Approaches to Nurturing Undergraduate Research in the Creative Industries – a UK Multi-Institutional Exploration

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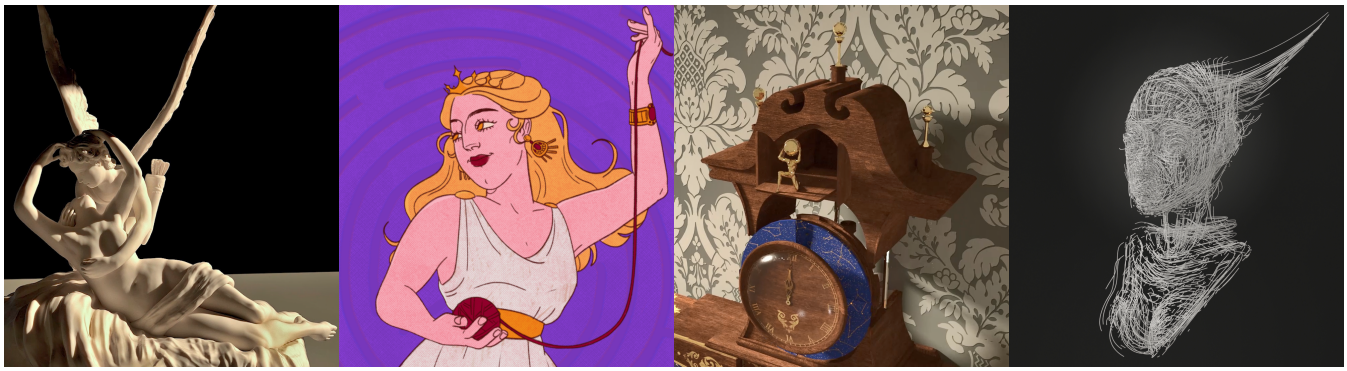

Figure 1: *Screenshots of student projects (from left to right): First, a frame of the animated sculpture "Reimagining Antonio Canova's sculpture 'Psyche revived by Cupid's Kiss'" by Nia Christova (NCCA), secondly a character design "Ariadni" by Alexis Bratu (University of Greenwich), then, a frame from the animation project "Assembling fantasy-realism assets for virtual productions" by Maya Pourpoutidi (NCCA), and finally, one of a set of designs from the project "Exploration of 3D sculptures and traditional fine arts to create an innovative CG illustration" by Stefano Feltre (NCCA)*

Abstract

Undergraduate students aspiring to pursue careers in the creative industries, such as animation, video games, and computer art, require the ability to adapt and contribute to emerging and disruptive technologies. The cultivation of research skills fosters this adaptability and innovation, which is why research skills are considered important by employers. Promoting undergraduate research in computer graphics and related techniques is therefore necessary to ensure that students graduate not only with the vocational but also with the advanced research skills desired by the creative industries.

This paper describes pedagogical approaches to nurturing undergraduate research across teaching, learning and through extracurricular activities – pioneered at three UK Higher Education Institutions. Providing observations, we are sharing educational strategies – reflecting on pedagogic experiences of supporting undergraduate research projects, many of which are practice-based. With this paper, we aim to contribute to a wider discussion around challenges and opportunities of student-led research.

1. Introduction

The creative industries, which among others encompass film, television, animation, visual effects, and video games [Dis24], make extensive use of computer graphics and related techniques. Students who aspire to work in the creative industries need to be able to navigate a permanently innovative and constantly changing environment, where R&D skills are highly sought after [LH11] and needed to help drive adoption and innovation in an evolving industry. However, traditional university curricula often lack up-to-date content and methodologies. Here, undergraduate (UG)

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research typically focuses on knowledge and subject skills development, with high-level research often playing a subordinate, peripheral role. Course revalidation and deployment are measured in timescales of years, leaving little opportunity for adapting to emerging trends. This can lead to a gap between R&D skills provided by UG courses and those demanded by the creative industries.

In this paper, we present the experiences gathered at several UK higher education institutions, where we have pioneered a number of successful strategies for engaging undergraduates in research activities. In section 2 we provide an overview of UG research and related issues, followed by section 3, where we explore different approaches that we have followed at our institutions, discussing our experiences of undergraduate research. In section 4 we present results, highlighting commonalities and differences between our experiences - followed by conclusions and an outlook on future endeavours in section 5.

2. Undergraduate Research in Computer Graphics and Related Disciplines

In many UG programmes, research is relegated to so-called capstone projects, which is by far the most common form in which undergraduate research is encountered. In some cases, these can even include projects conducted across more than one department or institution [KWE*23]. Much less common is UG research as promoted by the "Council on Undergraduate Research" (CUR), which defines undergraduate research as "A mentored investigation or creative inquiry conducted by undergraduates that seeks to make a scholarly or artistic contribution to knowledge" [CUR24]. The facilitation and support of research at undergraduate level is a much-debated topic, involving questions as to how to best integrate higher-level research skills into taught programmes. While background research and literature on UG research across various computing domains exists, there is a gap in publications on undergraduate research in the case of computer graphics and the creative industries. While there clearly is a need for more systematic undergraduate research, which due to the nature of the creative industries would ideally follow an interdisciplinary approach [Joe16], there are few publications that could guide educators towards the establishment of (non-capstone) UG research courses or similar initiatives.

Among such initiatives are summer schools, such as the NSF (U.S. National Science Foundation) - a funded multi-disciplinary summer research experience for undergraduates on "Undergraduate Research in Collaborative Data Visualization Applications" that hosted 32 undergraduate students between 2014 and 2018 [U.S14], which was reported on by Byrd and Vieira [BV17]. This initiative introduced undergraduate students from different academic disciplines to data visualisation and guided them during their participation in research projects with various data visualisation needs. In the computer graphics domain, there is the Central European Seminar on Computer Graphics [IIFW16], a conference-like annual undergraduate seminar organised by an international co-operative of computer graphics and vision groups, which has been running since 1996.

More common are extracurricular or one-off UG research projects, such as the multidisciplinary development of an AR training application for the U.S. military [SDZ*19], the integration of undergraduate students in an applied research project involving Geographic Information Systems (funded through a regular research council grant) [KCSZ17] or the extracurricular video game research projects [HE17], facilitated by George Mason University's "Office of Student Scholarship" (`https://oscar.gmu.edu`). Another extracurricular approach was taken by the creators of the game "Life on the Edge" [SSA*20], who developed the game as part of a practice-based research project, engaging 14 undergraduate students from four different disciplines as paid research assistants over a period of three years. While these examples focus on undergraduate research of topics that are related to the creative industries, the setting in which they have taken place is primarily concerned with the facilitation of UG research in general, and notably independent of the discipline in which the research is taking place.

A successful example of the formal integration of a non-capstone research project course into an undergraduate degree programme is the course described by Anderson et al. [AAF16]. Here, they implemented a collaborative research project course within a software development context for a computer graphics and animation programme. This paired researchers with one or two UG students to solve current research problems. Subsequently, Anderson et al. [ACA19] applied a similar approach to several undergraduate programmes, including programmes with a computer animation and computer art & design focus instead of a more traditional computing focus.

An important yet frequently overlooked aspect relates to the infrastructure for undergraduate research, independent of the discipline in which it takes place. Such infrastructure can create significant barriers to the facilitation of UG research projects. This includes the availability of funding [PMRR08, MBM*18], which may originate from either institutional or external funding bodies, is typically extracurricular and often limited to specific disciplines, such as environmental research [NER23]. A lack of institutional recognition and support [MBM*18, SNG*22] provides fewer incentives for staff to participate, and funding constraints can also impact access to publication outlets.

3. Approaches to fostering Undergraduate Research Activities

The facilitation of undergraduate research requires involved faculty/staff to understand and be able to overcome misaligned student expectations and misconceptions about the nature of research, such as the necessity of experimentation, exploration, and independent work. Undergraduate students can be intimidated by the uncertainty of results that are inherent in research projects. The lack of existing "out of the box" solutions to rely on takes students oftentimes outside their comfort zone [SIG19], requiring them to step beyond the taught curriculum and discover their own solutions. The following examples show different approaches explored with positive results (Fig. 1) across three UK universities.

3.1. Undergraduate Research at the National Centre for Computer Animation, Bournemouth University

For more than 2½ decades, the National Centre for Computer Animation (NCCA) has run a dedicated research course/module in its undergraduate programmes [CMA10]. This embraces practice-based multidisciplinary research, combining science and art, in which students propose and embark on a computer-graphics-related project according to their personal interests, such as image generation using generative AI, or producing work that reaches beyond taught curricula. The current version of the course is the "Research & Development project", which runs for one semester of the final (3rd) year of the NCCA's UG degree programmes.

3.1.1. A Final Year UG Research Course

In the current structure, students are expected to have met the following Intended Learning Outcomes after successfully passing the course:

- to have undertaken research of a chosen type (academic, practice-based, production-based), using a recognised methodology;
- to demonstrate an awareness of the 'state-of-the-art' of the chosen research area and an ability to translate this into the development of innovative solutions;
- to have developed an artefact of a type relevant to the project and to have planned, managed, and delivered a project to a set brief (a project proposal that the students have to develop themselves) within a given timescale;
- to have written and presented a research paper or a critical report, contextualising and analysing their project;
- to have devised a 'poster' that effectively communicates the outcome of their project and to demonstrate presentation skills during a special 'poster session' for the project.

After an introductory lecture that outlines the structure and content of the course, students, aided by tutors that have been randomly assigned, have about a month to develop their ideas and then formulate proposals for their R&D projects. During this first month, students attend several lectures, which provide an introduction to relevant academic research and industrial innovations, with emphasis on well-established methodologies that are relevant for the creative industries. The basics of project management are also outlined. Students are then split into smaller groups to also attend the seminar "Research and Innovation in Creative Industries", where each group attends a seminar run by different members of the faculty to discuss concrete examples of current as well as historical research and innovation in the context of the creative industries.

A second lecture about research ethics, delivered by a specialist guest lecturer, outlines current issues and practical procedures that any researcher must follow. An additional lecture by a specialist subject librarian introduces the students to modern tools and techniques for searching relevant sources of different types, be they academic publications, articles in professional outlets or blogs, or visual materials. This lecture is furthermore supported by "library workshops" where students can practice their source-searching skills under the librarian's guidance.

Finally, a special two-hour session is devoted to presentations by members of the faculty who present their own research projects. Students also have access to a selection of student R&D projects from previous cohorts. All of this helps students to develop their own proposals, which are then formally submitted, after which individual supervisors/tutors whose expertise most closely matches particular projects are assigned to the students.

Students then have about two months to work on their projects, accompanied by weekly tutorials with supervisors. Closer to the submission deadline, two additional lectures on "How to write a report in the form of a research paper" and on "How to devise a poster and present it" are given.

At the end of the course, students submit a research report as well as an artefact (e.g. a short animation, a game prototype, a VR artefact, etc.) that they will have developed to prove that their approach works. Finally, the submission of the coursework is followed by a number of public presentation sessions: there, each student presents their poster in front of a panel of faculty members, as well as their fellow students.

3.1.2. Observations and Results

Our approach encourages students to undertake research on a chosen topic, where their research is translated into the development of innovative solutions and an artefact as an innovative piece. We allow students free creativity in exploring a challenging topic without the constraint of failure, where they can be more experimental than in other courses. One of the most important aspects of this approach is that things are allowed to go wrong, as long as the students can explain their results. In terms of assessment, the "journey" is more important than the "destination". As a result, the rate of failure in this course is very low – failure being defined as a grade of less than 40% – and usually due to technicalities, such as late and/or incomplete submissions; over the 2021/2022 and 2022/2023 academic years, only four of the 152 students taking the course failed. During the same two-year period, fifteen (9.8%) of the students achieved grades of 80% or higher, which we usually consider to be an indication that a student's project may be suitable for submission to an international conference.

Over the years, at the NCCA this has resulted in many co-created publications [ACA19]. Over the last decade alone, 22 posters and papers internationally, not counting presentations at the British Conference of Undergraduate Research (BCUR). This has included high-impact international journals, such as IEEE Computer Graphics & Applications, or presented at prestigious international conferences like ACM SIGGRAPH or Eurographics. Our students have participated in and won awards at international competitions such as the ACM SIGGRAPH Student Research Competition. UG research projects with artistic outputs have also been exhibited nationally (e.g. at 'Art in Flux: Access All Areas, British Computer Society' London, 2022 [AGS22]).

Frequently, students are supported directly by staff through co-authorship. Primarily student-led, co-authorship ensures a degree of familiarisation with research processes including systematic and comprehensive background research, the explicit application of established research methodologies, academic rigor, a structured approach to academic writing and critical reflection. These collabo-

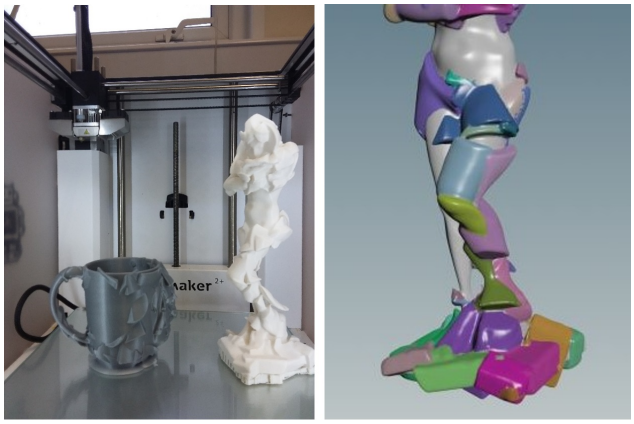

Figure 2: *Experimental results of the 4D Cubism project by Quentin Corker-Marin.*

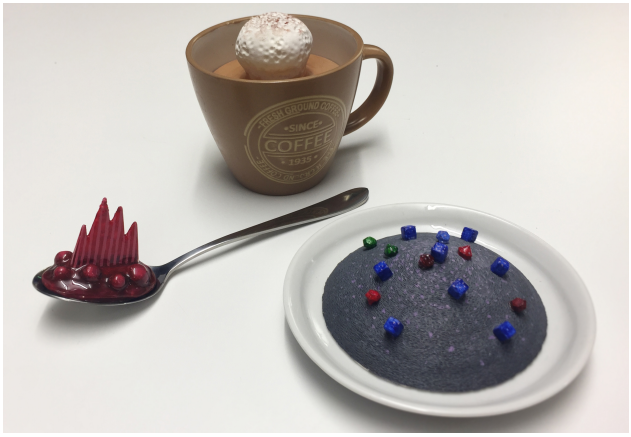

Figure 4: *Synesthetic sculptures (acrylic and varnish on 3D-printed PLA) from the project "Feast for the Eyes" by Meijia Wu.*

rations encourage a skills transfer, supported learning, and often result in public-facing presentations of students' research outputs.

Our experience shows that this can be a highly rewarding experience for both staff and students, with resulting research outputs (artefacts and publications) adding considerable value to a graduate's CV and employability. Another side effect is the development of the student's confidence in their own abilities. Several of the NCCA's graduates have directly entered R&D positions in the creative industries, where their work, helped by skills developed in their UG research projects, has resulted in films' visual effects, publications, and even a Technical Achievement Award from the Academy of Motion Picture Arts and Sciences.

3.1.3. Successful Student Projects

The range of types of research projects that the students undertake in this course, can be seen in the following set of examples:

- Quentin Corker-Marin's project dealt with an original approach to creating and producing artistic shapes in a cubist style (Fig. 2). For this, he proposed mathematical models and algorithms for adding cubist features to (or *cubification* of) time-variant sculptural shapes as well as a practical technological pipeline embracing all the main phases of their production, implemented with artist-friendly user interfaces. A new concept of a 4D cubist camera was introduced for multiple projections from 4D space-time to 3D space, allowing for a combination of these by using space-time blending to create animated sculptures. 3D printing for stop-motion animation was considered as one of the final pipeline processing stages. Presented at SIGGRAPH [CMAP17], the work was awarded the 2nd place at the ACM Student Research Competition and a full-scale paper was subsequently published in IEEE Computer Graphics and Applications [CMPA18]. The project was also exhibited in 2021 as part of the "Once Upon a Time in Animation" (OUaTiA) exhibition at Poole Museum, UK.

Figure 3: *Fruit decay simulation by Bianca Cirdei. Top left: photograph of a real apple; Top right: CG model of the apple; Bottom left: partially rotten apple; Bottom right: rotten and shrunk apple.*

- Some students focus their research on topics related to simulation and visual effects, such as the project "Decay and Fungus Growth on Vegetable Matter" (Fig. 3), which extended existing approaches to simulate decaying fruits. This work was submitted to the ACM SIGGRAPH Student Research Competition, where it was awarded the 1st place in the undergraduate category [CA18]. The student also contributed to a publication discussing the development of the project within the UG research course [ACA19]. The project was also exhibited at the OUaTiA exhibition.

- The project "Feast for the Eyes" by Meijia Wu (Fig. 4), aimed to shed light on the perceptual experiences of people diagnosed with flavour-to-vision synesthesia. Those diagnosed with this form of cross-sensory condition perceive abstract shapes, colours, or textures whilst tasting the flavours of food and drinks. For this, the research team developed an original method in 3D design, resulting in several 3D printed artefacts that resulted from collaborative co-design derived from synesthetes' sketches and artistic interpretation. By exploring 3D sculpting

Figure 5: *Four frames of animation, showing a 3D kinetic sculpture reimagining Francis Bacon's "Study for Portrait (Michel Leiris)" by Ellen Conlan Ellis.*

techniques and treatments of printed materials, the research team produced a set of three physical artefacts to represent synesthetic perception. The results of this UG research were published at ACM SIGGRAPH as a poster [WG20], and the artefacts were exhibited as part of the OUaTiA exhibition.

- Ellen Conlan Ellis's R&D project titled "Interaction and feasibility of the traditional 2D stroke in the 3D scape" was concerned with developing techniques for re-imagining a 2D painted still portrait as an animated 3D sculpture. Whilst preserving the distinctive fine art style features of the initial painting, the resulting artefact was designed to possess an original quality in its own right. This was achieved by primarily exploring both artistic and technological aspects of a production pipeline using modern 'off-the shelf' software tools, adding some effects that the tools lacked. The case study to prove the concept is based on Francis Bacon's "Study for Portrait (Michel Leiris)". The final artefact (Fig. 5) has a definite painted quality, as well as a distinctive unsettling emotional impact. The project was published as a short paper in the EUROGRAPHICS Workshop on Graphics and Cultural Heritage [CA21]. The project was also exhibited at the hybrid Media Art Exhibition "Art in Flux: Access all Areas" in London in 2022.

These are just some examples for the types of research projects conducted by undergraduate students at the NCCA, illustrating the breadth of different research topics and directions facilitated by the NCCA's undergraduate research course.

3.2. MOVEMENT by the University of Greenwich and the University of the Arts London

The University of Greenwich's (UoG) Office of Undergraduate Research, which forms part of the Institute for Communities and Environment (ICE), offers small seed funding grants to undergraduate research projects in disciplines including graphic design, animation, or architecture. This concerted, systematic approach to support student-focused research has yielded tangible results. Last year the Office for Undergraduate Research supported the MOVEMENT Summer Festival (Fig. 6) with a small pedagogic research grant.

3.2.1. Skills Workshops at MOVEMENT

This seed funding helped to support a series of skills workshops that focused on students' transferable skills across software (Nuke, Houdini, Toon Boom), analogue practices (charcoal drawing, storyboarding, dynamic poses – Fig. 7), and innovative practices (AI in 2D and 3D animation, AI & Motion Capture). These skills workshops were primarily process-focused, and not so much interested in outputs, as in the application of new skills. The skills workshops were research-centred and employability-oriented, communicating software-independent experimental skills: the declared objective consisted in improving students' employability prospects, by centring around transferable skills and innovation. In this vein, for instance, practitioner Constantine X was sharing their artistic practice in AI as a creative technique for ideation and environment building.

Importantly, students were given a forum for collaboration, and their own technical research into animation methods - whether arcane or advanced, resulting in short animations of experimental nature. The students learned from the guest speakers and workshop facilitators of the conference, new and innovative methods of creative practices. The workshops involved practice-based research through experimental animation using various techniques as a mode of interrogation. Research questions varied, but included questions on creative agency in innovation: "What is the role of artificial intelligence in experimental animation?" Applying innovative research methods, the students further explored the possibilities of experimental practices and technologies through making. By observing, comparing the processes and the results, and reflecting on their experiments, the students gained a better understanding of both practice-based and practice-led research. The activity culminated in a collaborative, public-facing screening at Greenwich Picturehouse, where students were able to share their research into animation practices with a wider public.

As a collaboration between University of the Arts London and the University of Greenwich, MOVEMENT is now an annual festival that sees a variety of activities including workshops, networking, screenings, and a public conference on career trajectories within the Creative Industries.

3.2.2. MOVEMENT: History, Aims and Objectives

Founded in 2018, the MOVEMENT Conference has seen over a dozen keynote speakers from diverse sectors of the Creative Industries including Games, Visual Effects, Animation, Product Design, Graphic Design, Character Design and many others.

The aims of the MOVEMENT conference are to provide a forum for knowledge exchange on experimental innovative creative practices, to build networks with industry professionals, and to encourage students to actively prepare for a career within the creative industries. Furthermore, MOVEMENT has become an annual *jour fixe* to provide up-to-date knowledge about techniques and technologies used in the creative industries, inspiring action around climate & social justice, EDI (Equality, Diversity, and Inclusion), and other pressing themes.

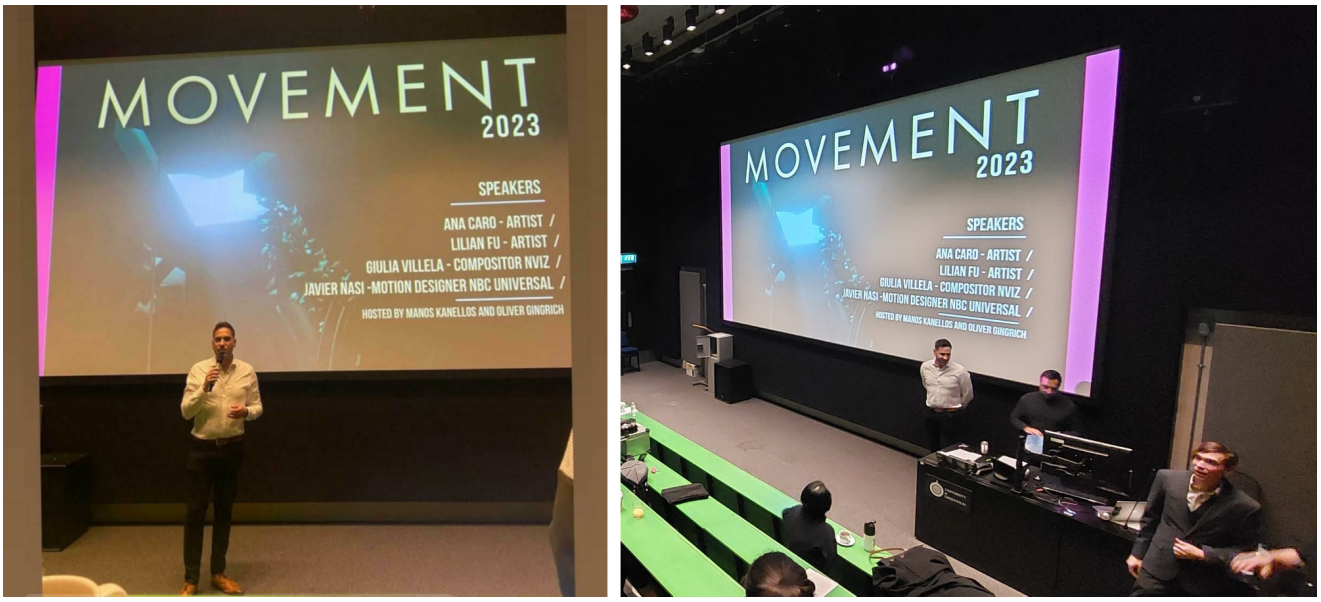

Figure 6: *Photos from the MOVEMENT conference 2023.*

4. Discussion

As already mentioned in section 2, there exist barriers to UG research, not least in disciplines related to the rapidly evolving creative industries, where inflexible UG curricula (e.g. in the UK, curricula are usually reviewed on a 5-year cycle) frequently do not produce graduates with the skill sets needed by such industries.

Getting undergraduate students to engage in actual research does not happen without obstacles. For formally assessed work, the uncertainty of the end results and the prospect of potential failure can be disconcerting for students, reducing their willingness to experiment. Structuring this assessment in a manner that allows some form of failure without impacting the grade can ameliorate this. In the NCCA's approach (Section 3.1), this is addressed by the staff-student collaborative nature of the projects. Here, the student's choice of research subject without constraint or fear of failure provides an engaging student experience. This caters for the educational needs of these UG students who specialise in subjects tailored to the creative industries – in these projects, specifically, predominantly involving computer animation, visual effects, and video games. Another important factor for the UG students' research project success is the support and guidance provided by the students' tutors/mentors, who need to be encouraging and keep in mind that undergraduate students will need help when it comes to formulating their research questions and framing their projects. In our experience, for many UG students, among the greatest difficulties stems from the open-ended nature of research, such as deciding when a suitable goal has been achieved and "enough" has been done, which – again – can be addressed through guidance provided by the students' tutors/mentors.

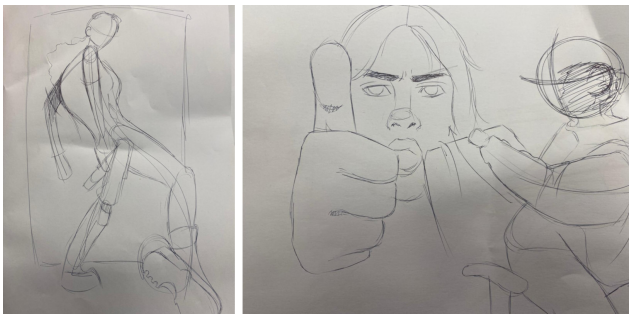

Figure 7: *Analogue practices developed by students in the course of skills workshops at the MOVEMENT Summer Festival.*

Most UG students lack academic writing practice [AAF16], and the write-up of their research projects – either in the form of a report or a paper for submission to an academic conference – can be intimidating for students. This is another case where it is important for the students' tutors/mentors to take the time to discuss the writing process with their students and to provide them with guidance and support. The same is frequently also required for the preparation of presentation materials (posters or slides).

A motivating factor that we have observed among some students is the possible opportunity for public presentation of their work, which, as noted by Romero et al. [RTP*14], provides a means for improving a student's professional portfolio and – by extension – their curriculum vitae. The same can be said for the opportunity to have the students' work published, which can be facilitated by inviting student submissions to dedicated conferences, such as the aforementioned BCUR (British Conference of Undergraduate Research), the International Conference of Undergraduate Research [Mon24] (ICUR, which, despite its name, is only open to students from participating institutions) or the MOVEMENT conference de-

scribed above (Section 3.2), which provides one of the main vehicles for supporting applied and practice-based undergraduate research by the University of Greenwich and the London College of Communication of the University of the Arts London. Of course, apart from bespoke events, such as the MOVEMENT conference, or presentation venues for UG research, such as BCUR, undergraduate research can also be submitted to any other academic conference. These sometimes include tracks that specifically cater to undergraduate research, such as the ACM SIGGRAPH Student Research Competition. However, participation in regular international conferences tends to incur significant costs, particularly in terms of travel and accommodation, and the lack of funding for UG research can restrict the access of students to such venues.

5. Conclusions and Future Work

In this paper we have described pedagogical approaches pioneered at three UK Higher Education Institutions for encouraging undergraduate students to engage in high level research in disciplines related to the creative industries. The two approaches presented and discussed both motivate UG students to conduct research and provide support to the students, but follow different strategies. The first approach, presented in Section 3.1, has created a bespoke non-capstone-project course that is embedded in the final year of UG programmes (here, students are encouraged to freely experiment by removing the fear of failure by emphasising the research process in the assessment). This course is well established and has resulted in many projects being submitted and presented at international academic conferences. The second approach, presented in Section 3.2, is a collaboration between two Higher Education Institutions, who have established an annual conference/festival as a vehicle for UG students to engage in practice-based research.

In addition to highlighting successful elements of our pedagogical strategies, we have shared and discussed some observations, with the aim to contribute to a wider discussion around the challenges and opportunities of undergraduate research.

For future work, we hope to synthesise from our experiences a specialised "toolkit" as a user-friendly step-by-step booklet/documentation, covering: learning objectives outcomes, course design and syllabus, assessment criteria, reading/resources list, teaching material guidance, and sample projects to aid other educators in establishing successful UG research courses and/or initiatives.

6. Acknowledgements

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References

[AAF16] ANDERSON E. F., ADZHIEV V., FRYAZINOV O.: Aiming High: Undergraduate Research Projects in Computer Graphics and Animation. In *EG 2016 - Education Papers* (2016), Santos B. S., Dischler J.-M., (Eds.), pp. 17–24. doi:10.2312/eged.20161021. 2, 6

[ACA19] ANDERSON E. F., CIRDEI B., ADZHIEV V.: Vegetable Matter Decay: An Exceptional Student 'Innovations' Project. In *Eurographics 2019 - Education Papers* (2019), Tarini M., Galin E., (Eds.), pp. 61–62. doi:10.2312/eged.20191030. 2, 3, 4

[AGS22] ALMENA M., GINGRICH O., SHEMZA A.: Art in Flux: Access All Areas. Hybrid Media Art Exhibition, 2022. URL: https://www.artinfluxlondon.com/access-all-areas.html. 3

[BV17] BYRD V. L., VIEIRA C.: Visualization: A conduit for collaborative undergraduate research experiences. In *2017 ASEE Annual Conference & Exposition* (2017). doi:10.18260/1-2--29108. 2

[CA18] CIRDEI B., ANDERSON E. F.: Withering fruits: vegetable matter decay and fungus growth. In *ACM SIGGRAPH 2018 Posters* (2018), SIGGRAPH '18. doi:10.1145/3230744.3230783. 4

[CA21] CONLAN ELLIS E., ADZHIEV V.: Reimagining a 2D Painted Portrait as a Kinetic 3D Sculpture. In *Eurographics Workshop on Graphics and Cultural Heritage* (2021), Hulusic V., Chalmers A., (Eds.), pp. 79–82. doi:10.2312/gch.20211409. 5

[CMA10] COMNINOS P., MCLOUGHLIN L., ANDERSON E. F.: Educating technophile artists and artophile technologists: A successful experiment in higher education. *Computers & Graphics 34*, 6 (2010), 780–790. doi:10.1016/j.cag.2010.08.008. 3

[CMAP17] CORKER-MARIN Q., ADZHIEV V., PASKO A.: Space-time cubification of artistic shapes. In *ACM SIGGRAPH 2017 Posters* (2017), SIGGRAPH '17. doi:10.1145/3102163.3102214. 4

[CMPA18] CORKER-MARIN Q., PASKO A., ADZHIEV V.: 4d cubism: Modeling, animation, and fabrication of artistic shapes. *IEEE Computer Graphics and Applications 38*, 3 (2018), 131–139. doi:10.1109/MCG.2018.032421660. 4

[CUR24] CUR – COUNCIL ON UNDERGRADUATE RESEARCH: What Is CUR's Definition of Undergraduate Research?, 2024. URL: https://www.cur.org/about/what-is-undergraduate-research/. 2

[Dis24] DISCOVER! CREATIVE CAREERS: What are the creative industries? HM Government, 2024. URL: https://discovercreative.careers/students-and-parents/what-are-the-creative-industries/. 1

[HE17] HUDSON S., EYMAN D.: Anyone can play: Forming undergraduate interdisciplinary research around video games. *Council on Undergraduate Research Quarterly 37*, 4 (2017), 41. URL: https://link.gale.com/apps/doc/A504564028/AONE?xid=ed997467. 2

[IIFW16] ILČÍK M., ILČÍKOVÁ I., FERKO A., WIMMER M.: 20 Years of the Central European Seminar on Computer Graphics. In *EG 2016 - Education Papers* (2016), Santos B. S., Dischler J.-M., (Eds.), The Eurographics Association. doi:10.2312/eged.20161022. 2

[Joe16] JOEL W. J.: The need for interdisciplinary undergraduate research. In *ACM SIGGRAPH 2016 Posters* (2016), SIGGRAPH '16. doi:10.1145/2945078.2945137. 2

[KCSZ17] KHMELEVSKY Y., CHIDLOW K., SUGIHARA K., ZHANG K.: Engaging and motivating students through programming competitions and gis applied research projects. In *Proceedings of the 22nd Western Canadian Conference on Computing Education* (2017), WCCCE '17. doi:10.1145/3085585.3088491. 2

[KWE*23] KHMELEVSKY Y., WONG A., EBADIFARD N., ZHANG F., BHANGU G., HAINS G.: Pan-institutional applied research within undergraduate and post-degree diploma teaching programs. In *Proceedings of the 25th Western Canadian Conference on Computing Education* (2023), WCCCE '23. doi:10.1145/3593342.3593353. 2

[LH11] LIVINGSTONE I., HOPE A.: Next Gen: Transforming the UK into the World's Leading Talent Hub for the Video Games and Visual Effects Industries. Report produced for the National Endowment for Science, Technology and the Arts, 2011. URL: https://media.nesta.org.uk/documents/next_gen_wv.pdf. 1

[MBM*18] MORRISON J. A., BERNER N. J., MANSKE J. M., JONES R. M., DAVIS S. N., GARNER P. W.: Surveying faculty perspectives on undergraduate research, scholarship, and creative activity: A three-institution study. *Scholarship and Practice of Undergraduate Research 2*, 1 (2018), 43–54. doi:10.18833/spur/2/1/1. 2

[Mon24] MONASH UNIVERSITY: The International Conference of Undergraduate Research, 2024. URL: https://www.icurportal.com/. 6

[NER23] NERC – NATURAL ENVIRONMENT RESEARCH COUNCIL: Funding for NERC studentships. UK Research and Innovation, 2023. URL: https://www.ukri.org/what-we-do/developing-people-and-skills/nerc/nerc-studentships/funding-for-nerc-studentships/undergraduate-research-experience-placements-reps/. 2

[PMRR08] PECKHAM J., MILI F., RAICU D. S., RUSSELL I.: REUs: Undergraduate Research Experiences and Funding. *J. Comput. Sci. Coll. 23*, 5 (2008), 208–211. URL: https://dl.acm.org/doi/abs/10.5555/1352627.1352660. 2

[RTP*14] ROMERO M., THURESSON B., PETERS C., KIS F., COPPARD J., ANDRÉE J., LANDAZURI N.: Augmenting pbl with large public presentations: a case study in interactive graphics pedagogy. In *Proceedings of the 2014 Conference on Innovation & Technology in Computer Science Education* (2014), ITiCSE '14, p. 15–20. doi:10.1145/2591708.2591727. 6

[SDZ*19] SHEN Y., DEAN A. W., ZHANG X., LANDAETA R. E., MERINO E., KREGER J. C. A.: Work in progress: A multidisciplinary approach for undergraduate research in augmented reality systems. In *2019 ASEE Annual Conference & Exposition* (2019). doi:10.18260/1-2--33584. 2

[SIG19] SIGGRAPH CONFERENCES: Beyond the Comfort Zone, a Research Journey. ACM SIGGRAPH blog, 2019. URL: https://blog.siggraph.org/2019/03/beyond-the-comfort-zone-a-research-journey. 2

[SNG*22] SHARMA R., NAIR A., GUO A., PALEA D., LEE D. T.: "it's usually not worth the effort unless you get really lucky": Barriers to undergraduate research experiences from the perspective of computing faculty. In *Proceedings of the 2022 ACM Conference on International Computing Education Research - Volume 1* (2022), ICER '22, pp. 149–163. doi:10.1145/3501385.3543976. 2

[SSA*20] SPERANO I., SHAW R., ANDRUCHOW R., COBZAS D., EFIRD C., BROOKWELL B., DENG W.: Creative, interdisciplinary undergraduate research: An educational cell biology video game designed by students for students. *Scholarship and Practice of Undergraduate Research 4*, 2 (2020), 5–14. doi:10.18833/spur/4/2/7. 2

[U.S14] U.S. NATIONAL SCIENCE FOUNDATION: REU Site: Undergraduate Research in Collaborative Data Visualization Applications. NSF Award Abstract #1359223, 2014. URL: https://www.nsf.gov/awardsearch/showAward?AWD_ID=1359223. 2

[WG20] WU M., GINGRICH O. M.: A feast for the eyes: Representing synesthesia through 3d printed artefacts. In *ACM SIGGRAPH 2020 Posters* (2020), SIGGRAPH '20. doi:10.1145/3388770.3407429. 5