A Research Methodology Course in a Game Development Curriculum

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Abstract

Research methodology courses can often be considered part of a computer science curriculum. These basic or advanced-level courses are taught in terms of traditional research methods. This paper presents and discusses a research methodology course curriculum for students studying programs focusing on digital game development (more specifically, focusing on game engineering). Our research methodology course prepares students for their upcoming thesis by encouraging a research-oriented approach. This is done by exploring new research areas in game engineering as a basis for research analysis and by applying research methods practically in a smaller project. This paper presents the course structure, assignments, and lessons learned. Together with existing literature, it demonstrates important aspects to consider in teaching and learning game research methodologies. The course evaluation found that the students appreciated the interactive lectures, close staff supervision, and detailed feedback on the scientific writing process.

CCS Concepts

• ***Applied computing*** → ***Education; Computer games;*** • ***Human-centered computing*** → *Human computer interaction (HCI);*
• ***General and reference*** → *Cross-computing tools and techniques;*

1. Introduction

A clear trend within the industry and society is that interaction and the visual experience are becoming increasingly important, and the gaming industry in Sweden and internationally is growing steadily. The game development sector also creates and tests new technologies used in many other areas and industries. Therefore, a degree in game engineering is also attractive in many industries outside the gaming world where real-time interaction and performance are important. Digitalization is also part of everyone's life, and over the last decade, we have seen technologies such as augmented reality (AR), virtual reality (VR) and extended reality (XR) develop. Therefore, it is crucial to understand the technology and engineering behind games and the impact of human-computer interaction. Telemetry, or tracking and analyzing behavioral data from games, has also increased in importance in the last few years [NDC13].

This paper describes the curriculum for a university course that might not be commonly found within traditional computer science or game programs. This paper presents how aspects of a traditional research methodology course curriculum have been targeted toward digital game development education. The developed course curriculum is an example, which is now part of a Master of Science in Game Engineering (former Master of Science in Game and Software Engineering) degree program and two Bachelor programs, one in Technical Artist in Games and the other in Game Programming. This mandatory course has been taught since it was developed in 2017, based on a previous course studying current game techniques. The content was then complemented with state-of-the-art research-influenced assignments at the university research laboratory. It is our experience that a research-oriented research methodology course can improve the students' learning in their upcoming thesis, both for bachelor's and master's of engineering students. The overall research question asked in this paper and that warrants future discussion in the light of the above is:

- How should a research methodology course in a game development curriculum be structured?

The paper is organized as follows. Section 2 presents some background and related work in curriculum design in traditional research methodology and gives examples of important aspects of methodologies for games. Section 3 outlines the research methodology in the games course curriculum taught at the university. Section 4 presents some lessons learned over the last seven years and discusses how the current course further could be modified based on evaluations. Finally, Section 5 presents some conclusions and future work.

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2. Background and Related Work

There are many traditional research methodology courses and literature in the area covering the topic in different domains. This background and related work focuses on some key resources for research methodology curriculum development and more specific methods applied to games. Whereas *research methods* consist of all techniques, tools, and strategies employed for conducting an experiment, *research methodology* is defined as a systematic approach to collecting and evaluating data throughout the research process. The scope of this paper lies in the context of research methodology and curriculum development for game development students. There are two important sources to be considered while drafting the higher education curriculum for various courses at the university level:

- The Association for Computing Machinery (ACM) and the Institute of Electrical and Electronics Engineers (IEEE) societies establish international curriculum guidelines for undergraduate courses in computer science (CS) every ten years or so. To accommodate the evolving technical landscape in CS, the latest guidelines [AC23] also included the Association for Advancement of Artificial Intelligence (AAAI).
- The Higher Education Act/Ordinance at the national level contains provisions about the higher education institutions accountable to the government.

ACM/IEEE/AAAI has identified 17 different fields within CS. Of these, two fields, namely, *Graphics and Interactive Techniques (GIT)* and *Human-Computer Interaction (HCI)*, are most directly connected to Computer Graphics (CG) and gaming. It is also evident that gaming has received more attention in their latest guidelines compared to the previous version [ACM13, AC23]. The GIT-specific discussion shows that a balance of theory and applied instruction will enable students to understand, evaluate, and implement relevant graphics techniques. For instance, comparing and contrasting different rendering techniques is an illustrative learning outcome. Similarly, another learning outcome is identified as evaluating important subjective technical characteristics of a VR system, such as avoiding motion sickness. It is also pointed out that the field of CG has expanded and become more pervasive, and also requires dealing with ethical questions and conundrums in various applications.

The Higher Education Act/Ordinance in Sweden [Col23] has outlined certain requirements for game programming students at the master's, dual-degree (bachelor's and master's in five years), and bachelor's levels. A key requirement is to show in-depth methodological knowledge of a chosen topic within the main subject. To this end, the student should have demonstrated having acquired certain skills and abilities upon completing the program. This includes the ability to 1) plan and, with adequate methods, carry out research and development work and 2) critically and systematically integrate and apply the knowledge acquired within the education.

Following the above-stated guidelines established by ACM/IEEE/AAAI and the Higher Education Ordinance in Sweden, it is evident that a more systematic structured course on research methodology when dealing with CG and gaming topics would be highly relevant to the core topics of the educational curriculum. In the last decade or so, more concerted efforts have been made towards a more systematic design of game curriculum [McG12, MT16, Ken16]. To this end, this paper will evaluate the applicability of relevant scientific methods to address the undertaken research and other issues (for instance, ethical considerations) that should increasingly be seen as necessary components of scientific methodology.

2.1. Research Methodology in Games

Some work is focused on using games or gamification as a way to teach research methods. The course presented in this paper has not taken this approach directly, but it could be interesting to explore further. In [GN14], for example, games were used to teach research methods and ethics in the social sciences. Sillaots et al. [SFSG*20] used a browser-based adventure game to introduce the field of research methods to students on game design programs. They aimed to increase the student's motivation and competence in research methods while finding relevant research topics and suitable matches with game design and game studies supervisors. Sillaots et al. [SFSG*20] mention that the game could also be more suitable to other non-game programs due to general concepts of quantitative, qualitative, and design-based methods.

Sillaots [Sil14a] also explored teaching research methods through gamification since it is reported that with traditional lectures, presentations, and even more active seminars, the topic can be perceived as dry and boring. This work explored if gamification could make the topic more engaging in terms of more immersive learning activities and *flow*. Three of their courses include gamification (one for master's and two for bachelor's students). Quantitative and qualitative information was gathered, and flow could be obtained in most scenarios. Even if most students liked the game-like teaching, they reported that some did not find it enjoyable. However, Sillaots has also reported that some students can find that the focus shifted too much from course content to gameplay aspects [Sil14b].

Marnewick and Chetty [MC21] used MinecraftEDU to teach students about research methodology theory and literature. They report that their students preferred gamification over traditional lectures but highlight that more research is needed on how to incorporate it successfully to teach the topic. Some have explored using games directly as a research-creation method, as proposed in [PUC20]. Here, two courses were studied and evaluated whilst describing the lessons learned in using games to advance research through game making, using games as research tools, and presenting research topics and findings through games.

Polack-Wahl and Anewalt [PWA05] emphasize the importance of introducing a course on research methods to teach students about learning strategies. They introduced a research methods course as an elective to increase the number of students who would conduct an individual study on a relevant topic in computer science, focusing on a research area of their choice. Topics included in their course were exploring research areas, reviewing papers, searching literature, research proposals, managing research, and giving technical presentations. Below, we highlight some previous work that has introduced research methodology in gaming or covered research methods specifically for games.

Mäyrä et al. [MHJ12] present a collection of articles studying the topic of research methodologies for games and point out that game studies need a series of different approaches. Lankoski and Björk [LB*15] also present a compilation of chapters in a book focusing on research methods for games. Here, the articles are divided into chapters on (1) qualitative approaches for studying games, (2) qualitative approaches for studying play and players, (3) quantitative approaches, (4) mixed methods, and (5) using game development for research.

Lankoski and Eladhari [LE19] developed a new 15 ECTS course for teaching game research to bachelor students on a game development program. Topics covered include observation methods, surveys, interviews, and an introduction to statistical analysis. Their course design follows a *constructive alignment* design [BTK22b], aiming to align the learning goals, tasks, and evaluation. The course is designed in two parts. In the first part, the students learn about game design research methods. They should perform a smaller study based on relevant publications in the second part. They highlight that the students can also choose a quantitative research method if they are interested in challenging themselves further. A reported outcome is that the course led to a better understanding of research methods and their application.

Nacke et al. [NMBD19] presented a course at the ACM Conference on Human Factors in Computing Systems (CHI) 2019, focusing on different user research methods for game evaluation and playtesting. The aim was to give the participants skills in improving the design based on feedback from the players. This course also mentions observation, interviews, gameplay breakdown reports, and quantitative methods such as game analytics. Examples in the course were also taken from their extensive book on games user research [DMBN18].

Since the field of game research is quite recent, it has not got as established methodologies as other areas [DAO20]. De Angeli and O'Neill [DAO20] conducted a review paper of game research methodologies published between 2013-2018 in four venues: (1) CHI Play, (2) the Digital Games Research Association conference, (3) the International Conference on the Foundations of Digital Games, and (4) the Games and Culture journal. The output is an overview of methods, tools, and strategies for recruitment for game research. One interesting aspect of the survey is that they name specific questionnaires used whilst exploring the survey as a research method. There have been previous examples of applying a research methodology course in a specific area, for example, in artificial intelligence (AI) [Ram16]. This paper focuses on appropriate content in a research methodology curriculum on game development programs with a stronger focus on game technology and engineering.

3. The Research Methodology in Game Curriculum

The course introduces the student to research methodology through the development, evaluation, and comparison of methods, techniques, and tools and their impact on different systems or organizations. It is the aim that the student understands the research methodology that makes such evaluation and comparison possible. The student also gains experience in current research by planning, conducting, and reporting a small research project in game technology. The course introduces information retrieval, research methods, scientific writing, and evaluation. Components of the course include an introduction to research, searching and critically evaluating scientific literature, formulating scientific questions/problems, selecting appropriate research methods, research ethics, collecting and analyzing data, validity threats, and practicing scientific writing. The course also includes studies of the research frontier in game and software engineering that form a basis for the course assignments.

The research methodology course has an advanced level and is double-classified in the subject areas of computer science and software engineering. It is worth 7.5 credit points in the European Credit Transfer System (ECTS). Admission to the course requires that the student has completed courses corresponding to 120 credits in a relevant field. The course is taught in Swedish, English, or a combination. The course structure includes lectures, supervision, individual and group project work, presentations of student works, and reading scientific literature and using it practically within the course assignments. The course runs over nine or eighteen weeks, depending on the enrolled game program. The bachelor's students take it in nine weeks, and the master of engineering students in eighteen weeks.

3.1. The Learning Objectives

The learning objectives of the course are described below. After the course, the student should be able to:

Knowledge and Understanding: (1) be able to account for different research methods, data collection, and analysis and (2) be able to take advantage of current research articles in gaming and software engineering.

Skills and Abilities: (1) be able to use scientific databases and search engines to identify relevant research articles in gaming and software technology based on search strings, (2) be able to collect and analyze data in a smaller research project and compare the results with relevant research articles, and (3) be able to explain state-of-the-art techniques within a specific game and software engineering area.

Values and Attitudes: (1) be able to keep the scientific concepts and relate them to a smaller research project.

3.2. The Content

Before the course starts, the students are encouraged to browse the learning platform. They are informed that they can start to think about current keywords for potential research topics in game and software engineering, which will be part of an exercise in the course. They can also start thinking about a relevant game and software engineering project topic that would interest them to explore further in the course. It is mentioned that this topic potentially could overlap with the focus of their thesis work, thus having relevant synergy effects.

The literature on the course is a selection of chosen articles in the area of game and software engineering and relevant reference literature in research methodology. Since the course focuses on state-of-the-art techniques, the scientific literature varies yearly. In addition

to these articles, the students also explore additional articles that form a basis for the final project (short paper) in the course assignment. The students are also given a list of recommended reading references [BHOL07, Daw09, BHT10, CW11, Zob14].

The course begins with lectures on research methodology and is later conducted in two main parts: (1) Article analysis: seminar form where current research articles in the field are presented, opposed, and discussed by the students under the supervision of teachers, and (2) Report: in-depth scientific report writing in a self-selected area. The articles presented have different technical themes selected through information searches by students and teachers and distributed to the students before the seminar. The students presenting the articles prepare a research-based presentation that clearly illustrates the chosen technology area.

Other students should have read the material before the seminar to be able to participate in the discussions. In one part, the students are given a special role as opponents for the presentations, who must adopt a critical attitude to the research and technology presented to initiate a good discussion. In the course, the students choose, alone or in pairs, to write a report on a current technology that follows the practice of a scientific article. The report should be centered around a scientific question or problem formulation and include an initial technical solution, data collection and analysis, and a comparison with the literature. This report should also be presented at a final seminar. There are seven lectures in this course.

- L1: Introduction lecture
- L2: Literature search and review 1 (by a Librarian)
- L3: Literature search and review 2 (by a Librarian)
- L4: Research methods 1
- L5: Research methods 2
- L6: Presentation and opposition
- L7: Academic writing

L1 is an introductory lecture that briefly overviews the course, including the course context, learning objectives, teaching activities, assignments and examination criteria, course literature, etc. Furthermore, the definition of research and the difference between research methods and methodology are also explained. L2 and L3 are given by a librarian who is mainly responsible for information retrieval in the computer science area at the university. The students must prepare some keywords in the area they are interested in. During these two lectures, the students are encouraged to bring their mobile phones or computers to the classroom. The librarian introduces the most relevant databases in the area and asks the students to try to search and compare the results they found from the different databases. After a discussion on the databases, advice for references and citations is presented, and one of the reference management tools, Zotero, is introduced.

L4 and L5 are two lectures that give a detailed introduction to different research methods used in the game area. We start with forming research questions or hypotheses by showing examples from previous student theses or publications. When it comes to each research method, a research question in the game area is always discussed first and then the research method that can answer this question. In L4, using different examples, we present the systematic literature review (SLR) research method, survey, and case study. Students can better understand each method's appropriate use and benefits through the examples. Particularly, when we talk about the survey method, some standard questionnaires used in game research, such as the Game Experience Questionnaire (GEQ) and Simulator Sickness Questionnaire (SSQ), are introduced to the students. In L5, we focus on implementation and experiment, the most used research methods in the game student thesis. The importance of implementation is explained to students since it develops new solutions. However, it is not enough in scientific research; we need to compare them with some exciting solutions, and then we need to have the experiment as an essential method to align with implementation.

Four aspects of experiment design are discussed during this lecture: variables, process, validity, and ethics. Ethics is one of the most emphasized aspects of the lecture since, in the game area, there are many experiments involving human participants. We introduce how to conduct a human experiment ethically, including tips for participants' requirements, user grouping, invitation letters, consent forms, data storage and processing, etc. The ethics review aims to ensure that the participants are not physically or mentally harmed. Different ethics review organizations are briefly introduced, and a detailed discussion of how to do a self-assessment for a student project is provided.

L6 starts with discussing how to evaluate others' research based on the content, manuscript formatting, availability and visibility (where published). The students are shown examples of professional scientific paper review forms to understand better the most important elements for evaluating a scientific paper. Then, the presentation and opposition process of the later degree project course and other research papers are explained. The staff shares advice based on their own experiences. A comprehensive introduction to Assignment 1 is given at the end of L6, and afterward, the students can ask questions about it.

The last lecture, L7, is about academic writing. We start with a discussion with the students on who the reader of their thesis and scientific papers could be to emphasize that the texts that they are writing must be easily understandable to a peer in the area. By showing the general structure of a scientific report, which typically includes an introductory part, a report, and a final part, different writing techniques in those three parts are shared with the students. Then, examples are listed to show the students how to cite using references in their texts properly. The lecture ends with the explanation and Q&A session for Assignment 2. The overall course design overview is shown in Figure 1.

3.3. The Pedagogical Method

The diversity of the students is considered in the design of the teaching activities. There are students with a surface learning approach and a deep learning approach. The pedagogical approaches in this course aim to encourage students with a surface learning approach to learn more like a deep learning approach. Our goal is that as many students could feel that learning is pleasure [BTK22a] through this course. To achieve this, we start with traditional classroom-based lectures to introduce the students to theoretical knowledge in the course. To ensure the students can understand the theoretical contexts, all the lectures include several

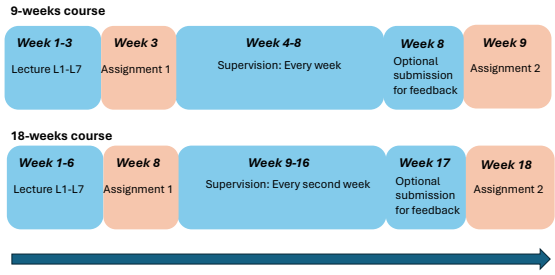

Figure 1: *An overview structure of the course design.*

practical examples and a small discussion in the classroom. During the COVID-19 pandemic, those lectures were conducted through Zoom.

After the seven lectures, a flipped classroom approach is applied in the teaching and learning [GHP15], which is also successfully used in a research methodology course in another area [VdZA19]. The students must prepare an idea as a basis for the report before their first supervision slot. The first supervision time is called idea pitch, which allows students to get relevant topic feedback and recommended reading suggestions. For those who are not so active in their study, to encourage them towards a deep learning approach, they are always given some questions to teach themselves to be better prepared for the next supervision time. The supervision runs every week for a nine-week course and every second week for an 18-week course. Besides, considering the students in this course have a more technical-oriented background, they are often motivated and capable of programming but lack training in scientific writing. An optional submission was added for the students ten days before the final deadline. Feedback on the scientific writing of their final report can be provided through their draft submission to help the students improve their skills in academic writing.

3.3.1. The Laboratory Environment

The role of relevant infrastructure and research-oriented activities in education [SDA*18] should not be underestimated in developing a relevant research methodology project and later thesis topic. In addition to the need for staff in the domain, supporting the research methodology and other courses with relevant infrastructure is also important. At the university, the student can access a new infrastructure laboratory, which benefits education, research, and collaboration with society. In our research laboratory, we have the following research equipment and software.

The students can work with different portable eye trackers and VR headsets with integrated eye tracking. This has become increasingly relevant for the game development area [Sun10]. They can also access traditional VR headsets without eye tracking and VR headset accessories, such as wireless adapters. The laboratory also has several types of wearable sensors allowing students to explore electroencephalography (EEG), galvanic skin response (GSR), and electrocardiography (ECG) unit sensors, for example, through the iMotions biometric research software platform (+VR Eye Tracking Module) in gameplay. Mixed reality devices are also available, allowing the students to explore increasing immersive technology trends.

The laboratory also has Cleanbox technology, allowing the cleaning of devices for AR/VR HMDs. This has become increasingly highlighted after the experience of the COVID-19 pandemic and its impact on future experiment design protocols. In the laboratory, the students can also test graphics algorithms against different graphics card setups for performance evaluations.

3.4. The Assignments

There are two assignments in the course. Assignment 1 is a combination of individual and group work. The second assignment is a project in a group of 1-2 students. The two assignments with their credit size and grading scale are listed below:

Assignment 1: Article Analysis, 2 hp, G-U
Assignment 2: Report, 5.5 hp, A-F

The final research methodology course is graded using grades A (Excellent), B (Very Good), C (Good), D (Satisfactory), E (Acceptable), FX (Fail-complementing required), and F (Fail). The report in Assignment 2 determines the final grade when both moments have been passed.

Below is a description of Assignments 1-2 with their corresponding grading criteria. These assignments were chosen to be described further since they are relevant to ongoing state-of-the-art research in games and interactive systems. The assignments are described as they were communicated to the students.

3.5. Assignment 1

Assignment 1 consists of two parts. In Part 1, the students are asked to register in groups of four to six students. Each group member then selects an article on game and software technology. We use research articles published in gaming technology in the last five years. Hence, the literature and topics developed with each course instance keep the topics state-of-the-art. The group then adds all these selected articles to the ZIP together with the other necessary info (student names, the motivation for article selection (relevance), information on how the articles were selected), and the group submits the compiled ZIP file.

In Part 2, one or two days after submitting the articles, each group will be assigned a selected current game technology research article to present a seminar (20 minutes). The student group's presentation must be research-based and account for state-of-the-art technologies in a specific gaming and software technology area. Their presentation should include an introduction, relevance/gap, research questions/problem formulation, scientific research method, gaming and software engineering solution, results, evaluation/discussion, conclusions, future work, and references.

The group will also be assigned another article to review within the game and software technology area (10 minutes orally and one page in writing). The review should evaluate its pros and cons on all parts of the article (introduction/context, relevance/gap, research

	Assignment 1	Assignment 2
be able to account for different research methods, data collection and analysis		X
be able to take advantage of current research articles in gaming and software engineering	X	X
be able to use scientific databases and search engines to identify relevant research articles in gaming and software technology based on search strings	X	X
be able to collect and analyze data in a smaller research project and compare the results with relevant research articles		X
be able to explain state-of-the-art techniques within a specific game and software engineering area	X	X
be able to keep the scientific concepts and relate them to a smaller research project		X

Table 1: *The mapping of the learning objectives to the course assignments.*

question/problem formulation, scientific research method, game and software engineering solution, results, evaluation/discussion, conclusions, future work, and references). The presentation slides of the article analysis and the critical evaluation of another research article must be submitted on the learning platform (Canvas). The submission format is a compiled zip file with two separate documents in PDF format (one zip file per group) and presented orally by all group members at the seminar. The evaluation criteria can be found below. A UX can be completed to a G or submitted for a new assessment in the next examination round. An incorrect submission format or late submission will result in a U.

Grade G: Completed presentation of a research article and a critical written evaluation of another research article also presented orally by all group members at a seminar.

3.6. Assignment 2

In Assignment 2, the students (1-2 people) must write a scientific report, which could be a pre-exercise for their degree project. Before starting with the report, they give an initial pitch to the course staff and discuss their potential idea for the report, focusing on research methods, collection, and analysis of data for the report. The pitch session helps guide the students in practice towards selecting a scope for the report that is relevant, reasonable in scope and has the potential to gather some initial results.

The students should use appropriate current research articles in game technology for the background of their report. They also need to be able to account for different research methods, collection, and analysis of data. As part of the report, they must be able to collect and analyze data in a small research project and compare the results with relevant research articles. They also need to be able to give a research-informed account of state-of-the-art techniques within a specific game technology area (summary, keywords/classification, introduction/explanation, introduction/broader perspective/context, relevance/gap, research question/problem statement, scientific research methodology, game and software engineering solution, results, evaluation/discussion, conclusions, future work, relevant, and complete references) in a report. They should also be able to relate scientific concepts to a small research project.

The report should be four pages, including the references, and submitted in a PDF format. They are required to structure the report using the ACM SIGGRAPH or Eurographics templates. Based on academic writing, the report normally should include an abstract, introduction, background/related work, method, results, analysis/discussion, conclusion, and future work. The evaluation criteria can be found below. FX can be completed to an E or submitted for a new assessment in the next examination round. An incorrect submission format or late submission will result in an F.

Grade E: The report is based on a scientific problem. The game and software engineering proposal will generate an initial result (data is collected and analyzed in some form). The report is carried out as described above, focusing on a current game and software technology (content, spelling, formatting, grammar, logical structure, scientific concepts, collecting and analyzing data, etc., with minor problems).

Grade D, as with E plus: Well-written report (content, spelling, formatting, grammar, logical structure, scientific concepts, data collection and analysis, etc., has few problems).

Grade C, as with D plus: The report must refer to several relevant current game and software technologies in the recommended reading on the learning platform. The report must also discuss relevant ethical aspects of the research and the validity of the threats.

Grade B, as with C plus: Very well-written report (content, spelling, formatting, grammar, logical structure, scientific concepts, data collection, and analysis, etc.) that bases the solution on at least two research articles on current games and software technologies. The work integrates concepts and ideas with a meaningful structure based on analyzing several examples (beyond the recommended reading) in current game and software technologies.

Grade A, as with B plus: Central facts are summarised in a broader and deeper analysis where comparisons and parallels are made, and own values and reflections are included based on state-of-the-art game and software technologies. The research problem formulation, as well as the collection and analysis of data, can generate new knowledge, which could contribute to further research (gap in current game and software technologies).

4. Results and Discussion

After each course is finished, the university sends out a course evaluation survey to the students within three weeks. The course evaluation survey includes seven core questions with a scale of 1-4, in which 1 means "Not at all" and 4 means "To a great extent." The seven core questions are:

- The structure and design of the course have been supportive of my studies.
- The learning activities of the course have given me the possibility to attain the course objectives.
- The design of the examination elements awarding credits in the course has made it possible for me to demonstrate that I have attained the course objectives.
- During the course, there has been active feedback, which has been valuable to my studies.

- The response from teachers and supervisors has motivated me in my studies.
- The course has promoted dialogue and collaboration in learning.
- I have participated in the activities and discussions that have been offered, and I have taken responsibility for my learning.

Our course received around 3.7 in most years. After the core questions, there is also an open question on the strengths and drawbacks of the course and suggestions for improvements.

Positive reflections: Most students find that every week or every second-week supervision meeting helps them understand their topic and how to apply the proper methods to write the final report. The students think these meetings provide an excellent opportunity to get guidance and feedback from the teachers, motivating them to achieve the learning objectives. Another teaching activity the students appreciated was the additional feedback for the written report. Some students mentioned that the detailed feedback they received, particularly in writing, is precious to improve their academic writing skills for this course and their future thesis. The other positive reflections are the good structure of the lectures and assignments and the intriguing and interactive lectures that help students conceptualize the subject.

Negative reflections: During the beginning years, we added the lecture contexts based on students' suggestions, and then after a while, the students pointed out that some contexts were repeating. We removed the repeating parts and restructured the lectures after receiving this feedback. During the COVID-19 pandemic, we have also tried using a Discord server to conduct our supervision support, not only for the fixed supervision time but also for the students to leave a message anytime. However, it led to some students feeling a lack of serious communication and supervision. We have learned that even for distance teaching, a more focused meeting and a formal meeting platform are necessary. We returned to the pre-booked Zoom meetings the next year, and now face-to-face meetings are used again.

Suggested improvements: The improvements suggested by the students are mainly to provide more precise information on Assignment 1 and improve the information display structure of the learning platform.

The introduced research methodology course has better prepared the students for their upcoming thesis. The research topics selected by the students varied. These topics include GPU/CPU performance improvements and tests, game experience evaluations, XR, applied Artificial intelligence (AI) in games, etc. Some initial student projects have also even reached a scientific publication after their thesis has been conducted. The examples highlighted below started as topics in the research methodology course (or the former present game techniques course with a similar structure for the research-oriented project report) and were developed further in the thesis work to result in scientific conference papers or as a technical book chapter.

In the first example report, one student focused on exploring the topic of capturing expressions with real-time facial motion capture as a theme. This later resulted in a more extensive bachelor's thesis in digital game development, exploring the topic of social interaction with real-time facial motion capture. The outcome of the work was reworked and then published as a conference paper [PS17]. As a second example, a student started to focus on clustered shading, assigning arbitrarily shaped convex light volumes using conservative rasterization, and reworked it into a thesis topic, which later was reworked into an accepted article for GPU Pro 7 [16]. In the third example, one student showed a great interest in the method of conducting user experiments. In his master's thesis, he designed a set of user experiments to compare the user experiences in different menu systems, interaction methods, and postures in VR and reworked it into a conference paper [AH23]. There are even more examples of game engineering student work being able to result in scientific publications, and the presented course has contributed in this regard.

5. Conclusions and Future Work

This paper has presented an existing curriculum for a research methodology course focusing on digital game development programs. The research question posed at the beginning asked how a course on research methodology in a game program curriculum should be structured. Some previous work has focused on using gamification to teach research methodologies. Based on the literature found over the last few years, it has become increasingly important to incorporate traditional concepts of research methodologies in a game curriculum. Many qualitative research methods are more commonly applied in game user research. Aspects of quantitative methods and experiment design and execution are also crucial for game programming students.

As previously mentioned, research methodologies are becoming increasingly important in many aspects of gaming. Hence, such courses' focus should be on novel topic areas targeted with real examples from academic and industrial research and developments. An outcome of this work is that a research methodology course should introduce aspects of both qualitative and quantitative research methods relevant to the game area. We recommend developing a more research-oriented approach and game-focused course material to improve the research methodology course for game students. In this process, incorporating scientific literature to work on state-of-the-art material and staff competence are important aspects of such a course. Future work includes synthesizing the results of the student assignments concerning the existing literature. It is also our belief that the topic of generative AI should be introduced as a part of research methodology courses in the future.

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References

[AC23] ACM/IEEE-CS/AAAI: Computer science curricula 2023 version gamma, the joint task force on computing curricula. https://csed.acm.org/wp-content/uploads/2023/09/Version-Gamma.pdf, 2023. 2

[ACM13] ACM/IEEE: Computer science curricula 2013, curriculum guidelines for undergraduate degree programs in computer

science. https://ieeecs-media.computer.org/assets/pdf/CS2013-final-report.pdf, 2013. 2

[AH23] ANDERSSON J., HU Y.: Exploring the impact of menu systems, interaction methods, and sitting or standing posture on user experience in virtual reality. In *2023 IEEE Games, Entertainment, Media Conference (GEM)* (2023), pp. 1–6. 7

[BHOL07] BERNDTSSON M., HANSSON J., OLSSON B., LUNDELL B.: *Thesis Projects: A Guide for Students in Computer Science and Information Systems*. Springer, 2007. 4

[BHT10] BAXTER L., HUGHES C., TIGHT M.: *How to Research (Open Up Study Skills)*. Open University Press, 2010. 4

[BTK22a] BIGGS J., TANG C., KENNEDY G.: *Ebook: Teaching for Quality Learning at University 5e*. McGraw-hill education (UK), 2022. 4

[BTK22b] BIGGS J., TANG C., KENNEDY G.: *Teaching for Quality Learning at University*. Open University Press, 2022. 3

[Col23] COLLECTION S. C.: Swedish higher education ordinance (1993:100). https://www.riksdagen.se/sv/dokument-och-lagar/dokument/svensk-forfattningssamling/hogskoleforordning-1993100_sfs-1993-100/, 2023. 2

[CW11] CUNNINGHAM D. W., WALLRAVEN C.: *Experimental Design: From User Studies to Psychophysics*. A K Peters/CRC Press, 2011. 4

[DAO20] DE ANGELI D., O'NEILL E.: A review of game research methodologies. In *Proceedings of the 15th International Conference on the Foundations of Digital Games* (New York, NY, USA, 2020), FDG '20, Association for Computing Machinery. doi:10.1145/3402942.3402970. 3

[Daw09] DAWSON C.: *Projects in Computing and Information Systems: A Student's Guide (2nd Edition)*. Pearson Education Canada, 2009. 4

[DMBN18] DRACHEN A., MIRZA-BABAEI P., NACKE L. E.: *Games User Research*. Oxford University Press, 2018. 3

[GHP15] GILBOY M. B., HEINERICHS S., PAZZAGLIA G.: Enhancing student engagement using the flipped classroom. *Journal of nutrition education and behavior 47*, 1 (2015), 109–114. 5

[GN14] GERODETTI N., NIXON D.: Students as producers: Designing games to teach social science research methods and ethics. In *Proceedings of the 8th European Conference on Games Based Learning*, vol. 1. Reading, January 2014, pp. 143 – 150. URL: https://eprints.leedsbeckett.ac.uk/id/eprint/1328/. 2

[Ken16] KENWRIGHT B.: Holistic game development curriculum. In *SIGGRAPH ASIA 2016 Symposium on Education* (2016), pp. 1–5. 2

[LB*15] LANKOSKI P., BJÖRK S., ET AL.: Game research methods: An overview. 3

[LE19] LANKOSKI P., ELADHARI M. P.: Constructive alignment in teaching game research in game development bachelors programme. In *DiGRA 2019 Pre-Conference Workshop (TGPA: DiGRA2019)* (2019). 3

[MC21] MARNEWICK C., CHETTY J.: Mining and crafting a game to teach research methodology. *International Journal of Educational Technology in Higher Education 18*, 1 (Sept. 2021), 62. doi:10.1186/s41239-021-00299-2. 2

[McG12] MCGILL M. M.: The curriculum planning process for undergraduate game degree programs in the united kingdom and united states. *ACM Transactions on Computing Education (TOCE) 12*, 2 (2012), 1–47. 2

[MHJ12] MÄYRÄ F., HOLOPAINEN J., JAKOBSSON M.: Research methodology in gaming: An overview. *Simulation & Gaming 43*, 3 (2012), 295–299. doi:10.1177/1046878112439508. 3

[MT16] MARKLUND B. B., TAYLOR A.-S. A.: Educational games in practice: The challenges involved in conducting a game-based curriculum. *Electronic Journal of e-Learning 14*, 2 (2016), pp122–135. 2

[NDC13] NASR M., DRACHEN A., CANOSSA A.: *Game Analytics: Maximizing the Value of Player Data*. Springer Science & Business Media, 2013. 1

[NMBD19] NACKE L., MIRZA-BABAEI P., DRACHEN A.: User experience (ux) research in games. pp. 1–4. doi:10.1145/3290607.3298826. 3

[PS17] PETTERSSON E., SUNDSTEDT V.: A perceptual evaluation of social interaction with emotes and real-time facial motion capture. In *Proceedings of the 10th International Conference on Motion in Games* (New York, NY, USA, 2017), MIG '17, Association for Computing Machinery. doi:10.1145/3136457.3136461. 7

[PUC20] PHELPS A., UNIVERSITY CONSALVO M.: Teaching students how to make games for research-creation/meaningful impact: (is hard). In *Proceedings of the 15th International Conference on the Foundations of Digital Games* (New York, NY, USA, 2020), FDG '20, Association for Computing Machinery. doi:10.1145/3402942.3402990. 2

[PWA05] POLACK-WAHL J. A., ANEWALT K.: Work in progress - research methods: Teaching students how to learn about learning. vol. 2005. URL: https://www.scopus.com/inward/record.uri?eid=2-s2.0-33947244502&partnerID=40&md5=d20761e711238d1a2507567287fd2bd3. 2

[Ram16] RAMANUJAN R.: A.i. as an introduction to research methods in computer science. *Proceedings of the AAAI Conference on Artificial Intelligence 30*, 1 (Mar. 2016). doi:10.1609/aaai.v30i1.9866. 3

[SDA*18] SANTOS B. S., DISCHLER J., ADZHIEV V., ANDERSON E., FERKO A., FRYAZINOV O., ILČÍK M., ILČÍKOVÁ I., SLAVIK P., SUNDSTEDT V., SVOBODOVA L., WIMMER M., ZARA J.: Distinctive Approaches to Computer Graphics Education. *Computer Graphics Forum* (2018). doi:10.1111/cgf.13305. 5

[SFSG*20] SILLAOTS M., FIADOTAU M., SÖTHE-GARNIER R., UPSHALL D. R., CALLAGHAN P., NORAK K., ELSHENAWY A. M. S. A., EMIROĞLU O. S., GORSHKOVA E., SELINA I., HÖ A., ALAWODE O. A.: Methodyca: A digital game to teach research methods. In *Proceedings of the 11th Nordic Conference on Human-Computer Interaction: Shaping Experiences, Shaping Society* (New York, NY, USA, 2020), NordiCHI '20, Association for Computing Machinery. doi:10.1145/3419249.3420062. 2

[Sil14a] SILLAOTS M.: Achieving flow through gamification: A study on re-designing research methods courses. vol. 2, pp. 538–545. URL: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84923532199&partnerID=40&md5=d427b286a08394760ddd9c5c7de7fb94. 2

[Sil14b] SILLAOTS M.: Gamification of higher education by the example of course of research methods. In *Advances in Web-Based Learning–ICWL 2014: 13th International Conference, Tallinn, Estonia, August 14-17, 2014. Proceedings 13* (2014), Springer, pp. 106–115. 2

[Sun10] SUNDSTEDT V.: Gazing at games: Using eye tracking to control virtual characters. In *ACM SIGGRAPH 2010 Courses* (New York, NY, USA, 2010), SIGGRAPH '10, ACM, pp. 5:1–5:160. doi:10.1145/1837101.1837106. 5

[VdZA19] VAN DER ZWAN N., AFONSO A.: Activating the research methods curriculum: A blended flipped classroom. *PS: Political Science & Politics 52*, 4 (2019), 749–753. 5

[Zob14] ZOBEL J.: *Writing for Computer Science*. Springer, 2014. 4

[16] ÖRTEGREN K., PERSSON E.: Clustered shading: Assigning lights using conservative rasterization in directx 12. In *GPU Pro 7: Advanced Rendering Techniques*, Engel W., (Ed.). A K Peters/CRC Press, 2016, pp. 43–68. 7