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Classification of Video Games Bachelor's Curricula

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Abstract

As in any professional field, aspiring video game artists, designers, and developers must acquire the necessary skills and knowledge for a successful career. Higher education institutions offer varying video game Bachelor's degree programs to meet the diverse needs of the industry. Our objective in this study was to explore these curricula to gain insight into and understanding of the contemporary video game higher education landscape.

We explored 113 Bachelor's degree curricula in Europe that had publicly available information in English about their courses. We classified the courses within each curriculum using ten devised classifiers based on the IGDA Curriculum Framework 2008 but modified them to suit our interests. The content of the classified curricula was then used to create curriculum profiles – data vectors that characterize a curriculum based on its contents. These profiles allowed for hierarchical clustering and principal component analysis (PCA) to identify and investigate the three common types of video game curricula: video game art, interdisciplinary video game design, and video game technology/programming.

Our results indicate that art and programming curricula are highly specialized, with clear distinctions in yielding Bachelor of Arts and Bachelor of Science degrees. Curricula focused on interdisciplinary video game design do not have such clear distinctions in the degree titles and content specialization. They are more varied in their profiles and tend to bridge the gap between art and programming curricula, reflecting the interdisciplinary nature of game design as a profession.

Compared to results from previous studies, we found that contemporary curricula place a greater emphasis on graduation projects, internships, and soft skills. Our findings provide an overview of the current state of higher education in video games, which may prove helpful for those working with or interested in these curricula.

Keywords: video game higher education, video game curricula, Bachelor's curricula, video game design and development, video game art, video game programming

1. Introduction

Video game development is a collaborative effort involving people from various disciplines, such as coding, game design, and art. The International Game Developers Association (IGDA) has outlined nine main areas for creating video games in their Curriculum Framework 2008 document (IGDA, 2008). These areas include game studies, game design and programming, visual and auditory artifact creation as well as the business and production in video game development. Each of these areas contains numerous sub-topics for further study and exploration.

When creating video game curricula, higher education institutions are advised by the IGDA to select a subset of the nine areas outlined in their Curriculum Framework 2008 document. Covering all nine areas would result in a superficial curriculum, so institutions must choose which areas to emphasize based on their strengths, current needs, and capabilities. Designing a comprehensive program can be challenging, as it requires a deep understanding of the field and the needs of the industry both now and in the future. Making the curriculum too specialized or too broad can negatively impact graduates' job prospects (Czauderna, 2018). Common themes in video game curricula include art, technology, and design (Mateas & Whitehead, 2007).

At the University of Tartu, we are designing a Bachelor's degree curriculum for Video Game Designers and Developers. The video game industry in Estonia is growing (GameDev Estonia, 2022) and we need more game designers and developers with higher education to meet the demand. In designing our curriculum, we surveyed the European video game curricula. Our findings may also be helpful for countries outside of Europe that are developing similar curricula. We focused on Europe because the Bologna Process (European Union, n.d.) standardizes higher education and allows for easier comparison of curricula across the region.

The objective of this research was to create an overview of the video game Bachelor's curricula which provides insight and answers various questions that designers, students, industry professionals, and policymakers may have. For example, it can provide insight into the interdisciplinarity of curricula focusing on video game art, technology or design, and whether these curricula adequately differentiate between Bachelor of Arts and Bachelor of Science degrees. Additionally, comparing our findings with previous studies may reveal recent trends in the profiles of video game curricula.

We gathered information about various video game Bachelor's curricula in Europe first from three online platforms and then from the university web pages. This provided a sufficiently comprehensive dataset of the available curricula and their respective courses. We then created course classifiers based on the IGDA Curriculum Framework (IGDA, 2008) topics and used these to classify the courses. This provided a largely standard classification of video game study topics while also allowing us to investigate our own interest areas. As there is an assumption of three common types of video game curricula, we used hierarchical clustering and principal component analysis to investigate if such types exist and how separate they are. Lastly, we compared the average curricula profiles from our clusters with those found by Ip a decade ago (Ip, 2012) to validate the methodology and discover any temporal changes.

2. Background

Video game curricula have been evolving for over two decades. Initially, video game development (GD) education grew out of computer science (CS) programs. There were several reasons for incorporating GD into existing CS programs but mainly because the technical side of GD requires very good programming and software engineering skills, both prominent in CS. However, the initial reasons also included the decline in the popularity of CS programs in the early 2000s and the lack of formal ways to study the emerging and interdisciplinary field of GD. These factors were driven by a need to keep CS curricula relevant by meeting the growing needs of the industry and students. Incorporating video game programming into CS programs helped to increase the popularity of CS among young people who played video games and wanted to create their own (Estey et al., 2009; Leutenegger & Edgington, 2007; Roden & LeGrand, 2013). The creation of dedicated programs allowed for the formal and academic study of the emerging field of GD (Coleman et al., 2005; Parberry et al., 2006; Peng, 2015).

However, creating video games is very different from traditional computer science and software engineering in many ways (Kasurinen et al., 2013; Pascarella et al., 2018). The requirements for designing a video game are vastly different from those of typical software development. Video game players expect a unique experience, and designing software to produce a specific experience is considered a *second-order problem* (Howell & Stevens, 2019; Salen & Zimmerman, 2003). This problem comes from the fact that one can directly design the game mechanics, but each player's subsequent dynamics and experience are unique. However, designing and providing the desired player experience is what ultimately matters for a video game. In traditional software development, user experience is also important, but the primary focus is ensuring that the software performs its intended function correctly. In video games, the experience itself is the primary focus.

The differences between traditional software engineering and video game development further include specialized architecture and programming design patterns, working with large collections of multimedia files, and the unique challenges of testing games compared to developing regular software (Pascarella et al., 2018). These factors make video game development a distinct field with its own challenges and requirements.

This distinctiveness has led students and educational institutions to develop specialized video game design and development curricula (Bayliss & Bierre, 2008; Kessler et al., 2009; Mochocki, 2018). However, due to the interdisciplinary nature and novelty of the field, there can be a significant variation in the design of these programs. The IGDA Curriculum Framework (IGDA, 2008), with its nine main fields that a curriculum could include, is thus extremely helpful for curriculum designers. The document has mapped out the interdisciplinary areas required for game development but has intentionally left the specific focus and selection of these areas to be determined by individual institutions.

Typically, a video game curriculum falls into one of three broad categories: *art*, *interdisciplinarity*, and *technology* (Mateas & Whitehead, 2007). The art and technology categories are relatively straightforward:

curricula from the art category focus on the craft of creating multimedia objects for video games, while curricula focused on technology cover video game programming. These curricula are typically associated with Bachelor of Arts (BA) and Bachelor of Science (BSc) degrees, respectively. The focus on interdisciplinarity is more prominent in curricula centred on video game design. These programs often allow students to focus on either art or technology and may grant a BA or BSc degree. They can have a wide variety of subjects, including management, communication, and a strong foundation in art and technology.

Interdisciplinary programs are usually titled *Games Design*, *Games Production*, *Game Design and Development*, *Multimedia and Creative Technologies*, and so on. The authors of interdisciplinary programs have observed that, while these programs can provide a strong foundation in computer science, the students who enroll in them differ in some respects from CS students. In particular, students in video game design and development curricula tend to place a greater emphasis on creativity in programming than CS students (Bayliss & Bierre, 2008). The interdisciplinary nature of these programs also attracts students with different aspirations and talents than traditional CS programs.

The interdisciplinary curricula aim to provide both generalist and specialist education (Czauderna, 2018). An academically educated professional in the field of video games should have a solid understanding of each specialized field (design, art, programming, and production) and be proficient in at least one of them. The goal of interdisciplinary programs is not to educate computer scientists but to train video game designers who can work at the intersection of design, technology, and art. Therefore, such programs must provide a diverse education that covers multiple disciplines (Murray et al., 2006).

There have been studies on developing specific interdisciplinary courses (Linhoff & Settle, 2008) or individual modules (Fachada & Códices, 2020). This type of research is valuable for educators who are designing interdisciplinary sections of a curriculum. However, we were more interested in the profiles of entire curricula.

Morrison and Preston (Morrison & Preston, 2009) analyzed 21 fully video game-related degree programs and mapped out their *computing*, *gaming*, and *arts/humanities* profiles. Their results showed a relatively even distribution of highly specialized art programs and programs with equal emphasis on a) *gaming* and *art*, b) *gaming* and *computing*, and c) programs balanced in all three areas. However, their classification is based mainly on the course content being explicitly about video games or not. This means that, for example, game engine development and game analysis were both categorized under *gaming*, although when considering the academic fields of these courses, they could respectively be under *computing* and *humanities*. This makes it difficult to accurately compare the different programs and understand their focus and content.

A more detailed survey was done by Ip (2012), who looked at 306 programs in the UK and categorized them based on the *topic areas* defined by Skillset (an organization that supported creative media industry training in the UK). There were four game design skill topic areas, four game programming skill topic areas, and six game art skill topic areas, each with their own sub-areas. Ip categorized all the surveyed curricula by their degree (e.g., BA, BSc) and main theme (*Generic/Games Design*, *Games Programming/Games Computing*, *Games Art*). Their survey classified the content (individual courses) of each program into the Skillset topic areas, resulting in a detailed profile of each curriculum.

Since their study is more than a decade old, we believe that conducting a similar survey can provide valuable insights into any changes that have occurred in the field over the past decade.

3. Method

To find the Bachelor's level video game curricula for our study, we searched three online platforms designed to provide information about higher education study opportunities: Studyportals (studyportals.com, bachelorsportal.com, and mastersportal.com), Educations.com (educations.com), and Keystone Bachelorstudies (bachelorstudies.com). On Studyportals, the only search category related to video games was *Video Games and Animation*. On Educations.com, the only available and chosen category was *Game Design*. On Keystone Bachelorstudies the available categories were *Game Design* and *Game Theory*, and we chose the first one. For all sites, we then specified Europe as the location.

The initial search yielded 608 results from Studyportals, 411 from Education.com, and 48 from Keystone, for a total of 1067 search results. Of these, 251 were Master's programs, 705 were Bachelor's programs, and 111 were other programs (e.g., Pre-Bachelor and diploma programs).

3.1 Search Results and Filtering

As we were interested in Bachelor's curricula, we kept only these and removed duplicate search results. We also removed curricula that did not last three years or did not have the option to be completed in three years. This included 4-year programs that required a full year of practical experience, internship, industrial experience, study abroad, foundation, placement, or sandwich year. There were also several 1-year "Top-Up" curricula. This filtering process resulted in a total of 357 3-year Bachelor's curricula.

We further manually filtered the results to focus on curricula explicitly teaching video game development and/or design. Of the 357 Bachelor's curricula provided by the three sources, 127 were not focused on the desired areas. These were typically pure art or computer science degrees. Our criterion for inclusion was that a curriculum had to have more than three courses explicitly focused on video game design or development.

To accurately compare the curricula, we needed to determine the time students are expected to spend on each course. Most curricula use a credit system, where credits correspond to hours of work by students. This measures the amount of work required for each course. In Europe, the European Credit Trading System (ECTS) is commonly used, while the UK uses the Credit Accumulation and Transfer Scheme (CATS). With ECTS, one credit is approximately 26 hours of work, while with CATS, one credit equals 10 hours. One ECTS credit is equivalent to two CATS credits (Oxford, n.d.).

The number of credits assigned to each course can vary greatly. This means it is important to determine the exact number of credits for each course to profile the entire curriculum accurately. The number of credits assigned to each course also provides insight into the relative importance of each course within the curriculum, as students are expected to spend more time on courses with more credits.

We searched for each curriculum using a Google search or the corresponding university homepage. Most of the websites we found included a list of courses and their credit values or provided a link to a more detailed course specification file. Unfortunately, not all the curricula we found had this information readily available. If we could not find this information after making a reasonable effort, we removed the curriculum from our survey. In total, we were unable to include 121 curricula in our survey due to a lack of information.

While investigating the curricula webpages, we occasionally found that a university offered additional curricula on video game design or development that were not included in our initial search results. In these cases, we added these newly found curricula to our dataset. A total of six such curricula were added in this manner. After this process, we had a dataset of 113 Bachelor's level curricula that were explicitly related to video game art, design, or development and provided a publicly accessible list of courses and their corresponding credit values.

Since the curricula we found were intended for exchange students, their primary language of instruction was English. This also resulted in a significant portion of our sample coming from English-speaking countries, such as England, Wales, and Scotland. Table 1 provides the exact number of curricula from each country after filtering.

Table 1. Filtered curricula counts per country

Country	England	Wales	Belgium	Sweden	Scotland	Croatia	Greece	Germany	Ireland	Portugal
Count	91	7	4	4	2	1	1	1	1	1

This dataset does not provide a complete overview of the video game education landscape across Europe, as many countries offer curricula in their native languages. In such cases, the details of these curricula are typically not available in English. For more information about video game education in Europe, including the curricula in countries' native languages, see the 2019 European Video Games Industry Insights Report (EGDF, 2021).

3.2 Curriculum Structures

The curricula we found had a wide range of structures. Generally, curriculum contents can be divided into three parts: *core* courses, elective courses called *optionals*, and *paths* or specializations. Core courses are required for all students in the curriculum, while elective courses allow students to choose from a pool of courses to fulfill certain credit requirements. The ratio of core to elective courses varies greatly. Paths or specializations are wider areas of focus within the program and consist of several courses. Students can choose a path and must complete the courses within that path. Figure 1 provides visual examples of how a curriculum could be organized based on these components.

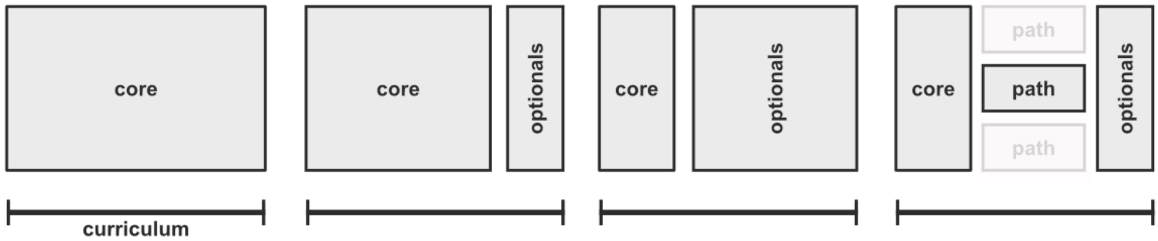

Figure 1. The leftmost curriculum consists only of the mandatory core. The second one includes some optionals, but the core makes up the greater part. The third one has a thinner core and more optionals for the students to pick from. The rightmost structure has paths to choose from.

While this provides a general overview of the structures of the different curricula, there may also be additional restrictions on elective courses. For example, a student may be required to choose two specific courses from a set of three or to make the same choice for two courses. Additionally, the pool of optionals can vary greatly. Some curricula have a small pool, while others have a large pool with courses from various unrelated fields.

Due to the wide variety of curricula structures and the options available for students to complete their program, we decided to base our curriculum profiles on the mandatory core courses only. This provides a clear understanding of the subjects that all students in the program are required to learn and the minimum learning outcomes they must achieve to pass.

The different path options were typically listed as separate programs that share the same core courses. In such cases, these were already included in our dataset as separate entries.

3.3 Classification

To classify the core courses, we chose 11 classifiers: *Industry*, *Design*, *Development*, *Math*, *Game Studies*, *Art*, *Soft Skills*, *Portfolio*, *Internship*, *Thesis/Project*, and *Other*. These classifiers are generally based on the 9 IGDA Topics outlined in the IGDA Curriculum Framework 2008 (IGDA, 2008), but there are some differences, as shown in Table 2.

Table 2. The correspondence between the IGDA Topics and our proposed classifiers.

IGDA Topic	**Our classifier**
1. Critical Game Studies	Game Studies
2. Games and Society	
3. Game Design	Design
4. Game Programming	Development
	Math
5. Visual Design	Design or Art*
6. Audio Design	
7. Interactive Storytelling	

IGDA Topic	**Our classifier**
8. Game Production	Industry
9. Business of Gaming	
N/A	Soft Skills
N/A	Portfolio
N/A	Internship
N/A	Thesis / Project
N/A	Other

* The corresponding IGDA sub-topics match either our classifier Design or Art, depending on their nature.

We grouped the IGDA topics *Game Production* and *Business of Gaming* into a single classifier *Industry*. Similarly, the IGDA topics *Critical Game Studies* and *Games and Society* were grouped into a single classifier called *Game Studies*. We also created separate classifiers for soft skills, portfolio, internship, and the thesis project because, while these may be explicit courses in a curriculum, they do not fall under any of the IGDA topics. Learning soft skills may be an implicit part of other courses, but we were interested in the proportion of explicit soft skills courses in the programs. We also separated math to see how much emphasis the different programs place on explicit math courses. Specifying the required level of mathematical knowledge is a common consideration in curriculum design (Blow, 2004).

The IGDA topics separate art and design into three categories: *Visual Design*, *Audio Design*, and *Interactive Storytelling*. In our study, we first grouped all of the different media (visual, audio, and text) together and then defined separate classifiers *Art* and *Design*.

The difference between art and design is an important one, and is well distinguished in the book *Foundations of Art and Design* (Pipes, 1999). Art focuses on the craftsmanship, the technical skill required to create something, such as modeling a 3D asset, drawing an immersive background, or recording and editing sound effects. In contrast, design focuses on the bigger picture and the problem-solving, planning, and organization involved in creating a product or experience (Pipes, 1999). This is emphasized by Schell (Schell, 2008), who explores the role of a video game designer as someone who creates an experience for the player. As such, many researchers in the field of video game education (Argent et al., 2006; Czauderna, 2018; Estey et al., 2009; Roden & LeGrand, 2013) have found it useful to differentiate between art and design in their analyses.

For example, topics dealing with areas like the design of game soundscapes, the mood, tension, and resolution the player should experience from the audio are what we classify as design. On the other hand, technical areas that deal with the craftsmanship of audio recording, audio tool usage, composing scores, modeling audio in specific environments, and creating sound effects are what we classify as art. We admit that a strict distinction is not always clear, as many topics and courses include design, art, and even the industry together. An example of the latter is the topic of audio creation workflow, which we classify as both art and industry.

3.3.1 Correspondance to Ip Topic Areas

The closest existing study to ours was made by Ip, which profiled 306 programs in the UK about a decade ago (Ip, 2012). To compare the results later, we establish a correspondence between Ip's topic areas and our classifiers. The topic areas used by Ip in their course categorization were based on Skillset definitions and were separated into the categories of game design (G), programming (P), and art (A). In comparison with classifiers, we have separated Ip's single topic area *G2: Game Design and Storytelling* into *Design* and *Art*, as storytelling is considered an art rather than a design skill. All the programming topic areas correspond to our classifier *Development*. Our separate classifier *Math* corresponds to *P1-1: Mathematics* from Skillset. All art topic areas (A1–A6) are included in our classifier *Art*. Our classifier *Industry* includes *G4: Game Business and Production* and *P4: Game Creation Processes*. See Table 3 for a full breakdown.

Table 3. The correspondence between our classifiers and the topic areas used by Ip.

Topic areas used by Ip	**Our classifier**
G1: Game Critique	Game Studies
G2: 3 – Games Design G2: 4 – Visual Design G2: 5 – Audio Design	Design
G2: 6 – Interactive Storytelling	Art
G3: Game Programming P1-2: Programming P1-3: Algorithm Development P2: Programming Low-Level Architecture P3: High-Level Programming	Development
P1-1: Mathematics	Math

Topic areas used by Ip	**Our classifier**
A1: Observational Drawing A2: Visual Invention and Visual Communication A3: 2D Digital Art A4: CGI, 3D Modelling A5. CGI Texturing A6: Rendering and Lighting	Art
G4: Game Business and Production P4: Game Creation Processes	Industry
Other	Soft Skills
	Portfolio
	Internship
	Thesis / Project
	Other

3.3.2 Creating the Curriculum Profiles

To be able to later compare and cluster the different curricula, we created *curriculum profiles*. These are vectors showing the percentage contributions of our classifiers in one curriculum's core. They allow seeing, for example, the percentage of required *Development* courses in a curriculum. Without the course classification and computing of the curriculum profiles, it would not be feasible to understand the similarities and differences between the numerous curricula.

We classified the 1644 courses from the 113 curricula using one or more classifiers based on the course name. For example, a course titled *Game Programming* would be assigned the classifier *Development*. In case the name was too vague, we used the course description, learning outcomes, or other available information on the corresponding university website.

We then used the classified courses to calculate the curriculum profiles. For each curriculum, each course contributed to the classifier that was assigned to it. The contribution was individually weighed by the percentage of credits the course was worth in the curriculum's core. If a course was assigned to multiple classifiers, its contribution was divided equally among them. This process resulted in profiles for each curriculum indicating the percentage of learning in each classified area. Figure 2 provides an example of a curriculum with classified courses and the resulting curriculum profile.

COURSES		Industry	Design	Development	Math	Game Studies	Art	Soft Skills	Portfolio	Internship	Thesis / Project	Other
Game Design 1: Introduction	7.5		✓									
Programming with C/C++ 1: Introduction	7.5			✓								
Programming with C/C++ 2: Algorithms, Data Structures and Design Patterns	7.5			✓								
Programming with C/C++ 3: Computer Games in 2D	7.5			✓								
Game Design 2: Game Development	7.5		✓	✓								
Linear Algebra, Trigonometry and Geometry	7.5				✓							
Game Production 1: Arcade Games	15	✓										
Game Design 3: System Design	15		✓									
Programming with C/C++ 4: Computer Games in 2D	7.5			✓								
Real-Time Graphics Programming for Games 1	7.5			✓								
Game Design 4: Level Design	7.5		✓									
AI Programming 1	7.5			✓								
Game Production 2: Vertical Slice	15	✓										
Game Design 5: Theory and Method	7.5		✓									
Game Design 6: Experimental Game Design	7.5		✓									
Degree Project in Game Design	15										✓	
		0.2	0.325	0.325	0.05	0	0	0	0	0	0.1	0

CURRICULUM PROFILE

Figure 2. An example of one curriculum profile for the Game Design and Programming curriculum from Uppsala University. One of the few curricula where the course credits were not all whole numbers.

As shown in Figure 2, the courses of one program are classified using our classifiers. However, the actual classification of individual courses was done separately, without the classifying researcher being aware of the program that the course belonged to.

4. Results

We performed hierarchical clustering analysis on the 113 clusters using Ward's method and the Euclidean distance function. We found that three clusters gave the most useful results, as shown in Figure 3. Additionally, the within-cluster sum of squares indicated that three clusters might be optimal for these data. Semantically, these three clusters can be thought of as the *Game Programming*, *Game Art*, and *Game Design and Development* clusters. We titled the first cluster *Game Programming* to distinguish it from the last cluster, which we call *Game Design and Development*.

For each cluster, we calculated the percentage of programs that offered different degrees (BA, BSc, or Other) and determined the percentage of main curriculum themes (*Industry*, *Design*, *Development*, *Art*) based on the curriculum title only.

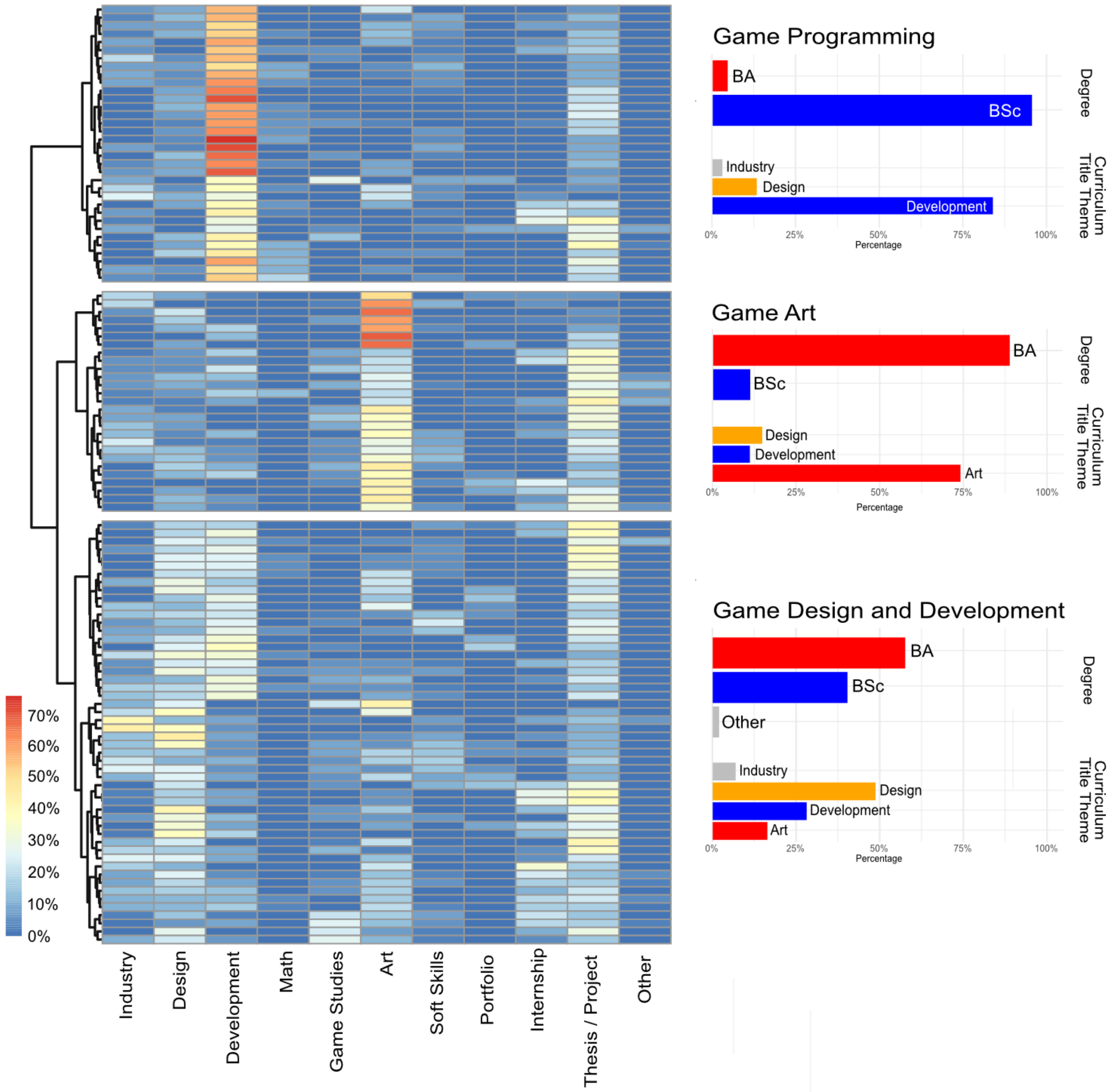

Figure 3. Results of the hierarchical clustering analysis.

The clusters show that game programming and game art curricula tend to be highly specialized in their respective areas. In both cases, some curricula have around 70% (with a maximum of 75% and 68%, respectively) of their core curriculum dedicated to either development or art only.

The *Game Design and Development* cluster differs from the other two clusters in that its curriculum core content is not as focused on design courses. The maximum percentage of explicit design content in a curriculum in this cluster was only 44%, indicating that these curricula focus more on the industry, development, and art areas. This focus is not uniform across all curricula, with some focusing more on one area than others.

A similar pattern can be observed in the awarded degrees and the titles of the curricula in the *Game Programming* and *Game Art* clusters. In these clusters, almost all of the degrees are either BSc or BA, and the titles of the curricula are very specific. For example, the cluster *Game Programming* includes curricula titled *Games Programming*, *Computer Games Development*, *Computer Games Technology*, and *Computer Science for Games*. Similarly, the cluster *Game Art* includes curricula specifically titled *Games Art*, *3D Animation and Games*, and *The Art of Video Games*.

The third cluster includes curricula with titles such as *Game Design and Development*, but this is not the only prominent theme in that cluster. There are also curricula called *Games Design*, or where design is combined with another area besides development, *Games Art and Design*, and *Computer Game Design and Enterprise*. Similarly, there are curricula in this cluster with titles such as *Games Programming*, *Games Development*, and *Game Art* that, due to their broad focus, fit better into this cluster than the more specialized clusters for game programming and game art.

The degrees awarded in this cluster are also more evenly split, with 57% of the curricula earning a BA and 40% of the curricula earning a BSc. This deviation from the pattern seen in the first two clusters, where BA degrees were awarded for most of the *Game Art* cluster curricula and BSc degrees were awarded for almost all of the *Game Programming* cluster curricula, is also reflected in the titles of some of the curricula in this cluster. For example, *Computer Game Design and Enterprise* and *Computer Games Design* both earn a BSc, while *Game Development: Programming* earns a BA. There are not many such exceptions, but they do exist.

4.1 Principal Component Analysis

The principal component analysis (PCA) yielded interesting results when we used only the *Design*, *Development*, *Art*, and *Industry* course classifiers. These were, on average, the most prominent classifiers when we excluded the *Thesis / Project* classifier as it did not refer to a specific area of study. On average, 24% of the curricula profiles were attributed to the classifier *Development*, 16% to the classifier *Art*, 14% to the classifier *Design*, and 8% to the classifier *Industry*.

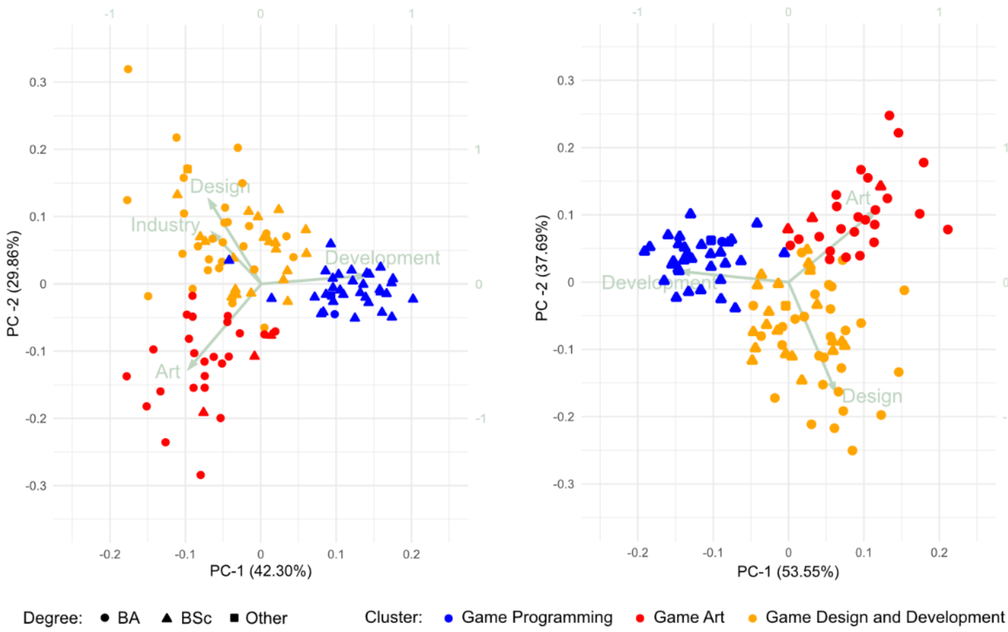

Figure 4. Results of PCA with four (left) and three (right) classifiers.

The results of the PCA (see Figure 4) show that the *Game Programming* and *Game Art* curricula are mostly separate from each other. The *Game Design and Development* curricula, on the other hand, show a wider range of profiles in the PCA results. Their profiles can have varying levels of separation from both the *Game Art* and *Game Programming* curricula, but they are also the ones that have profiles that fall in between these two groups.

The results of the PCA show that the curricula in the *Game Design and Development* cluster that are furthest along the *Design* loading vector are mostly awarded BA degrees. This suggests that, at least in this analysis, curricula with a high percentage of courses classified as *Design* tend to result in a BA degree. However, in other areas of the cluster, the degrees awarded to such curricula are more evenly distributed between BA and BSc.

4.2 Comparison with Previous Results

When comparing our results with those of Ip, it is important to consider the differences in how the various themes of the curricula were derived. It is not explicitly mentioned in Ip's study, but it is reasonable to assume that they classified the curricula into three themes based on the curriculum title and description. In our study, we divided the curricula into themes using hierarchical clustering based on their content profiles.

We matched our classifiers to the topic areas applied by Ip as featured in Table 3 and used only the matched classifiers in the comparison. The Ip study did not provide standard deviations or confidence intervals, so we can only compare our data with specific average data from Ip. This comparison is provided in Figure COMP.

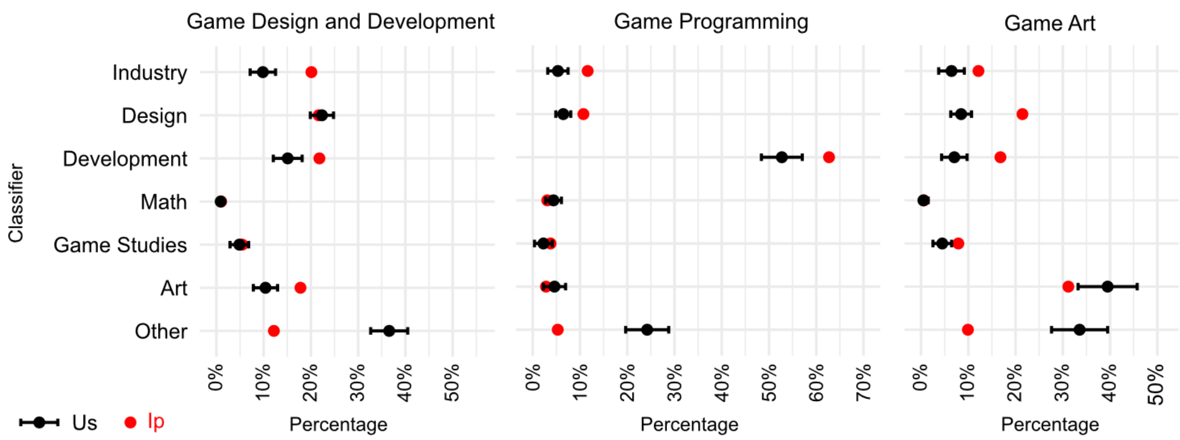

Figure 5. Comparison of our course profiles and those of Ip in all three curriculum themes.

In all three clusters, there is a notable increase in the class *Other*. This classifier consists of courses dedicated to soft skills (on average 4%), portfolio development (2%), internships (5%), final projects or theses (20%), and other courses (1%) that did not fit into the other classifiers. These are what Ip also classified under their topic area *Other*, indicating that there has been an increase in the amount of time students are expected to spend on their final projects, theses, internships, or taking courses on soft skills.

As a result of the increased weight of the classifier *Other*, we would expect to see a decrease in the other classifiers in all three clusters. However, no statistically significant change was observed in the *Math* in all clusters, as well as the classifiers *Design* and *Game Studies* in the *Game Design and Development* cluster, and classifiers *Game Studies* and *Art* in the *Game Programming* cluster. This can indicate that the focus in these areas has rather increased.

The only classifier for which the percentage has explicitly increased is *Art* in the *Game Art* cluster. This is likely because the curricula we clustered under the cluster *Game Art* are more focused on art courses than the curricula included in Ip's curriculum theme *Game Art*.

5. Discussion and Conclusion

As with any analysis, particularly cluster analysis, different methods, and parameters can yield somewhat different results. Our goal in this study was to provide a useful overview of the landscape of English-language video game Bachelor curricula in Europe. It is clear that the three curriculum focus areas of *Art*, *Interdisciplinary Design*, and *Technology* identified by previous research (Mateas & Whitehead, 2007) exist and have distinct content profiles.

Our findings show that some of the surveyed curricula of the *Game Design and Development* cluster serve as a bridge between curricula from the clusters *Game Art* and *Game Programming* (Figure 4), providing students with the knowledge and skills to connect the work of game artists and programmers. However, there are also many curricula from the cluster *Game Design and Development* that, instead of having large percentages of *Art* and *Design* classifiers, have a higher proportion of *Game Studies* and/or *Industry* classifiers (Figure 3), indicating a more diverse profile compared to the other clusters. This underscores the high degree of content variation in *Game Design and Development* cluster curricula, aligning with the suggestions and findings of previous researchers (Czauderna, 2018; Kasurinen et al., 2013; Mateas & Whitehead, 2007) and the diverse requirements of the game designer role (Schell, 2008).

From the perspective of industry needs, our findings suggest that there may be a lack of emphasis on art courses in the curricula. Previous research (McGill, 2009; Tunnel & Norbisrath, 2022) has shown that video game developers and programmers need to have some knowledge of art in order to be successful. However, the percentage of art courses in the *Game Design and Development* cluster is low (5%), and even lower in the *Game Programming* cluster (1%).

Additionally, soft skills, which are typically learned through activities in other courses, are essential for success in the video game industry (McGill, 2009; Tunnel & Norbisrath, 2022). Given the interdisciplinary nature of game development, skills such as communication, work ethic, and problem-solving are particularly important. It is encouraging to see that there are also dedicated courses on these topics, averaging 4% of curriculum content across all clusters.

We observed a significantly larger percentage of courses with the classifier *Other* than the amount found by Ip (Ip, 2012). This may indicate a shift towards more project-based learning (PBL) approaches. This is positive, as PBL has been shown to increase competence in teamwork and communication skills (Rupérez et al., 2022).

Overall, these results provide a modern overview of the landscape of Bachelor’s degree curricula in video game higher education in Europe. By complementing the findings of Ip from a decade ago, our results can help curriculum designers understand how these curricula differ from one another and how the *Game Design and Development* curricula serve as an intermediary between *Video Game Programming* and *Video Game Art* curricula.

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