# A Team-Approach to Putting Learner-Centered Principles to Practice in a Large Course on Human-Computer Interaction

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***Abstract*—We present a case study on how a team of instructors put learner-centered principles into practice in a large undergraduate course on Human-Computer Interaction (HCI) that was run in 4 parallel groups of about 50 students. The course stands on the crossroads between software engineering, business, and research in so far as student-teams apply human-centered design techniques to develop mobile apps, test them with real end-users, read research papers and regularly reflect upon their experience. As a proof of the course-concept, selected results from formative and summative assessments are presented. The summative results show that students rated the course as one of the best of the 87 computer science courses run in the summer term of 2015 at the University of Vienna. The primary goal of this paper is to provide instructors intrigued by learner-centered approaches with ideas for their own practice. In particular, this paper is of interest to those who teach Human-Computer Interaction and to those who seek inspiration on mapping their course to the 14 learner-centered principles.**

***Keywords—Learner-centered principles; project-based learning; human-computer interaction; formative and summative assessment; student-centered learning.***

## I. Introduction

Learner-centered instruction is gaining importance whenever the goal of education shifts from memorizing facts to building competences, taking on responsibility, working effectively in teams, promoting creativity, etc. These assets are core to students' employability and are particularly relevant in business- and engineering related fields.

In this paper, we investigate how a team of 4 instructors put the 14 learner-centered psychological principles developed by the American Psychological Association [1] into practice in a large undergraduate course (200 students arranged in 4 parallel groups) on human-computer interaction (HCI). This course had been co-designed from a student-centered mindset and a history of adaptation over several years. In the preceding summer term, students rated it as one of the best of 87 computer science (CS) courses at University of Vienna, whereby parallel groups of one course were counted as one course. More precisely, it was rated as the best CS bachelor-level course, when discarding courses that were rated by less than 5 students. The respective anonymous, summative online survey was compulsory for all CS courses (Section V).

The highly positive summative result motivated us to share the course concept (Section III). We analyzed students' perceptions of the course in order to understand the reasons behind this success. In particular, we were interested in which ways the student-centered "philosophy" and the consequent course design and activities contributed to the success. In order to find this out, we analyzed the students' ongoing online reaction sheets (433 overall) for statements that would reflect one or more of the 14 learner-centered principles [1] (Section IV). Both this formative and the above mentioned summative procedures can be seen as complementarily providing a confirmation of the course-concept.

From our – the instructors' – view, we think that, besides the learner-centered focus, a combination of factors and approaches to teaching and learning were key to the success of the course [2]. These features are summarized in Section III and backed up with the students' "voice" in Section IV. Examples are the incremental improvement of the course through several years of listening to students' reactions and expectations, the dedicated team of instructors and tutors supported by a usable eLearning platform, transparent, multi-facetted assessment and prompt feedback, the absence of a final exam, a high degree of interaction during the course, and the highly relevant and ubiquitous subject matter of human-computer interaction. We found that the learner-centered paradigm [2]–[4], provides a good theoretical framework to express the key features of our approach. This theory stands for a holistic approach respecting learners and viewing them as constructive participants in the learning process. Learners want to learn, interact, grow personally and solve real, authentic problems, when offered a resourceful environment and guidance where needed [5]. This is the core of what we wanted to provide. For example, the students themselves wished to learn to program mobile apps to be able to actually accomplish something exciting and closely connected to their real lives. We are aware that this intrinsic motivation played a significant role in the students' positive attitude towards the course. Nevertheless, the task to facilitate the course for about 200 students came with a number of challenges that needed to be thoughtfully addressed and are discussed in this article.

This paper is intended to inspire other (HCI) instructors in terms of how the 14 learner-centered principles can be put into practice. Furthermore, it contributes a case study showing how a learner-centered approach can work well in large classes.

## II. Background & Related Work

Learner-centered education has its roots in the Person-Centered Approach by the American psychologist and psychotherapist Carl Rogers, who himself was influenced by John Dewey's emphasis on experience as a basis for learning. Rogers and his followers, for example David Aspy [6] and Reinhard and Annemarie Tausch [7] conducted numerous empirical studies that confirmed the effectiveness of what they called "student-centered teaching" [8].

Central to this approach is Carl Roger's proposition that "The organism reacts as an organismic whole to this phenomenal field" [9, p. 468]. Numerous scientific studies [3], [6], [10], [11] confirm that learning is most persistent if it addresses all three levels of development – our intellect, (social) skills, and attitudes – in a climate of realness, respect and encompassing, empathic understanding. These findings have been carried forward to include consistent advances from studies on motivation, autonomy support, current theories of constructivism, individual diversity, social inclusion and others, and eventually resulted in a set of learner-centered principles [1]. These principles have stood the test of time in meta-studies [12] and countless studies using a variety of research methodologies [4]. In higher education, a spectrum of activities [13]–[15] and approaches such as Project-based Learning or Collaborative Learning fitting most criteria of student-centered learning have been developed [2].

In a nutshell, "Student-centered learning puts students' interests first, acknowledging student voice as central to the learning experience" [13]. This encourages us to consider the students' "voice" in conducting research that has the potential to refine learner-centered concepts (see Section IV).

The case study we present here is based on a human-computer interaction (HCI) course, which we teach at the University of Vienna. Due to its highly interdisciplinary setting situated at the intersection between design, psychology, engineering, and science, teaching HCI is a challenge calling for untraditional approaches. Since the development of the ACM SIGCHI (Special Interest Group on Computer-Human Interaction) Curricula for HCI [16] many non-traditional teaching approaches, where hands-on experiences complement theoretical input, have been developed and tested in the context of HCI.

Reimer and Douglas [17], for example, suggested teaching HCI with the studio approach, which is well known from the field of architecture. In a studio, students work on real-life problems and knowledge is mainly transferred via "crit sessions" in which the teacher uses constructive criticism to show design weaknesses and to offer improvement suggestions. McCrickard et al. [18] suggest case methods for teaching HCI as those are inherent to all involved study fields (case history methods in design, problem-based learning in science, and decision-making cases in engineering). With the help of these methods, students learned by examining practical cases and solving problems. Another way of conveying HCI best practices to students is the usage of patterns and anti-patterns, as explored by Borchers [19] and Kotzé et al. [20]. While Borchers only used patterns (solutions to recurring problems), Kotzé et al. also used anti-patterns in teaching, which are frequently used solutions which "backfire" in a negative way and thus should be avoided. Results show that positive advice (patterns) generally is preferable over negative advice (anti-patterns), which tend to confuse students.

All of the aforementioned teaching methods for HCI strongly emphasize the importance of intertwining theory and practice, especially through "learning by doing" and by learning from working on real projects. Interestingly, however, all HCI-course examples provided in the ACM/IEEE Computer Science Curricula [21] allocate at least 50% of the assessment to a traditional exam (except for the pure online-course run at Stanford University). Even though these courses are similar in content to our course, we use a multi-facetted assessment schema for assessing students' team- and individual outcome without resorting to traditional exams. This helps to make our course more consistent to student-centered principles.

## III. HCI: A Quick Course Overview

### A. *History and basic philosophy of our course*

About a decade ago, when the course on HCI has first been taught at the University of Vienna, the respective HCI module consisted of 2 courses: a lecture with 3 academic hours (á 45 minutes) per week (during one term with 15 weeks), and a lab with 1 academic hour per week. The lecture course with about 180 students was assessed via a written exam. The lab course was split into 6 groups of about 30 students who were expected to solve 4 assignments, such as assessing web-sites for usability, or designing and evaluating prototypes for predefined interfaces. As the theoretical lecture-style course did not seem appropriate for building students' competence in the design of usable interfaces, the first author of this paper invented an "interactive mode". There, students could apply the theoretical information immediately. Via an ePortfolio they collected bonus points for accomplishing tasks and could use these bonus points to account for 70% of achievement needed for the final exam (that participants were obliged to take anyway). This mode was elective and optional, but more than 80% of the students had chosen it and asked for it in other courses as well!

Shortly after this experience, the computer science curriculum had been redesigned and, based on student-representatives' initiative, the HCI module became a 4 academic hour/week mixed lecture-lab course, with a group size of about 50 students/group. This marked the beginning of a truly learner-centered course concept, "liberated" from the requirement of having one final exam. We (since 2013 the team of authors of this paper) focused on human-centered design (HCD) competence to be acquired while developing usable human-computer interfaces [22]. Accordingly, we assessed various kinds of student achievements, ranging from small, individual exercises to team projects covering the whole

HCD process organized into 4 milestones (see below). We were aware that this new mode would require more of our time but equally would allow for more interaction and excitement from working on real projects like mobile apps for emergency, healthcare, finding restaurants, improving root finders, etc.

In other words, we felt we wanted to help students acquire the necessary knowledge and skills and accompany them in real projects rather than instructing and assessing them from an expert position on retrieving or applying given information [8], [13]. This was our guiding principle that we expressed in several planning meetings and that we enacted throughout the course. All four of us wanted to have a lively, enticing course in which students would be guided to learn some essentials, apply them creatively and collaboratively, and test the outcomes with real end users.

Different to most other HCI courses [21], our course had:

- no traditional exams
- sufficient time for interaction in class, comparable to the flipped-classroom mode [23].
- online reaction sheets [24] after each course unit, in which students "can express themselves individually and personally regarding the course. They can tell of the way it is or is not meeting their needs, they can express their feelings regarding the instructor, or can tell of the personal difficulties they are having in relation to the course" [10, p. 20].
- two "literature tests" (see Subsection D below) as knowledge-centered activities [2].
- free yet instructor-supported team-forming based on students' interests in project themes [25].

### B. *Essence of the course description*

To allow readers to get an idea about the course we first summarize important course data:

- mixed lecture-lab course, one weekly unit lasting 3h 15 minutes during one semester (about 14 weeks)
- about 200 students, 4th semester of bachelor curriculum, organized into 4 groups of about 50 students; team of 4 instructors, each covering their field of expertise and one of them acting as primary coordinator, 2 student tutors
- course is mandatory for computer science students and elective for teacher candidates, psychologists, etc.
- prerequisites: introductory courses of computer science.

The HCI course targets the following HCI-related learning goals and outcomes: Students…

- … design user-friendly and universally accessible human-computer interfaces
- … integrate basic features of cognitive- and communication psychology into the context of HCI
- … apply user interface and usability guidelines
- … apply the human-centered design process in the development of a simple, interactive mobile application
- … evaluate user interfaces regarding their usability.

On a general level, students are expected to:

- gain insight into another discipline like psychology and thereby extend their scientific horizon
- develop more openness toward the perspectives of other sciences
- experience teamwork and be able to reflect upon it.

### C. *Course organization: Structure, content, eLearning*

A typical unit followed a predefined structure. It comprised a discussion of students' reaction sheets [24], followed by up to 3 student presentations. Student-teams of 3-4 people presented the results of their milestones. Another team was designated as a feedback team, with the goal to provide critical feedback and ask discussion-sparking questions. Then the upcoming assignment or project-milestone was explained and students were invited to ask questions such that, at the end, all should have a clear understanding of the steps ahead. The subsequent content-focused part was usually an interactive presentation of any of the instructors, on theoretical foundations of HCI with an emphasis on those that were relevant for the upcoming milestone or assignment. These presentations were enriched with interactive elements, such as asking questions, voting, break-out groups or classroom discussion. 1-2 breaks allowed for refreshment and interaction.

Other components that were included in some of the lectures were guest lectures, programming tutorials, and project consultancy. An overview over all components and how they were structured can be gained from the course website: http://vda.univie.ac.at/Teaching/HCI/15s/.

### D. *Assessment of students' achievements*

Students were informed about the mode of assessment in the first unit. Moreover, assessment criteria as well as each student's intermediate assessment status were transparently displayed on the eLearning platform. Giving early feedback to students was one of the instructors' priorities. For example, we reviewed and assessed the documents that student-teams delivered after finishing a project milestone usually within one week such that we could give students immediate feedback. Besides the team project in which students followed the HCD process in 4 milestones, there were 2 assignments to be solved by students on an individual basis. They served to prepare each participant for the project such as to prevent team-members – as far as possible – to hold up the work of the team by a complete lack of knowledge or skills. The first assignment served to sensitize students with regard to the usability and user experience of various human-computer interfaces, the second assignment was aimed at building basic mobile app programming skills.

Additionally, to acquaint students with very recent developments and research designs, two literature tests were offered. In essence, instructors carefully selected articles from conferences on HCI, and students were supposed to read them such as to be able to respond to a number of multiple-choice and free-form questions in a limited time, while still having the printed article at their disposal. In sum, the following schema was used to assess students with a maximum of 100 possible points to receive:

Individual tasks:

- Assignment 1 – activate own experience (A1): 10P
- Assignment 2 – app programming (A2): 15P
- Literature test 1: 10P; Literature test 2: 10P

Team project, 3-4 students/team (mobile App):

- Milestone 1 – requirements (M1): 8P / student
- Milestone 2 – prototyping (M2): 8P/ student
- Milestone 3 – app programming (M3): 12P/ student
- Milestone 4 – user testing (M4): 12P/ student

Communication:

- Student presentations: 7P / student
- Feedback team: 2P /student
- Reaction sheets: 6P (the three best were chosen with a max. of 2P each)

The class concluded with a final team review session with one of the instructors. These meetings included a retrospective reflection on the team project and collaboration, as well as the final evaluation of students based on the gathered points.

Importantly, an open feedback culture developed, through which students received instantaneous feedback after their presentations, and fast feedback on each of their milestone deliverables, assignments, and literature test results. The students very much appreciated that all tasks were tuned to reflect the course goals and that they had access to their achievement-status at any time.

## IV. PUTTING LEARNER-CENTERED PRINCIPLES TO PRACTICE

Our goal is to qualitatively and systematically illustrate how each of the 14 *learner-centered principles* [1], [4], [26] was perceived by students. To do so we analyzed students' reaction sheet, using the following procedure. First, we put the 14 principles into a Wiki. Then the four of us individually went through the reaction sheets in order to identify statements that would reflect the perception of one or more of the principles. Over the course of the class, we had gathered overall 433 reaction sheets including formative feedback. For each of the 14 principles, we ended up identifying two to eight sample statements that clearly reflected the respective principle. Several of these statements fitted more than one principle. Once we had identified sufficient examples, we stopped the search process. Thereupon the first two authors selected the most expressive statements and translated those that had been submitted in German. Note, however, that even from this selected set only a smaller subset could make it into the paper due to space constraints.

In the following, we briefly describe each of the 14 learner-centered principles, and state how it was "implemented" in the course. Based on the selection procedure described above, we also provide excerpts from the students' reaction sheets to illustrate that the principles actually reached the students and were considered worth mentioning in the reaction sheets.

### A. Cognitive and metacognitive factors

*Principle 1: Nature of the learning process*

"The learning of complex subject matter is most effective when it is an intentional process of constructing meaning from information and experience" [1].

Following this principle, we aimed to connect the interactive lecture parts with learners' own experience, and used it to guide all course units and tasks. Implementing the principle was straightforward, since the experience of students with computational devices was abundant. Moreover, they tended to have an inherent interest in designing usable interactive interfaces – one of the core goals of our course.

The very first assignment, for instance, consisted of recalling and documenting previous experience with good and poor user interfaces. In the subsequent lecture, we then presented Nielsen's usability heuristics, a seminal set of 10 guidelines for informal evaluation of interactive interfaces [27]. The good and bad user interfaces were then to be evaluated based on these heuristics, allowing students to closely connect their own experience to fundamental HCI principles. This approach was seen positively by students, as, for instance, indicated by this positive expectation after the very first unit: *"The first assignment will integrate us well into the subject matter and will help us to get started with the class."* *[1]

Another example of combining information with experience was the work in small teams in class in order to elaborate or discuss aspects of the course material. A student reflected upon such in-class exercises as follows: "*In the second half, there was a fun exercise to create personas in small break-out groups. I think this exercise was very helpful to better understand the concept of personas. I also liked that persona examples from well-known companies such as Microsoft were shown. This illustrated the relevance of this method in the real world."* *

*Principle 2: Goals of the learning process*

"The successful learner, over time and with support and instructional guidance, can create meaningful, coherent representations of knowledge" [1].

To ensure such a positive and durable effect, we coherently synchronized the lecture content, student assignments, and team projects. This synchronization was positively mentioned many times, such as *"as always, I very much liked that the lecture was very well synchronized with the tasks [the milestone submission]."* *

To benefit from such a multifaceted course structure it is also necessary to clearly and understandably communicate it to the students themselves. Here, we found that specifically the comprehensive and easy-to-access course information on the course webpage was appreciated by students: *"Kudos to the course webpage; it is very clear."* *

*Principle 3: Construction of knowledge*

"The successful learner can link new information with existing knowledge in meaningful ways" [1].

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[1] Translated from German. Feedback sheets were written either in German or English. Quotes that we translated are marked with an *.

This principle calls for an incremental, cascading way of learning that we realized along the subject-specific as well as generic dimension. Starting with their existing knowledge of interacting with computerized devices, students incrementally constructed their own interactive apps in team projects. The incremental learning steps ranged from initial heuristic evaluations, different stages of prototyping, towards a final usable software tool. During this process, we offered multifaceted guidance by incrementally introducing more and more components of the (HCD) process in the course, providing several programming tutorials, and by offering a constant feedback channel to tutors (forum and in person) and instructors (consultation and feedback in units and via email). Note that the HCD as an iterative design process ideally lends itself to such a cascading teaching approach. The outcome of the project (usable software) is the result/materialization of the representation of knowledge. Its coherence is evaluated (amongst others) in usability tests with end-users, and feedback/results serve as further guidance for improved representations. We found multiple instances of students positively reporting on such cascading learning effects, as in this student feedback sheet: *"In the student presentations, it was clearly visible that they had learned from previous mistakes to further improve their own tool."* *

The presentations given by the students were seen as a particularly useful tool in the process of linking new information to existing knowledge. The presentations provided multiple perspectives and helped to build and extend upon existing presentation skills of the students: *"In comparison to other courses, the HCI presentations are more professional, as attention is not only given to the content of the presentation, but also the way of how the content is presented by the students."* * While students voluntarily signed up for presentations, we rarely had a lecture without any presentation. In the few lectures without student presentations, they were missed: *"Unfortunately, there was no student presentation, which usually spark new ideas for our own project."* *

*Principle 4: Strategic thinking*

"The successful learner can create and use a repertoire of thinking and reasoning strategies to achieve complex learning goals" [1].

Thinking and reasoning strategies are one of the core elements taught in the lecture parts, which introduce many HCI-specific models, methods, and strategies. This knowledge is applied in the student projects, which in turn are presented in the students' milestone presentations. Here, the students share their different strategies to solving tasks (e.g. how can I find/address end-users; which tools have which benefits/drawbacks), and the audience is expected to give feedback and pick up ideas. Interestingly, students explicitly noticed the lack of opportunities for broadening their repertoire of strategies, once only one team assigned itself to present their project-milestone. A student commented on this as follows: *The team presented nice and clear prototypes. [...] It was a pity though that only one team used the opportunity to present. It would have been nice to get further input about other teams' strategies for designing effective prototypes and mock-ups."* *

Another student appreciated a guest presentation in which a former student shared his current practical experience on HCI strategies, further grounding the taught strategies in authentic, real examples: *"In particular the guest presentation on the doctor/patient app was a nice example for HCI obstacles in the real software engineering world. In my opinion there should be more such mini guest talks."* *

*Principle 5: Thinking about thinking*

"Higher order strategies for selecting and monitoring mental operations facilitate creative and critical thinking" [1].

To foster thinking about thinking, we included a variety of metacognitive strategies into our course design. The best example for that are the components of constant feedback that students could provide in their reaction sheets, and which were discussed on a weekly basis in class. Similarly, the final team colloquium at the end gave an opportunity of reflecting on meta-level experiences and strategies learned.

Reflective components, however, were also inherently embedded in many of the day-to-day class room activities. For instance, we frequently engaged in short break-out activities in class, which fostered active communication and critical thinking about the learned strategies: *"Afterwards, we got together in small break-out groups, which again allowed us to actively participate in class. Such exercises are always a very welcome alternative to teacher-centered teaching. The exercise helped us to scrutinize and understand the problem at hand, and to find a practical solution for it."* *

*Principle 6: Context of learning*

"Learning is influenced by environmental factors, including culture, technology, and instructional practices" [1].

As learning does not happen in a vacuum, we sought to carefully integrate the course with the actual cultural and technological backgrounds of its students. Our idea of bridging the theoretical underpinnings in HCI with the practical everyday lives of students was very well received, as e.g. one student stated: *"I experienced the course as extremely positive and refreshingly different. It blends in nicely into the academic context, while at the same time combining pure theory with high, practical usefulness."* *

Similarly, the instructors play a significant role in contextual factors of learning. Here, we opted for a team of four different instructors, each bringing in a rich repertoire of teaching practices, with the goal that there would be something for everybody. One instructor, for instance, relied on illustrative visuals: *"For the introduction into HCI, I specifically liked the fact that there were many images, which made the content more fun and interesting. The example of older people using smartphone imo nicely summarized this topic."* * In another unit, an instructor used many examples in form of videos and own experiences to refresh some theory-heavy content: *"The lecture on perception and cognition was very well structured, and a variety of examples was given, which I liked the most. In addition, the professor added examples from his own experience. The amusing videos raised the spirit, which was a bit low due to the generally rather dry subject matter."* *

However, most importantly our underlying vision of this course was to be on par with the students, which we sought to implement through a variety of interactive practices with genuine openness to criticism and adjustment. This very student-centered approach led to ongoing, positive feedback: "*The theoretical part was very interactive and everybody needed to focus. I liked it a lot, because during the whole session we were kept interested. ... What I want from future sessions is that they will remain as interactive as they were up to today, but I hope that the other students will participate more."*

*B. Motivational and affective factors*

*Principle 7: Motivational and emotional influences on learning*

"What and how much is learned is influenced by the learner's motivation. Motivation to learn, in turn, is influenced by the individual's emotional states, beliefs, interests and goals, and habits of thinking" [1]. The following course-features and reactions are intended to illustrate how students received our effort to make the course motivating.

Undoubtedly, we found that the development of mobile apps helped to unfold students' intrinsic motivation in a vast majority of cases. A student expressed this in the following way: "*What surprised me and I did not expect is that we have to make an application for mobile phones, which will definitely make the subject even more interesting*."

Moreover, we collaborated in providing a constructive learning climate through including students into several aspects of learning such as forming teams, choosing when to present, asking them and listening to their feedback, etc., at the same time providing transparent requirements and specification of deliverables. A student reflected: "*The freedom that we had with choosing the topics for the teamwork surprised me. Several other courses prescribe a fixed topic and this constrains me in my creativity."* * Another student noted: *"Through considering the online reactions from the preceding unit, problems are recognized fast and, if possible, the course is adapted*." * Yet another student appreciated the student-staff interaction and wrote: "*In general, this course takes an interesting approach since the wall between students and instructors is experienced to be very thin, as opposed to other courses.*" *

A small but significant feature was that students could co-determine the number and duration of breaks. An appreciative response to this was: "*What I also must praise is that the professors ask the students how many/when they would like to take a break, so that we all stay focused.* "

*Principle 8: Intrinsic motivation to learn*

"The learner's creativity, higher order thinking, and natural curiosity all contribute to motivation to learn" [1].

Let us exemplify some instances of stimulating students' intrinsic motivation directly by quoting excerpts from their reactions: "*All I heard should indeed be very useful when I start making my own user interface, so that I know which colors to avoid, which functions to provide, and so on. Especially the received feedback on our project is something I consider very useful, and what I am truly thankful for."*

The intrinsic motivation in giving feedback was reflected as follows: "*I felt that the group gave feedback not because they have to but because their feedback was backed by real interest and a desire to help us to improve our next presentation.*" *

*Principle 9: Effects of motivation on effort*

"Acquisition of complex knowledge and skills requires extended learner effort and guided practice. Without learners' motivation to learn, the willingness to exert this effort is unlikely without coercion" [1].

The following two reactions illustrate the motivational "nature" and guidance provided in the course: "*I liked the fact that the instructors not only present stuff, but over and over share their own experience and thus provide students with solid examples how the theory can be applied in practice.*" * And: "*Due to good tutorials and the well-structured Android Developer page ("http://developer.android.com/") I managed a successful start with Android-programming.*" *

*C. Developmental and social factors*

*Principle 10: Developmental influence on learning*

"As individuals develop, they encounter different opportunities and experience different constraints for learning. Learning is most effective when differential development within and across physical, intellectual, emotional, and social domains is taken into account" [1].

One strategy we applied in following this principle was to balance requirements and creative freedom in all tasks. For example, student teams were free to choose the topic for their project. They could select it from a list of proposed topics or suggest a topic in accordance with their interests and backgrounds (see also Principle 8).

The following two reactions illustrate that whenever we acted in accordance with this principle, this was positively valued by students, and when we missed to pay attention to some aspect of this principle, students reacted critically:

- "*It was also very nice of the professors to help students, who did not yet have a team to find and facilitate team-formation."*
- "*I'm studying psychology and have chosen this subject to learn about a new application field of psychology. After this course, I'm not only interested in the theme of HCI, I'm even enthusiastic and very glad that I chose this course. ... Unfortunately, the second assignment was too difficult for me to complete. The programming-tutorials were not basic enough to help me as newcomer, and other things were too fast for me to keep up. For this assignment I would have liked to have an alternative requiring similar effort but being apt for non-computer scientists.*" *

As a consequence, we consider that in the future, students from communication science or psychology will be allowed to make up for their lack of programming skill by other contributions.

*Principle 11: Social influences on learning*

"Learning is influenced by social interactions, interpersonal relations, and communication with others" [1].

This principle significantly contributed to the constructive learning climate. The team of four lecturers (mix of senior and junior, male and female) coherently offered an interactive course-style with constructive openness, transparency, and respect, trying to understand each other as well as the students' view of the course as a whole. This reflected the course's pedagogical approach that was based on Carl Rogers Person-Centered Learning [8] and its technology enhanced successor PCeL (Person-Centered technology enhanced Learning) [28]. The instructor team acted as resourceful people, taking learners seriously as peers in the learning process. Some vignettes on the social and communicative dimension of the course are:

"*At the beginning the audience was not very active. Then we were offered to discuss the questions with our neighbors. For me it is easier to think out loud. I believe it is a splendid method to get the students more involved." **

*"Afterwards, we engaged in a break-out group exercise. Through this exercise, we actively connected to our peers from other teams, with the goal to understand their problems, and question their solutions." **

"*I was happy about the fact that we have to do both individual and group tasks, as "team-work" implies the interaction with colleagues and I am eager to meet new people*."

Milestone 4 from the team-project required testing the students' mobile apps with end-users. This confronted students with the fact that end-users' needs may well differ from the designers' perspectives. This experience provided an important learning effect, as students often shared in the final colloquium.

### D. Individual differences factors

*Principle 12: Individual differences in learning*

"Learners have different strategies, approaches, and capabilities for learning that are a function of prior experience and heredity" [1].

Following this principle in a large class appears to be a particular challenge. Would it be possible to make the course "right" for everybody in 4 cohorts of 50, i.e. overall 200 students? Our strategy on this was to take an active approach in acknowledging opinions, when voiced in oral or written feedback, and let students participate in searching for solutions on how to deal with diverse needs. An example was the number and duration of breaks during the 3 hour long course-units. We experimented with moving from one longer break to two short breaks – as students suggested. The important message in such experiments was: "Your voice counts, we listen to your reactions and you can have an influence."

Furthermore, some students preferred individual work while others preferred working in teams. This was part of our decision to provide diversity in terms of team- and individual work. Students tended to like this mix, as is illustrated by the following statement: "*Group work and individual are always good because of its dynamism and abilities to build individual skills and group skills.*"

*Principle 13: Learning and diversity*

"Learning is most effective when differences in learners' linguistic, cultural, and social backgrounds are taken into account" [1].

Following the linguistic dimension of this principle, early in the course we asked students whether they'd like to have some lectures in English (instead of German, the local language). The vast majority was in favor of this proposal, since they wanted to improve their English. Others hesitated, not being sure whether they'd understand sufficiently well, but were o.k. with trying out the English option. This experiment went very well, and provided extra learning, as students' – in part even enthusiastic – reactions testified: *"The language shift in this unit was a refreshing change, and I'm looking forward to the next unit held in English because I always like to improve my English skills." **

Aside of linguistic diversity, students welcomed the diversity in the team of instructors as well as the fact that we invited a guest-speaker from industry to share real experience. The following reaction illustrates the students' acknowledgement of these diversity aspects: "*I like the fact that the professors will change, as this is a good way to get different perspectives and ideas. I am also looking forward to meeting people who work in the domain (guests) and can share their practical experiences with us..*"

*Principle 14: Standards and assessment*

"Setting appropriately high and challenging standards and assessing the learner and learning progress – including diagnostic, process, and outcome assessment – are integral parts of the learning process" [1].

This principle is illustrated by the following student's statement from the first unit and illustrates the positive attitude regarding the multi-facetted course assessment mode (see also Section III): "*The distribution of the credit-points for the whole course was interesting. I wouldn't have expected that so many partial achievements would be taken into account. This is something I like because one isn't evaluated solely by the performance on the project.*" *

## V. SUMMATIVE COURSE EVALUATION

The Faculty of Computer Science evaluated the course by an anonymous online questionnaire. Questions consisted of general questions standardized across all courses, questions by the head of the study program regarding the course, and a set of open questions. The four groups were evaluated separately, and overall 38 students participated in the evaluation (7 females, and 31 males). The low participation in such official evaluations is not un-common, as (1) participation is voluntary, (2) it was conducted after the course had officially ended, and (3) it was set up online with students being invited via email. While we are aware of the natural biases that might stem from self-selected participation, the results are in-line with the data obtained from the weekly qualitative reaction sheets.

Table I shows a selection of the results, and sets it in context to the aggregated rating of all 87 computer science courses at the University of Vienna in the summer term 2015[2]. Overall, the quantitative evaluation was very positive. Respondents tended to find the course topics highly interesting (question 1.2: "I find the topics of the course very interesting…", see Table II) and the course very good (question 1.5: "Overall, I found the course…").

When being asked about the general didactical structure all of the students who responded had a very positive feedback (question 2.5: "The content of the course is didactically well structured"). Also they stated that the instructors' responses to their contributions and questions were remarkably positive (question 2.6: "The instructors' responses to the students' contributions and questions is appropriate").

Nearly all students responded that the course sparked a further interest in HCI and that the course motivated them to further delve into the topic (question 2.7: "The course encourages deeper involvement with the subject area").

TABLE I. MEANS AND STANDARD DEVIATIONS ACROSS ALL FOUR GROUPS, AS COMPARED TO THE OVERALL FACULTY OF COMPUTER SCIENCE EVALUATION IN THE SUMMER TERM 2015 (LAST COLUMN). LIKERT SCALE FROM 1 TO 5, WHERE 1 MEANS POSITIVE ("I AGREE" / "VERY GOOD") AND 5 NEGATIVE ("I DON'T AGREE" / "VERY BAD")

| Question | Group 1 (n=10) | | Group 2 (n=10) | | Group 3 (n=5) | | Group 4 (n=13) | | *All CS courses* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | μ | σ | μ | σ | μ | σ | μ | σ | *μ* | *σ* |
| 1.2) | 1.3 | 0.7 | 1.1 | 0.3 | 1.3 | 0.7 | 1.6 | 0.9 | *1.9* | *1.0* |
| 1.5) | 1.2 | 0.4 | 1.1 | 0.3 | 1.2 | 0.4 | 1.4 | 0.9 | *2.2* | *1.1* |
| 2.5) | 1.1 | 0.3 | 1.3 | 0.7 | 1.1 | 0.3 | 1.2 | 0.4 | *2.2* | *1.1* |
| 2.6) | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | *1.6* | *0.9* |
| 2.7) | 1.5 | 0.7 | 1.3 | 0.5 | 1.5 | 0.7 | 1.2 | 0.4 | *2.2* | *1.2* |

In the open questions students expressed their thoughts about what they liked and what they didn't like about the course. The resulting qualitative evaluation contained a few critical and several appreciative statements. On the negative side, one student complained that: *"Too much effort was required."* * Another student found: *"Assignment 2 [dealing with App programming] had little to do with HCI."* * and yet another student wrote: *"The literature test was not relevant."* All these indicate space for improvement. - On the positive side, students shared their impressions such as: *"Very fair instructors, well prepared and structured. All in all excellent and by far the best course this semester."* *

In summary, we found that this final summative evaluation was in-line with the results we gathered from the on-going formative evaluation through online and direct feedback.

In addition to this survey, students nominated the course for the University of Vienna's yearly Teaching Award, which we were happy to actually win. We got the award for the category of "innovative course concepts using digital media in MINT-subjects". Overall, 6 courses were awarded from approx. 7,000 courses conducted each year at the University of Vienna.

## VI. CONCLUSION

This paper makes a case for learner-centered instruction, even in classes with large (200) student populations that are split into parallel groups of 50 students. Our case study illustrates how this style can practically succeed in a team-instruction approach with technology-enhanced learning. We found the lively subject matter of HCI to be particularly suited for a learner-centered approach. This is because human-centered design calls for the *inclusion of end-users*, while correspondingly learner-centered instruction emphasizes the *inclusion of learners* into all aspects of the learning process.

In general, research underlying the learner-centered framework shows that learning is enhanced in contexts where learners have supportive relationships, have a sense of ownership and control over the learning process, and can learn with and from each other in safe and trusted environments [4]. All these aspects were reflected in our case study and we experienced that several of the overarching 14 learner-centered principles address *student inclusion* in some form, such that it can be seen as one of the pivotal values. Without authentic interaction [29], the vast majority of significant, experiential learning for both students and the team of instructors would never have happened. Though technology had a considerable share in that interaction via students' reaction sheets and forum postings, the face-to-face interaction was experienced at least as important. The group size of 50 called for a clear unit structure for effectiveness but was well suited for enriching face-to-face interaction in class.

In this paper, we reflected on our course through 433 written reaction sheets from students, backed up by a summative evaluation conducted by the Faculty of Computer Science. We analyzed the qualitative data through the lens of APA's 14 learner-centered principles [1]. In the future, we plan to extend these findings with a bottom-up analysis, as for instance practiced in grounded theory methodology [30]. We also plan to more comprehensively compare our course design to other courses. For instance, it would be interesting to see how the students' perception of the learner-centered principles differ in comparable courses, and what impact this difference has on quantifiable metrics such as drop-out rates.

Intriguingly, what made the teaching of the HCI course a valuable experience *for us as instructor-team* was the fact that *learning was reciprocal*. We too learned meaningfully from the different perspectives students and guest lecturers brought in through versatile opportunities for contact and sharing. All this is helping us to add to our expertise. We wouldn't like to miss the experiential learning from each other and are grateful to our students for supporting us on our journey to further improve the course on several dimensions.

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[2] The aggregated results of the overall CS evaluation are available online: http://tinyurl.com/eval-2015-cs-univie

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