Seven Factors to Foster Creativity in University HCI Projects

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ABSTRACT
This paper describes our approaches to foster creativity among students of computer science in the area of interactive virtual environments. We assume that everybody has creative potential. This potential may be covered by beliefs, experiences, and social background that hinder its use in the HCI education context. As a teacher or project coordinator, we can explicitly motivate and encourage inventive, unconventional thinking and development, give assurance, provide a supportive, save environment, and provide space to let students/co-workers discover and explore their creativity. Seven factors are identified and explained, which, in our experience, support creative, inventive thinking in HCI projects.

Keywords
Education in HCI, creativity, project management

Inventivity needs **creativity** needs **space to develop**.

1. INTRODUCTION
Human-computer interaction (HCI) is an interdisciplinary field drawing from diverse disciplines, including computer science (CS), design, and psychology. It is often not taught as a dedicated course of study, but is embedded into a CS curriculum which has its core in a mathematical, algorithmical, and technical context with some extensions to teach human and social issues. Much of the curriculum is rule based: students learn to structure problems and programs based on rules, guidelines, and programming paradigms. They become experts in designing and building systems based on predefined requirements. For example, designing and implementing a program for a specific automatic teller machine (ATM) requires a precise fulfilment of the prescribed requirements, like protocols, interface, and security rules, to insure secure transactions with this specific machine from bank to customer. There is creative space in which it is decided how to program the system in the best possible way, and this decision process can also be an art in itself. Nevertheless, the creativity required in imaginative HCI interface design encompasses much more than this, as new ideas evolve outside prescribed sets of rules. Inventiveness needs the readiness to go new ways, to take an outside view on one's own discipline, and to question existing rules and conventions.

The thesis of this paper is that, as a necessary requirement for many tasks in computer science, the mind-set of a typical computer science student is focused on embracing, in the best possible way, the instructed rules, knowledge, and goals. Creative thinking is rarely supported or encouraged. The structure of exams aids this; in CS exams there typically is only one right answer. This is handy for the instructor, but may lead to the impression that there is only one right way of doing things. As a result, students love to learn about the "right" rules to solve their problem, neither intending to verify those rules, nor to develop their own new, workable solutions. Free flowing creativity is not often taught in this field, as it is not a necessity in the core of the CS discipline.

This is very much different in art and design. Art students learn their craft, but at the same time are requested to develop their own innovative ideas and present, discuss, and defend these openly. They are focused on creating new and innovative pieces and are requested to focus on the process of creativity early on in their education. Design students draw from the creative processes in art, learn the skills of their relevant subjects, and, additionally, focus thoroughly on the requirements of the task. Creativity is an established part of art and design education and becomes part of the working tools available to its practitioners.

To enable creative, innovative design among students in CS-based HCI courses, consideration must be given to the students' potential lack of experience, low self-esteem, and lack of knowledge concerning creativity. Creative abilities are present in every person, but need tools, training, believe in one's own creativity, motivation, and opportunities to be used in achieving task and goal to be unlocked. Tools can be taught as part or in addition to regular courses. Believe in one's own creativity, the base for being creative, can be encouraged by training and experiences in class. Motivation can be fostered by making the projects fun, visible to a broad community, and providing encouragement to go novel ways. Opportunities for creative approaches can be provided as openly defined HCI design tasks. This paper identifies the context, goals, and approaches taken to encourage CS students to develop innovative, inventive, interactive mixed reality and virtual environments. It describes guidelines identified and followed in our courses and discusses results.

2. CONTEXT

This paper is focused on our approaches supporting undergraduate CS students to develop inventive applications and interfaces in our courses. We developed, used, and verified our approach in this specific context, but expect the identified guidelines or factors to be generally relevant. This section discusses the students' backgrounds, the types of courses, and the goals we have for our courses. From the goals we derive and discuss our perception of required skills and mind-sets of students for being able to accomplish the tasks given in class.

2.1. Courses and Background of Students

The students in our courses are third to fifth years students, pursuing a five year German Diploma in Computing Science (comparable with MSc level). By their third year, they already possess a solid theoretical base in mathematics, programming principles, and theory. Some basic HCI principles are taught in the first years, though the education is not focused on HCI. In their third year, they often still lack significant programming and project experience. In general they have not completed projects, seminars, or other types of courses that involve creative, inventive types of work.

At the University of Hamburg, students in their third year have to focus on a specific area of CS, one of them being the field of "interactive media." Students in "interactive media" select courses from a large set of CS courses, including subjects such as software design, interface design, software ergonomics, multimodal signals, virtual reality, and unconventional interfaces. Our specific courses range from dedicated projects to lectures with exercises, mostly with a focus on HCI, new types of interfaces, and mixed and virtual reality systems and applications [2]. Usually, our courses include a dedicated student project or project like exercises. In addition to the CS (major) courses, students also take a minor subject. Many students studying "interactive media" take psychology as a minor and some take a minor in arts.

2.2. Project Goals

We pursue several goals by commonly including projects in our courses. Being in the exciting, rapidly changing field of interactive media and virtual environments, we would like to encourage in our courses the emergence of new, innovative, inventive applications, interfaces, and interaction paradigms. Connected to this is the wish to motivate the students to critically review their accomplishments and designs, in the form of an informal evaluation or public demonstration. We believe that evaluation and discussion in all stages of design are vital for developing successful HCI products. Including this in the education process teaches not only the necessary skills but also encourages a strong focus on the user, an understanding of the diversity of people, needs, and expectations, and the necessity to validate one's assumptions.

Additionally, we would like to teach students project management skills, enabling them to work with focus, work successfully in groups, control time and budget, and, ultimately, finish their projects in time. Teaching project management skills is vital, as an evaluation can only be conducted with some kind of working prototype, making tools that assist in completing projects in the short semester time frame important. In our experience, imparting project management basics is only possible by teaching the tools, and then letting students conduct a project with fixed time, budget, and goals to let them experience the success or failure of the approaches taken. This normally leads to an understanding of the advantages and necessity of project management, even sometimes in small one person projects. Without this personal insight, the additional overhead of drawing up project plans is easily seen as a reason to drop project management altogether.

Last, but not least, we would like to have high quality working projects, which can be subjected to some kind of evaluation process and to allow students to gain some experience. Even better is a project that can be reused in further student or research projects. This requires highly motivated students with focus on quality and results.

We hope that by the time students start their diploma thesis research project, they are able to fully focus on their actual diploma work, while, as a matter of course, putting these previously discussed points into execution without the need for further encouragement.

2.3. Student Skills

From the goals listed in section 2.2, we identify the necessity for the following skills and mental attitudes of participants to equip them to successfully complete an HCI project that focuses on the creation of inventive, innovative applications, interfaces or interface paradigms:

1. Knowledge (of the field, theories and practical experience),
2. Inspiration (from creative projects in the field, from other fields, interdisciplinary),
3. Project management skills,
4. Knowledge of creativity methods,
5. Self-confidence (in their creativity and relevance of their work),
6. Motivation,
7. Focus (on goal and results).

For a successful student project, a teacher or project coordinator should make sure that their students or co-workers have the necessary skills (*skills*: items 1 to 4) and that they are also self-confident, motivated and focussed (*mind-set*: items 5 to 7). In a sense, the goal for the project is now transformed or complemented with a second list of goals, focusing on the skills and attitudes of the student or co-worker required to successfully fulfil the overall project.

3. FACTORS FOR PROJECT DESIGN TO FOSTER CREATIVITY

This section identifies and discusses seven guidelines or factors for the teacher or project coordinator that may support the achievement of these goals. Many of the guidelines compiled here draw from disciplines like didactics and project management. These guidelines help to put into practice the above-mentioned project and student-oriented goals for CS students in HCI. But they may also be of help for any other type of inventive single or group projects.

1. *Formation of a group and a supportive environment*

   The first step in our projects is to support forming a group out of a 'crowd' of individuals. The three main issues are to establish awareness of each other, to encourage mutual respect among the participants, and to encourage a friendly, supportive work environment. Developing creativity needs an environment where the expression of undeveloped, unfinished, potentially stupid ideas is not only tolerated, but welcomed. Expressing such ideas in front of strangers is something that most people do not feel comfortable with.

   One option is to spend most of the first meeting to get to know each other. This phase of a project is often underestimated; however, it is crucial for any type of class involving working together [6]. In our courses we do this by setting small tasks that are fun to do or by playing (hopefully) fun games. As humour and action seems to play a role in creativity, we try to include or encourage both humour and action as well. Getting to work together and see cooperatively achieved results come to life is an even stronger step into forming group awareness, mutual respect, and a friendly environment.

2. *Building confidence in creativity*

   Without a personal belief in their ability to be creative, a student will not be creative. There are a few important issues to address. The first is to focus the mind of participants on the "permission," better the explicit request, to being creative, innovative, and inventive. The second is to ensure them that they can be creative without having an already well-established reputation for being a creative person. The third is to let them experience their own creativity.

   The first issue can be addressed by clearly stating the inventive nature of the goal of the project and the difference to the normally conducted CS tasks. This can be done verbally or in writing, but also in form of previous examples - own or external. To address the second and third issues, we have students do a small project to experience their creativity. We do this as part of an initial get-together (see 1.) or a first exercise, where they together solve a problem involving creative thinking and working. For example, in our lecture on "interactive media" we introduced different kinds of media and, as a task, asked groups of 8 students to come up with 8 representations of specific "classic" opening lines in different media [1]. For instance, one of the opening lines was "It was dark and stormy night, when a confused professor tried to escape from the campus." The results were remarkable, diverse, and non-obvious. Expressing this opening line, students invented and performed theatre plays, videos, games, novels, photo novels, produced songs, drawings, audio dramas, sculptures, and more, with amazing creative capability. We believe that this opened the minds of the students a) to their own creativity, b) to the course's open approach to creative ideas, and c) to the generally welcomed inventive thinking in our field.

   In a group, creativity is based on the input of all participants. In our experience, not many tools for assisting creativity in groups, if any, are known by students let alone experienced. Overwhelming discomfort arises when a pin board and cards are employed in class for the first time, or when students are asked to contribute ideas verbally in front of others. The latter can be overcome by letting students experience that their comment is warmly welcomed and that their contribution helps everybody. An important prerequisite is an already established supportive, friendly environment (see above). One way to encourage contributions is to make everybody contribute something mandatory. This often is enough to "break the ice." Another way is to have some kind of reward for contributors (candies, fruits, acknowledgments, and first-choice). Once communication among people is established, general or domain specific creativity tools can be taught and should immediately be put into practice in small exercises. Examples are brainstorming, brainwriting, card story boards, drawing, mind mapping, and mood boards [7,8]. Training in these not only builds confidence in one's own creative potential but also provides the necessary tools and demonstrates the potential of getting support in a group, when having to develop "creative" ideas.

3. *Balance of a clear goal with space to evolve*

   For all participants, the requirements and the goals of the project must be clear. To aid this, a clear goal must be set with respect to expected time frames, expected content and deliverables, budget, the minimum expected scale of the project, and the participants. These goals are identified in the "task document" (see next point).

   Within this set of goals, especially within the expected content, there is the potential for creative ideas. If the goal leaves open space for creative interpretation of the project, then this is the starting point to foster creativity. One approach to enforce students' creative considerations is to set a vague technical goal like "prepare a prototype of a game, combining virtual and real content." A task like this cannot be developed without generation of own ideas. This also requires the instructor's trust in the students and an openness concerning the outcomes.

   The balance between open space and pre-set requirements is important. Lack of space for new ideas in the task hinders creativity. Too much space may lead to the perception that the project is ill-planned, arbitrary or nonexistent.

This, in turn, discourages creativity. In our experience, setting clear goals for schedule, form of delivery, presentation, and subject of the project, but giving vague technical or content instructions keeps this balance, and is highly motivating to students.

4. *Preparation of a "task document"*

Some de-facto points that should be followed in a task document are:

- Provide a clear mission statement (which, among other things, states that the project is supposed to include inventive new ideas).
- List measurable objectives and prioritize objectives.
- Set goals in all task areas (but leave considerable room for creative development).
- Provide a rough schedule and milestones, preferably with early written contribution and presentation of the individual project by the students. Written contribution can include the project title, the intended project content, the design document, the time schedule, and the work plan.
- Include the "creative phase" as part of the schedule.
- Include the "evaluation" as part of the schedule. This can easily be combined with the final presentation of the project.
- Have written documentation, including a small website, as a final requirement (a website is perfect for the student's portfolio).

5. *Motivation*

Unmotivated students are rarely creative. Creativity needs a certain kind of energy and focus to surface. Our approach to motivating students is to offer them as much personal benefit as possible beyond just passing the course. Our projects often leave space to develop ideas in an official context that otherwise could not be done additionally to university studies because of time constraints. We allow project areas that are new and playful. More importantly, we give space to work in individual areas of interest. For example, within a given task document, students interested in music are encouraged to develop an application in this area while in the same course, students who want to learn 3D modelling are allowed to include associated 3D tools in their project.

Seeing the first project results is an excellent motivation to conduct, continue, and to finalize a project. Even as little as a project title, with a small description, helps students to focus on their task and provides a seed for their commitment to the project. Thus, we encourage early presentation of the intended project, the initial ideas, and first prototypes and results, if appropriate.

Another motivation for the students comes from the possibility to learn skills useful for their career from conducting full projects. In larger projects, students in our courses organize their own project management. They elect their own project managers (overall and sometimes for each sub-task), make their own project plans, and control time and resources themselves. This process is guided only if necessary. This is highly motivating as students are in charge of their project and responsible for its outcome. Additionally, they get more self-confidence in conducting projects.

For an additional personal motivation, our project task design also aims at projects that can be added to the portfolio and which can be publicly presented. At the start of the project, we encourage enrolling good projects for student prizes or public presentation, and, if applicable, we motivate writing a student or scientific paper.

6. *Assessment*

At the University of Hamburg, the CS project work is not graded. This has advantages and disadvantages. An advantage is that students do not have to fear a bad mark, if their inventive approach did not work out. This is an important point in encouraging "unsafe," creative approaches to design. The disadvantage is that if they did an exceptionally good piece of work, this is not reflected in the pass/fail mark of the course. An explicit and potentially rewarding judgement can be achieved by peer-reviewing the projects among the students and also by presenting good projects publicly or having the students enrol them for prizes as a way of reward.

7. *Assistance versus interference*

The last influencing factor is assistance. The teacher or project coordinator is responsible to provide a suitable technical environment, teach the necessary project and personal skills, and create a friendly supporting work environment. This includes:

- Teaching project management tools,
- Teaching suitable tools for easy development, but leaving the choice of tools to the participants,
- Training creativity methods in a small course project. As a side effect, this already reduces potential objections to be creative in a team and give students the experience that they are creative people,
- Assisting with technical problems,
- Reviewing the projects, acknowledging, and reassuring the participants, if necessary.

What may hinder motivated students to engage in the project is interference with their ideas. Once it is established what they are going to do (a further, personal extension of the somewhat vague task document) then too much interference with their ideas may decrease their motivation. The teachers must learn to have trust in their students, help where assistance is requested, and try to keep interference with "their" project to a minimum.

4. RESULTS AND CONCLUSION

In the last two years we taught six courses in the field of "interactive media" that involved large projects or smaller exercises. These were "Interactive 3D Systems" (project, 6h/week), "Unconventional Human Computer Interaction" (project with seminar, 4h/week), "Media Art" (project with seminar, 4h/week), "Virtual Reality" (project, 6h/week), "Interactive Media" (lecture with project like exercise, 4h/week), and "Advanced Computer Graphics" (project with seminar, 4h/week) [3]. In all of the courses we had an extensive opening event (as described in section 3, point 1). The tasks given included space for the students' own ideas, but stated also clear minimum requirements for 'passing' the course. We tried to introduce all the necessary tools and provided for a friendly supportive environment. During the projects we gave assistance when requested, but also observed the project progress.

Our approach to "forming a group and a supportive environment", by spending much of the first meeting getting to know each other in an informal and fun way, seems very successful. Not everybody liked playing games without an explicit connection to the courses' subject, a method we used in some of the courses. We learnt that the most successful approach to address all students in the course combines a 'fun', collaborative, get-together with a first content relevant task. Students acknowledged the friendly and fruitful work environment in the courses. Some reported to have become aware of and worked with their co-students for the first time. The courses' results showed the students' commitment.

Following the approaches described in section 3 we had hardly any students drop out of our courses. Most projects were completed, some of them with amazing quality. We informally presented projects on exhibitions of international conferences like IEEE Virtual Reality's laboratory night [4], Mensch&Computer 2005 [5], and local university exhibitions. Many of our students are highly motivated, helping in preparing conferences and exhibitions, and supporting each other in their individual projects. Now, many of those students come with their own ideas for inventive diploma theses. We believe that following the approaches described above helped us in creating this environment.

From course experiences we learnt that creativity is supported by explicitly encouraging innovative design and thinking, by experiencing it, and through success, thereby, building the student's self-esteem. We also learnt that vital tools, like project management and some of the creativity tools must be taught, followed by immediate application of the tools; or they will not be used. As completed projects strongly reward the students and motivate them, while unfinished ones frustrate teachers and students alike, project management tools are necessary to keep an overview on the project and ensure early assistance and support. We found that students were happy to take on time consuming positions as project managers in larger student projects, just for the sake of learning relevant skills for their career and seeing results come to life. They reported to have learnt a lot, both technically and personally.

To conclude the paper, our experience is that, in order to foster *inventivity* among CS-based HCI students, it is very important to encourage and teach *creativity*. Creativity, in turn, requires enough open *space* in the task description, plus trust in students, *to develop*. This requires more work in designing tasks, teaching, working with participants, and assisting technically. However, it is also proportionally more rewarding, as students feel accepted and supported, are highly motivated, complete their projects, and, ultimately, present inventive, creative, often qualitatively high results from their project work.

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