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ABSTRACT

HCI (Human-Computer Interaction) education is often referred to as a 'living curriculum', reflecting the multidisciplinary nature of the field and the dynamics of many of its components, including interactive technology. Several educators have adopted (and adapted) a design studio approach to HCI courses, especially in MSc and design-oriented postgraduate programs. In this paper, we present an HCI design studio course offered at a department of design engineering in the University of the Aegean, Greece. The approach adopted in the course blends (a) design studio activities: design brief, desk crit, design reviews, portfolio; (b) core HCI and interaction design methods: contextual inquiry, field visits, concept design, wireframes, usability testing, etc. (c) pedagogical principles of problem-based learning (PBL): authentic context, ill-defined problem, work in groups, self-directed learning. We reflect on lessons learnt in a four-year retrospective, on the quality of the use of methods and outcomes, timing and sequencing of activities and intermediate and final assessments. We envisage that this case study provides interesting insights and information to other undergraduate or postgraduate HCI studio courses.

CCS CONCEPTS

• Human-centered computing • Human computer interaction (HCI) • Interaction design

KEYWORDS

HCI studio; design methods; pedagogical principles; lessons learnt.

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1 Introduction and related work

1.1 HCI teaching: some challenges

HCI teaching presents particular challenges for educators, which have been identified from the early days of the field [1][2] and they are still being discussed in academic literature [3][4][5].

In an attempt to realize these challenges, one has to consider that HCI is a multidisciplinary scientific field, synthesizing theories, methods and tools (mainly) from the fields of computer science, psychology and design. Currently, there are dozens of textbooks in HCI as well as in neighboring fields or subfields (e.g. interaction design, participatory research, usability), while there is a growing number of postgraduate and undergraduate HCI course programs. Therefore an HCI educator must make a purposeful selection from a very wide pool of topics, according to the objectives and context of the course. This is not an easy decision, given the fact that HCI courses are offered in various academic levels and curricula.

Additionally, HCI is a highly dynamic field in both theory and practice. In theory, there is a large and growing corpus of design and evaluation methods of interactive systems mainly drawing on design thinking, software engineering and empirical testing. In addition, we are constantly witnessing an evolution of the meaning and content of core HCI concepts like user experience, usability, accessibility, flow, engagement, presence, etc. Furthermore, the technology component of an HCI course is also highly dynamic due to the rapid evolution of natural user interface technologies, which creates the need for educators to update laboratory exercises and related educational content regularly. Finally yet importantly, the penetration of computing technology to all aspects of our everyday life has led to new HCI applications, moving from the desktop, to the public space and from personal to social computing; this trend has also been described in retrospect as 'waves of HCI' [6] and students must be acquainted (at least) with it in practical terms.

1.2 The design studio pedagogy for HCI courses

Several HCI educators have adopted (and adapted) a design studio pedagogy to HCI teaching, which promotes active learning, project work in an authentic context, student practice and tutor oversight. The design studio includes a unique set of concepts and processes like [7] the design brief, the desk crit, the design review (or jury), the portfolio and presentation to the client(s). The design brief is a

short and coherent description of the design project or problem and signifies the beginning of the design process [8]. The 'desk crit' [9] refers to the tutor-student interaction at the time of student design work (literally over the student's desk). The tutor performs the design review (or jury) during a presentation of the student's work [10]. The portfolio is an illustrative collection of design projects in a form that can be readily communicated to interested parties. The presentation to the client(s), who is visiting or external to the course, is often the last phase of a studio course.

One obvious feature of the studio pedagogy is that it is practice-based, i.e. students have to develop a design project in an authentic context that is close to what the students will meet in their professional lives. For example, the problem definition may be ambiguous and students may need to exercise active, self-directed learning to learn more about the problem space; an external client may be participating to the course by providing requirements and intermediate or final assessments; and so on. Practice is essentially reflective [9]: it is an iterative process of 'learning by doing' and 'reflection-in-action' that is followed by practitioners such as architects, psychotherapists, engineers and managers. According to Schon [9], '*practitioners themselves often reveal a capacity for reflection on their intuitive knowing in the midst of action and sometimes use this capacity to cope with the unique, uncertain, and conflicted situation of practice*." The connection of HCI teaching with practice is highly desirable since it presents students with the chance to deal with various practical and ethical issues (e.g. to prepare a statement of user consent for an empirical evaluation), which are often time-consuming and cultivate soft skills like critical thinking and decision-making.

Another unique characteristic of studio-based learning is that it rests on synchronous tutor 'mentoring' at the time when students perform design work. The studio pedagogy requires the tutor to observe, discuss, and review students' practice when it occurs, and to intervene at the students' zone of proximal development [11], i.e. at the point where knowledge and skills are hard enough to learn without help but not too difficult to grasp through tutor critique, coaching, and scaffolding. Furthermore, design reviews (juries) also rest on tutors who take the stand to scrutinize student work to put them pressure to develop their presentation, communication and critical thinking skills. This aspect of the studio pedagogy is valuable at an HCI course, especially at productive learning tasks like user interface design and development. However, it is not always desirable in other aspects of an HCI course, especially when learning about user research and evaluation, which are empirical, i.e. the evaluators should be the client(s) or end-user(s).

1.3 Reviewing some issues of transition: from lecture-based to studio-based HCI teaching

The instructional design of an HCI studio course must consider a number of practical issues of 'transition' from lecture-based to studio-based teaching. Important issues are whether lectures are offered, the level of detail of the problem (project) at hand and interactive technologies employed.

In a typical design studio there are no lectures, but perhaps short introductions to new topics. This is because students in design studios are often expected to have attended background courses. In HCI studios this is not often the case, especially in undergraduate computer science curricula where there might be a single HCI course throughout, like in [12][13]. However, some HCI studio courses do not provide students with lectures [14][15]. In this case, the students need to actively search and find learning resources to address their knowledge deficiencies, ether along or in groups.

Regarding the level of detail of the design project presented to students there are two distinct alternatives: to present students with a design compact and verifiable brief with specific requirements and constraints, or to present a general thematic area (or design domain) in which the student(s) must formulate the brief, possibly in contact to an external client. The former approach is presented in [17], which provides students with a clear-cut brief, i.e. mobile application for the elderly that allowed the user to translate textual phone messages if they were written in slang. The latter approach is followed in [7][16], where students are challenged to explore and decide on use of HCI methods at a 'design domain' in which they are asked to construct their projects themselves.

Regarding the type of interactive technology employed in the HCI courses, again there are two distinct approaches. Either students are required to make use of a particular technology to design or develop problem solutions (e.g. in [17] the aim is to develop a mobile app) or they may produce technological solutions on a range of technologies, like for example in [13]. The latter requires from the students to justify to some extent their decisions.

Last but not least, some 'alternative' approaches[1] to HCI design studios have been proposed, which include online, digital and distributed studios to augment, or even replace, physical studio space. This may be due to pressures on resources, like for example in [7] in which a virtual world was created to compensate for lack of physical space, and it is also in response to increasing professional and practical uses of online and digital tools like in [18] where the use of a social networking platform is employed.

1.4 Aims and scope

This paper presents a design studio approach to HCI teaching in a department of product and systems design engineering and reflects on lessons learnt from supervising and teaching this course over these last four years. The approach is discussed in terms of context, educational goals and pedagogy, course activities and outcomes. The lessons learnt are presented in terms of quality of method's applications and respective students' strengths and weaknesses observed, the quality of the deliverables and outcomes, issues of activity timing and sequencing, and intermediate (formative) and final (summative) assessments.

[1] https://drslxd19.id.metu.edu.tr/track-01-alternative-studios/

2 The HCI studio approach

2.1 Context and educational goals

The course is entitled 'Design of Interactive Systems Studio', and it is offered at the Department of Product and Systems Design Engineering[2] (D.Eng. 5-years of study) at School of Engineering, University of the Aegean, Greece. The department is the only one with that title and focus in Greece. Its course program includes a direction on 'Design of Interactive Systems' with ten related courses, namely: Human-Computer Interaction, Interaction Design, Cognitive Science, Information Systems Analysis and Modelling, Virtual Reality, Web Design and Development, Games and Edutainment, Design and Development for Mobile Devices, Natural user Interfaces and Design for All. Students must attend at least six of these courses successfully to apply for the studio course, which is offered at the ninth semester, before the diploma thesis.

The educational goal of the course is to enable students apply knowledge and skills of HCI and interaction design to the development of an authentic project with the participation of external clients and users. Students are expected to actively learn about making (a) creative use of HCI and design methods, techniques and tools; (b) experimentation and prototyping with contemporary interaction technologies; (c) iterative user research, design, prototyping and empirical evaluation.

2.1 Pedagogical principles

The pedagogical principles of the course blend design studio activities, HCI and interaction design methods and pedagogical principles of problem-based learning (PBL) [19][20][21]. In particular, the main studio activities that are embedded in the course are:

The design brief is developed by students themselves (and tutors' advice) in group work, on the basis of a thematic area (tutors' decision, different every year, Table 1) and respective field visits. **The desk crit** occurs during course hours on a work plan that is initially announced by tutors and refined or revisited by student groups themselves. **The design reviews** occur at three course milestones: research completed, prototyping completed, project completed (final presentation, open to external parties as well). **The portfolio:** the projects are presented at an illustrative fashion so that they can be included in student portfolios.

Despite that there is no prerequisite of applying specific HCI and interaction design methods, it is strongly advised that students conduct (or participate in) the following methods or activities. **Field visits** (accompanied with note taking, observation, interviews), which are organized by tutors and take place for all students at the first two weeks of the course. After these, students carry out contextual research without tutor supervision (e.g. contextual inquiries [22]). **Concept models**[3], **wireframes** [23] and **paper (or other low-fidelity) prototyping** [24] are expected by student groups to exercise their design thinking skills soon in the course schedule. **Technical tests and interactive prototyping** of various interactive technologies. This is also strongly advised to start soon in the course so that potential risks are identified promptly. **Empirical evaluation** methods of usability and the user experience [25] are strongly advised to occur during project development and not only at the end of the prototyping phase.

Table 1. Course thematic areas and participants

Year	Thematic area	Students	Groups
2015	Smart home	22	5
2016	Cultural heritage	24	6
2017	Cultural heritage	32	7
2018	Experiential tourism	30	6

We apply the following pedagogical principles of PBL [19][20]:

Ill-defined, authentic problems at hand. Students develop their projects by themselves based on personal interests and inspired by initial field visits, with the constraint that it is within the thematic area presented by tutors. This can contribute to critical thinking and what is expected to happen in their professional practice.

Group work. Students work in groups of complementary skills to cultivate 'soft' skills like cooperation and peer learning.

Active, self-directed learning. Students are expected to address their personal knowledge deficiencies autonomously (or in groups), because this will be the case in their future professional practice.

Tutor as facilitator. Tutors neither give lectures, nor do they provide answers to students' questions (which is not always easy to do so), but they provide general directions, point to knowledge resources (to some extent) and pose questions and challenges.

An additional element of the approach is that peer tutoring occurs, i.e. two tutors as always assigned to be present in the course, in order to promote rich feedback and challenging questions.

2.2 Course activities, process and outcomes

Course activities are generally divided into the following stages (Figure 1).

Introduction to the course and sensitization. This stage is orchestrated by the tutors and includes: (a) the presentation of the course philosophy, schedule, prerequisites, expected outcomes (deliverables), demos of past projects, and overview of design competitions or scientific conferences for further goal-setting and motivation, (b) field visits, (c) reflection on the above towards the construction of the design brief.

Research and inquiry. This includes desktop research (online resources), readings of scientific papers, and most importantly contextual research with several observation and interview strategies and contextual inquiries.

Conceptual design. This typically includes design thinking methods and concept modelling, wireframes/user interface designs. The adoption of methods depends on the problem at hand and it is the responsibility of students, with tutor advice.

[2] https://www.syros.aegean.gr/

[3] http://boxesandarrows.com/how-to-make-a-concept-model/

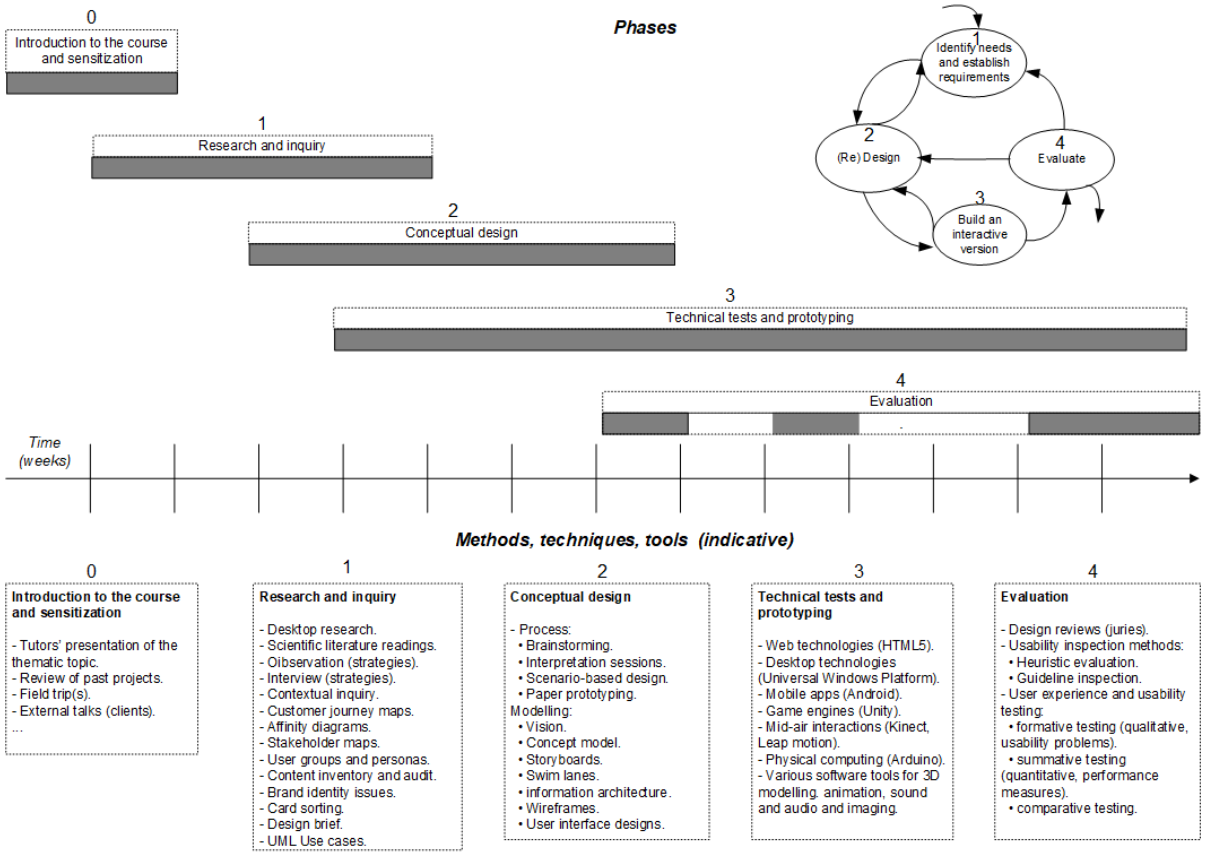

Figure 1. Course activities and process.

Table 2. Summary of selected student projects.

Project name and short description	Main interactive technologies
Orasis: Accessible Museum Collections for the Visually Impaired: Combining Tactile Exploration, Audio Descriptions and Mobile Gestures [26]	Mobile app (Android), touch gestures, Arduino (touch sensitive), 3D printing.
Cycladic sculpture: A Kinesthetic Approach to Digital Heritage using Leap Motion: The Cycladic Sculpture Application [27]	Game engine (Unity), mid-air manipulations (Leap motion).
Gocha: A Pervasive Role-Playing Game for Introducing Elementary School Students to Archaeology [28]	Mobile app (Android), location-based sensors (Beacons).
The Loom: Interactive Weaving through a Tangible Installation with Digital Feedback [29]	Game engine (Unity), Arduino connected to a wooden loom replica.
i-Wall: A Low-Cost Interactive Wall for Enhancing Visitor Experience and Promoting Industrial Heritage in Museums [30]	Touchboard (capacitive sensors), animated narratives (projected).
THREADS: A digital storytelling multi-stage installation on industrial heritage [31]	Desktop app (UWP), multitouch screen, Arduino
Design of an Interactive Experience Journey in a Renovated Industrial Site [32]	Desktop app (UWP), multitouch screen, Arduino

Figure 2. Interactive prototypes of student projects from left to right: (a) Cycladic sculpture (kinaesthetic interaction) [27]. (b) Screen shot of Gocha, a mobile pervasive game [28]. (c) The wooden replica of the loom as an interface for interactive weaving [29]. (d) i-Wall, a low-cost interactive table for exhibit narrations in museums [30].

Technical tests and prototyping with various interactive technologies, namely: web technologies (HTML5), desktop technologies (Windows), mobile apps (Android), game engines (Unity), physical computing (Arduino), and various other software tools for 3D modelling, animation, sound and audio and imaging.

Evaluation, in the form of either design review (by tutors in open presentations), usability inspections (by tutors or peers) or empirical testing of usability/user experience.

Besides the first phase, which is actually the kick-off for the course, the rest of the phases can be easily mapped to the definition of the interaction design process by Preece et al. [33]. In fact, the flows between stages are also the same, i.e. it is a highly fluid, iterative and incremental process. However, it is more practical to show the main phases (or activities) and process of the course in a Gantt-like chart to illustrate approximate lifetime and duration. Figure 1 illustrates these phases and activities, along with typical methods / techniques / tools used throughout the course.

At the end of the course, an open presentation is made by students. The final project deliverables are: a project paper (max 5000 words), the interactive prototype, a promotional and 'make-off' video and a project poster. A list of interesting projects that were outcomes of this studio course is summarized in Table 2.

3 Lessons learnt

We discuss lessons learnt about the main course activities and methods used (illustrated in Figure 1).

Regarding **course kick-off and sensitization**, we have seen that field visits are vitally important to present an authentic setting; therefore they are a key component for the kick-off of such a course. Examples of field visits that have been organized for this course are guided visits to museums and renovated buildings, observation of workshops and talks, hiking to cultural sites and walking in tourist attractions in the city. Field visits always include external guests, who provide short talks or tours, and they play the role of clients or end-users. They can provide sensitization moments and material to students as well as connect them with external experts. On the other hand, there are some practical difficulties with field visits, most importantly that sometimes they may not be conducted timely, with respect to course scheduling. However, this is another aspect of authentic conditions of working in HCI. In addition, we have noted that student groups typically show late or delayed finalization of their design brief. This is not surprising due to the wealth of information and available options, but presents a high risk for further project development. We intentionally instruct students to put increased effort from the very beginning in order to construct the brief especially with regard to aspects of functional requirements.

Regarding methods of **research and inquiry**, we have found, (not surprisingly) that students are quite resourceful in desktop research, but they fall short in critical readings of scientific literature. Although the latter might seem to be asking too much from students, it is required from most professional design engineers to study technical notes and papers in a similar fashion to other practitioners like lawyers, doctors and other engineers. In addition, students are considerably assisted by contextual research like interviews and observation, however, they are often carried away and may lose research focus, thus fall short in reaching to valuable insights. We often interrogate students about their contextual research to help them reflect on requirements or guidelines for design. Regarding requirements engineering (textual descriptions and modelling) this is often not satisfactory; this is not an easy task for non-experienced designers or requirement engineers; therefore we let them revisit their specifications in later iterations.

Conceptual design is an important stage of the project; many important design decisions are made at this stage [34] and a solid understanding of the problem at hand is needed, which is not always easy to grasp in the available timeframe. For example, for students to develop an understandable concept model, they need to identify the key phrase of the project, key actors and concepts (nouns), activities or operations (verbs), the terminology and visual design elements (colors, fonts, icons) of the user interface. We typically allow students to revisit their concept modelling, make consistency checks with their user interface designs and provide feedthroughs from low-fidelity prototyping. Since that low fidelity prototyping often provides insights to students, we always devote several course hours into peer testing, i.e. students conduct low-fi prototyping sessions with their peers with our supervision. Detailed user interface design is a strong point for many students since that they invest time and effort to identify design trends and refine their designs. Off course, we remain on a carefully selected set of user interaction scenarios for that.

Technical testing and interactive prototyping lasts for more than any other project phase (Figure 1), because it is ultimately the most important aspect of the project and the most unexplored domain. Additionally, since that we encourage integration of technologies, this may slow down prototyping work. Therefore simple tests are to be conducted early in the project duration. Another issue with interactive prototyping is that it may take too long and squeeze evaluation work. Thus, we encourage students to conduct a series of evaluations to ensure that their technical development is freed from fundamental usability problems. Overall, we have seen that some student groups have had fresh ideas and they have managed to deliver very interesting projects that combine multiple interaction technologies (Figure 2).

Empirical evaluation is a mandatory activity and it occurs at least twice in this course: at low-fidelity prototypes and at interactive prototypes towards the end of the design project. The latter is often short and qualitative, with a few participants, but it is often substantial in terms of findings. Additionally, usability inspections may be also organized with tutors or peers as participants; these are normally conducted before user tests. All these evaluation activities help students realize the shortcomings of their designs and to some extent address them to the final version.

Finally, a couple of more **general issues** that stem out of this course are about the quality of the project deliverables and individual

student assessment. Overall, students find it rather hard to write their project papers at a high-quality level, in contrast to putting up their videos, posters and their presentations, which are often of good quality. Regarding project assessments, tutors provide individually (different) analytic marks and review comments on all phases and deliverables of the project. However, evidence-based assessment of individual contributions to group work is difficult. We have employed assessment rubrics in previous work [35], however for this course we address contribution discrepancies with qualitative methods like self-assessments.

4 Summary and conclusion

We have presented an approach for an HCI design studio course and lessons learnt in a four-year retrospective. The course is focused on bringing students into authentic conditions of HCI and design practice. The pedagogical principles of this course are routed in design studio concepts, core HCI methods and problem-based learning (PBL). Various other practical elements of the course might be regarded worthwhile by practitioners, like the general process followed and the corpus of the methods that can be applied (outlined in Figure 1), and that the course is open-ended as with the use of interactive technologies as can be conveyed from student projects developed (Table 2). The course requires some background of HCI theory and interactive technologies, and therefore may be applied instead (or just before) final thesis at both undergraduate or postgraduate level. We have found that peer tutoring works best (2 tutors in each course) because more tutors provide richer feedback to student groups, while in some cases more tutors can undertake parallel, co-located supervisions. The course is regarded demanding for students, with several phases and deliverables, and it creates a good tracked record for their portfolio. We envisage that this case study provides insights to other cases of undergraduate or (more likely) postgraduate HCI studio courses.

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