the ads and again each skill and competency was examined. A frequency distribution of skills was tallied based on the code group in which each skill or competency was categorized. Once completed, the frequency distribution of the skills showed the most frequently requested skills by the prospects.

4. RESULTS
Experience and Education categories were evaluated separately from the Abilities, Skills and Knowledge categories since these two requirements are foundational to the Abilities, Skills and Knowledge areas, while the latter three are interdependent.

4.1 Education and Experience
Of the 68 ads, 65% either require or desire formal education or certification and 68% either require or desire game experience, as noted in Chart 1. The majority of the ads that mention education or experience require a certain level.

For education levels, 46 of those ads that mention education require or desire a Bachelor's degree. The remaining ads mention an MS (6), a 2-year degree (1), and other certifications (3), as seen in Table 2.

Chart 1. Education and Experience in Job Ads
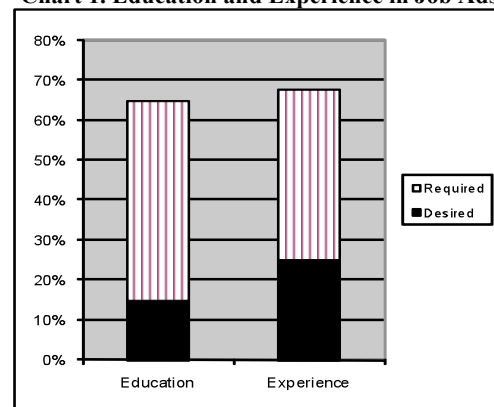
Game experience is mentioned (as required or desired) in 68% of the ads, with 34 of the ads requiring previous game experience. The most frequent type of experience sought, as shown in Table 3,

was game development experience (35). Ads also required game titles shipped (20), non-specific game industry experience (14), game design experience (8), game programming experience (6) and game play experience (3).

Table 2. Education Levels Mentioned in Job Ads

Degree Type	Frequency Count	Percent
BS	46	82.1%
MS	6	10.7%
Other	3	5.4%
2-year degree	1	1.8%

Table 3. Experience Mentioned in Job Ads

Experience	Frequency Count	Percent
Game Development Experience	35	40.7%
Game Titles Shipped	20	23.3%
Game Industry Experience	14	16.3%
Game Design Experience	8	9.3%
Game Programming Experience	6	7.0%
Game Play Experience	3	3.5%

4.2 Abilities, Skills, and Knowledge

The category breakdown between the three interdependent categories, Interpersonal and Personal Abilities, Technical Skills, and Supporting Knowledge Areas, appear frequently in all ads. Comparing these three categories against each other, interpersonal and Personal Abilities account for 24% of the qualities sought in a game developer, technical skills account for 42% of the qualities, and supporting knowledge areas account for 34%, as shown in Table 4.

4.2.1 Interpersonal and Personal Abilities

Interpersonal and personal abilities are those soft-skills, or non-technical skills, realized to be an important part of the new generation of computer scientists, as shown in Table 5. Attitude and disposition account for 42 qualities listed and problem-solving skills account for 41. Communication skills accounts for 38 qualities, interpersonal/team player skills account for 37, work ethic 31, and organizational/time management 27. Leadership was typically mentioned only in those ads that required a lead engineer or programmer, with 8 such qualities mentioned in the 68 ads.

Table 4. Abilities, Skills and Knowledge Category Breakdown

Skills, Knowledge, Abilities	Frequency Count	Percent
Technical Skills	388	41.7%
Supporting Knowledge	318	34.2%
Interpersonal/ Personal Abilities	224	24.1%

Table 5. Interpersonal and Personal Abilities in Job Ads.

Interpersonal & Personal Abilities	Frequency Count	Percent
Attitude/Disposition	42	18.8%
Problem-solving skills	41	18.3%
Communication skills	38	17.0%
Interpersonal skills	37	16.5%
Work ethic	31	13.8%
Organizational/ Time Management	27	12.1%
Leadership	8	3.6%

4.2.2 Technical Skills

Technical skills in job ads were broken into four subcategories, languages, software development tools and environments, development platforms, and application platforms, as shown in Table 6. Languages were mentioned 192 times in the 68 ads and the most frequently mentioned languages were C++ (34), C/C++ (17), ActionScript (18), Java (16), C# (15), JavaScript (11) and Python (9). SQL was also mentioned nine times, and HTML/DHTML/xHTML were mentioned a combined nine times as well. All of the languages mentioned are shown in Tables 8-10.

Table 6. Technical Skills Mentioned in Job Ads.

Technical Skills	Frequency Count	Percent
Languages	192	49.5%
Software Development Tools/Environments	158	40.7%
Development Platforms	28	7.2%
Application Platforms	10	2.6%

Table 7. Programming Languages Mentioned in Job Ads.

Programming Languages	Frequency Count	Percent
C++	34	50.0%
C/C++	17	25.0%
Java	16	23.5%
C#	15	22.1%
Python	9	13.2%
C	5	7.4%
Perl	2	2.9%
Assembly	2	2.9%
Ruby	3	4.4%
R	1	1.5%
Objective C	1	1.5%

Table 8. Scripting Languages Mentioned in Job Ads.

Scripting Languages	Frequency Count	Percent
ActionScript	18	26.5%
JavaScript	11	16.2%
Shell Script	1	1.5%
Unreal Script	1	1.5%
VBScript	1	1.5%
CGI	1	1.5%
Visual Basic	1	1.5%

Table 9. Markup Languages Mentioned in Job Ads.

Markup Languages/CSS	Frequency Count	Percent
HTML/DHTML/XHTML	9	13.2%
XML	8	11.8%
CSS	5	7.4%
XML/XSL	3	4.4%

Table 10. Other Languages Mentioned in Job Ads

Other	Frequency Count	Percent
SQL	9	13.24%
OpenGL	7	10.29%
PHP	4	5.88%
STL	2	2.94%
AMFPHP	1	1.47%
T-SQL	1	1.47%
SQL/JDBC	1	1.47%
Tea Temp Language	1	1.47%
GLSL	1	1.47%
HLSL	1	1.47%

Table 11. Tools and Environments Mentioned in Job Ads.

Software Development Tools and Environments	Frequency Count	Percent
Flash	16	10.1%
DirectX	9	5.7%
J2ME	6	3.8%
Maya	6	3.8%
.NET	5	3.2%
Perforce	5	3.2%
ASP	4	2.5%
BREW	4	2.5%
SQL Server	4	2.5%
Visual Studio	4	2.5%
Director	3	1.9%
Lingo	3	1.9%
Oracle	3	1.9%
Photoshop	3	1.9%

Mentioned twice each: 3D Studio Max, AJAX, AlienBrain, ASP.NET, DOOM3/Quake 4 engine, Havok, Hibernate, J2EE, JSP, MFC, QUAKE 3, Shockwave, Spring, Symantec Wise Package Studio, Torque, WCF, WPF, PhysX

Mentioned once each: Adobe AIR, Adobe Flex, Adobe Suite, Apache Ant, Boost, CVS, Cygwin, DataStage, DICOM, Direct3D 9/10, Dreamweaver, Drupal, Eclipse, Electroserver, Emotion FX, FMOD, GoPublish Framework, HTTP, jMonkeyEngine, Kynapse, libRocket, Lua, MCSD, Media Server, Microstrategy, Mono, MySQL, Netezza, ODE, Ogre, Papervision, Pixelux, Red5, Renderware, Ruby on Rails, SFML, SmartFox, SOAP, SoftImage, Struts, Tomcat, Unity3D, Unreal Engine, VWorldTerrain, Winforms, wxWindows, XNA

The 87 software development tools and environments mentioned were not as uniform. Table 11 shows those skills mentioned three times or more, with Flash mentioned 16 times and DirectX mentioned 9 times. J2ME and Maya were mentioned six times each, Perforce and .NET were mentioned five times each, ASP, BREW, Visual Studio and SQL Server were mentioned four times each, with Director, Lingo, Oracle, and Photoshop all mentioned three times each.

Of the remaining 67 tools and environments mentioned, these were only mentioned either twice or once in the ads. Game development environments, like Torque Game Engine, XNA, and Unreal Engine, were mentioned only once each.

In contrast to languages and software development tools and environments, development platforms (Table 12) and application platforms (Table 13), were mentioned infrequently. Windows was the most frequently mentioned development platform (15), ranging from Win32 to WinCE, as shown in Table 8. Linux and UNIX were mentioned a combined nine times, with Mac

Table 12. Development Platforms Mentioned in Job Ads.

Development Platform	Frequency Count	Percent
Windows	15	53.6%
Linux/Unix	9	32.1%
Mac	3	10.7%
CentOS	1	3.6%

Table 13. Application Platforms Mentioned in Job Ads.

Application Platform	Frequency Count	Percent
XBOX	3	0.3
PS3	2	0.2
Symbian	2	0.2
Wii	1	0.1
Nintendo	1	0.1
GBA/Ngage/PDA	1	0.1

mentioned three times and CentOS mentioned once. On the application platform side (Table 9), three ads mentioned XBOX, two PS3 and Symbian, one each mentioned the Wii, Nintendo, and GBA/Ngage/PDA. Again, either there is no clear consensus by industry or the skills in other subcategories are of greater importance.

4.2.3 Supporting Knowledge Areas

Supporting Knowledge Areas are knowledge areas mentioned in the ads that support the development of games. The most frequently mentioned subcategory was general software development processes, including version control processes, requirements analysis, design and development, and implementation. (Table 14) Code development skills were also very important and were mentioned 38 times, specifically the ability to write high-quality, documented code and the ability to work through coding problems by employing excellent debugging skills. The supporting areas of Graphics (30), Networking (26), Math (21), Physics (12) and AI (7) were mentioned, with Math being mentioned with 2D and 3D graphics development the majority of the time. Game Development Processes, those processes specific to the gaming industry, were mentioned 26 times. Object-oriented (17), MMO (12), and Multi-thread (7) programming skills were mentioned enough times to warrant their own subcategories, while Relational Databases were mentioned 12 times. The remaining subcategories were Web Development (20), Platform/Cross-Platform & Optimization Techniques (12), User Interface (10), Low-level/Embedded Systems (8), Tool Development (5), and Real-time Systems (3).

Table 14. Supporting Knowledge Areas

Supporting Knowledge Area	Frequency Count	Percent
Software Development Processes	52	16.4%
Code Development	38	11.9%
Graphics	30	9.4%
Game Development Processes	26	8.2%
Networking	26	8.2%
Math	21	6.6%
Web Development	20	6.3%
Object-Oriented Programming	17	5.3%
MMO Programming	12	3.8%
Physics	12	3.8%
Platform/Cross-Platform & Optimization	12	3.8%
Relational Databases	12	3.8%
User Interface	10	3.1%
Low-level/Embedded Systems	8	2.5%
AI	7	2.2%
Multi-thread Programming	7	2.2%
Tool Development	5	1.6%
Real-Time Systems	3	0.9%

6. CONCLUSION & IMPLICATIONS

This research analyzes those qualities sought of game developers in online job postings. Additionally, the category and subcategory results indicate that there may be an emphasis within the industry on certain skills, knowledge and abilities over others. As such, these areas may be worth investigating further to determine if they are critical components to be included in the curriculum for a game program at the post-secondary level.

The most frequently mentioned supporting knowledge areas, software development processes and code development knowledge center around the heart of software engineering and programming. Curriculum emphasizing those areas may indeed be building critical understanding in the graduates of those programs. Mentioned less frequently but still with importance in the frequency count are graphics (2D and 3D), game development processes, networking, mathematics, and web development.

Of the technical skills mentioned in ads, C/C++ and C++ language skills appear to hold a higher importance over other languages, with C#, Java, ActionScript and JavaScript all ranking high as well. Both the development and application environments appear to be less important. Of the software development tools and environments mentioned, few stand out, with Flash being the most frequently mentioned. This study indicates that either there is no clear consensus by industry in this area or that the tools and environments are not as important as the other technical skills and supporting knowledge areas.

Emphasizing soft-skills, like communication and interpersonal skills needed in a team environment, will benefit graduates who seek game development jobs. Nearly all subcategories were equally weighted, and with these qualities accounting for 24% of all qualities sought, it may indicate that curriculum developers must count this as a critical component in their program.

Possible follow-up research includes surveying those responsible for hiring new game developers to determine if there is an expectation gap and ascertain whether the findings in this pilot study align with their experiences. Additional research can be performed to determine whether jobs that do not require experience have different skill sets required over those that do, in order to establish if there is a clear difference in hiring students fresh out of college versus hiring someone who has previous experience working within the gaming industry.

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