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NON-TECHNICAL SKILLS TRAINING FOR DESIGNERS

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Abstract

Previous research indicates that the success of professional practice depends not only on the ability to solve problems and design solutions but also on project management and communications skills in working with others in a team and dealing with a client. So far design education provides little systematic training and assessment for these skills. We suggest that an appropriate form of training would combine situated approaches for experiential learning with explicit guidance. We examined one student project in engineering with ample opportunity for experiential learning and explored means for more explicit instruction to non-technical skills. Based on research of professional practice, a pilot version of a training programme was developed for design students. It incorporates team co-ordination, planning, client communication and problem solving. Learning progress is measured with a behavioural marker system. We found statistically significant improvements for planning and anticipation of potential outcomes and a tendency in the expected direction for co-ordination and considering team and client. However, so far the success seems to depend on face-to-face interaction and personal feedback, so the questions remains if the same concept can be applied to larger classes or distance learning.

Keywords: interactive learning, competence development, design education

1 Introduction

More and more evidence indicates that social skills have an important role to play in professional design practice. They cannot substitute technical professionalism but a lack of non-technical skills may jeopardise the success of an otherwise perfect design project. Even though the majority of time is spend on individual designing, many of the critical situation within a design project in industry involves communicating and collaborating with other people such as clients, management, other departments and team colleagues [1]. Zika-Viktorsson [2] also showed that project work requires a complex set of knowledge, skills and abilities for managing both the technical and social aspects of design projects. Some authors also argue that we gain a better understanding of designing if the organisational context and interaction between the people involved are taken into account [3, 4]. Designing involves the mental anticipation of a user and/or client; it is always designing for someone. Interacting with this other person can provide essential information for the designer or may be a business necessity. However, the users views do translate easily into design requirements, and their integration may actually complicate the design process [5]. Although the basic problem solving process remains the same, the actual design process varies for different types of organisations [6]. If we accept the importance of this non-technical dimension of design, is there any way that students of design can prepare for this part of professional practice?

So far design education provides very little training for non-technical skills. Prospective employers attribute high importance to social skills but they are not taught and assessed as part of the curriculum [7]. While accepting this demand there does not seem to be a straightforward solution to teach these skills. Since communication and co-operation is as much a craft as design, we find a similar debate between different approaches to train them, namely explicit instruction and experiential learning. Explicit instruction provides guidance and a set of behavioural rules, which incorporate received wisdom and help students to avoid known problems rather than learning from trial and error. We find this approach in the explicit design methodologies such as [8], and many commercial training products are based on the same principle and are no doubt effective. However, training transfer remains difficult: problems in the real world do not easily fit into one of the taught categories, and it may be unclear which rule to apply to them. The philosophy of experiential learning on the other hand is to provide opportunities for the learner to pick up what is relevant to them in a more natural setting. An increasing number of design courses include project work, during which students collaborate on a task for a number of weeks and thereby experience the social nature of design projects to some degree. However, the students are usually left to themselves to handle critical situations without any instruction and professional feedback or reflection. As for design education in general, I propose that the most adequate solution is a combination of both.

This paper describes a possible approach to non-technical skills training and how it could be evaluated. I will then report two pilot studies. The first one accompanied a one-year project course with engineering students at ETH Zurich. The second study provided instruction on communication and project planning for industrial design students at Robert Gordon University in Aberdeen. The aim was to test different teaching methods to find an effective and economical way of providing this training. The results include rankings of student performance on a behavioural marker system and feedback from the participants and staff.

2 Non-Technical Skills Training

2.1 Definition of Content

Lewis & Bonollo [9] offer a basic framework of professional skills for design education, which describes the critical information flow between client and designer during task clarification, concept generation, refinement, and the communication of results after the detailed design. Based on an analysis of design educators' comments to student work, they define professional behaviour at an individual level as following:

- Negotiation with client during task clarification and beyond for changing demands
- Problem solving, design process skills (wide range of ideas, systematic evaluation, careful consideration during detailed design, good visual presentation)
- Acceptance of responsibility for outcomes, behaving as an autonomous professional
- Interpersonal skills, establishing rapport with client
- Project management, planning, meeting targets

We complemented this list based on empirical research of professional practitioners [1, 2] and own observations of design teams in six different companies [10]. This research accounts for designing in a team context and points to potential areas of improving practice. Problem solving, planning and client communication remain important but have to be co-ordinated with others. We therefore added the following team aspects of professional behaviour:

- Exchanging information
- Co-ordination of activities in the team
- Assessing capabilities of others
- Workload management in the team
- Team building and maintaining
- Collaboration and support

Our observations and four case studies from the members of the Design Innovation Cluster at Robert Gordon University, Aberdeen also indicate that it is important to communicate what design competence is when dealing with lay people or other professionals. Industrial designers find themselves in a facilitator role between technical and marketing expertise, which they are not adequately prepared for. However, their core competencies are largely unknown to their partners and therefore need to be communicated. In retrospective interviews, both designers and clients valued the personal contact between them but described it as a result of a successful collaboration. Therefore another important learning objective was to make the students more aware of their skills set and not only show it in terms of objectify-cations abut also be able to talk about it during the process.

2.2 Training philosophy

The training draws on educational theories of situated learning [11] and previous research about team reflection to enhance learning [12, 13]. These approaches provide learning opportunities embedded in a realistic task, which gradually increases in difficulty and practice “local”, specific skills before moving on to a generic, global understanding. Generic principles are typically not taught explicitly but are acquired by means of a post mortem analysis or “abstract replay”. After one student has mastered a task, the whole class is encouraged to re-think the way the person arrived at the solution. This allows for vicarious learning and explication of strategies. We also used stories as instructional material to convey other people’s experience. Stories can promote understanding and help the learner to diagnose a problem; they also have high credibility [14].

2.3 Behavioural Marker System for Evaluation

For the evaluation, we drew on non-technical skills training in other industries such as aviation and the medical profession. In these high-risk environments Crew Resource Management (CRM) has been introduced in the last decade to improve team communication and prevent serious mishaps [15]. Pilots now have to pass simulator tests for their CRM skills in many airlines to retain their licence. Both for licensing and for educational purposes, an assessment tool is indispensable [16]. Psychologists have developed so-called behavioural maker systems for reliable and valid measurement of non-technical skills [17]. Based on a task analysis, professional behaviour is defined in terms of poor, average and good practice. The description is purely in terms of observable behaviour; any judgement of attitudes or intentions is avoided. Enacted scenarios and video recordings of real interaction are used to train observers. Most of these systems are intended for the use and management of complex systems rather than for design. Therefore the skill set is slightly different to the one we defined in 2.1. The staff involved in teaching the design course provided a content validation check of the behavioural maker system. For each element of the course, we specified which behaviours were relevant. Two observers applied the system to rate student performance during the sessions, and their written output.

3 Study 1: Reflection within experiential learning

In the first study, we followed engineering student teams through a one-year project (200 days) in their second year at ETH Zurich. The course was introduced to practice a broad skill set for product innovation such as problem solving, systemic thinking and social skills complementing the existing disciplinary teaching [18]. It is now a well-established element of design education with a new applied task every year. The class is generally quite large (about 150 students), so the students are split into twelve teams of 12-15 people supervised by a research assistant. They meet regularly at least twice a week, and the time demand can become quite intense, especially since the groups tend to develop their own dynamics in competing for even better presentation and fundraising. Students are generally very motivated and value the practical experience despite its high demands.

3.1 Accompanying Programme

We followed the teams, provided feedback on internal communication and cognitive strategies and offered an accompanying programme but were not involved in the design and running of the course itself [19]. The aim was to make the learning of social skills and strategies more explicit. We also wanted to provide students with tools for reflection that they could use in their professional practice. Part of our intervention was to measure how the students re-defined their task, how this changed over time and how they handled the overall workload. As part of the overall framework, we also offered a seminar and a discussion forum to enhance reflection, and analysed how the groups used their FirstClass platform.

Re-definition of a task refers to a person's understanding of what they are expected to do as opposed to the actual order they were originally given. It forms an important part in the psychology of work motivation since it is this redefined task that will influence which goals people set themselves as part of their work. Asked for their re-definition of the project task, the students provided a broad range of learning goals, which we grouped into three headings: working in a team (reach the goal together, contribute to team, social skills), developing a product (experience process, combine theory and practice) and aspect of the product itself (innovative, modular, usability). Only 21% of the answers referred to the requirements of the product as mentioned in the brief. Students seemed to value the experience (43% of the answers) and team dimension of the project (36%) even more then those who initiated it.

The observers visited the groups at three times during the year, recorded the process in a non-standardised manner and shared their records. Comparisons between groups are difficult based on these data but there were some striking similarities. Most groups showed a strong tendency to division of labour, which resulted in distinct subtasks and little holistic learning. The reason for this tendency may be the size of the group, which rendered discussions with the whole team unproductive, and amount of work, which suggested some specialisation. In view of the competition, members had to contribute their strengths with little time for personal development in other areas. Here the project unintentionally provided a very "real world" experience of pressure to perform rather than opportunity to learn. In subsequent years, attempts were made to minimise the competitive culture. A powerful change would be to reduce the group size but not without a huge impact on the required staff time.

The opportunities for reflection such as a logbook or discussion groups were generally used very little. The project was already subject to a lot of time pressure, and the additional moments of reflection did nothing to reduce this. Also the feedback on social interaction did not formed part of the standard assessment and therefore carried less weight.

3.2 Consequences for non-technical skills training

The project approach provides no doubt many opportunities for experiential learning of non-technical skills as defined in 2.1, and it is valued as such by the students. However, the attempts to facilitate reflection within this framework generated a lot of effort on our behalf without direct benefits for the students. Designed as an explorative study rather than a training programme, it contained little intervention, and the impact given the high time constrains for students, was not clear. Also for this scale of operation, specific feedback to individuals or teams from additional staff was far to time-consuming for all involved and not a practical framework for teaching non-technical skills. We therefore explored other forms of explicit instruction and distance learning, which could be integrated in educational design projects.

4 Study 2: Instruction as part of a design project

In the second study, we aimed to make the non-technical skills an integrative part of design education and provide a comprehensive training with less contact time than the large-scale observation. The purpose of this pilot was to establish the feasibility of such training on a broader scale and to test different forms of delivering the training for their effectiveness. In particular, the study is designed to determine which elements of the training need face-to-face contact in role-play or real encounters and which can be taught through a web-based format with written scenarios and feedback.

4.1 Course design

The non-technical skills training was delivered as part of a self-managed programme of study for third year students of Design for Industry at Robert Gordon University Aberdeen. Again, project work has been an integral part of the design education for a number of years. The scale is considerably smaller: The class consisted of 23 students in groups of four, and this particular project run for six weeks only. It was the first experience of collaborative work and a "real" client.

The project brief for the six weeks came from a local primary school, which had approved the university for a design concept to turn an underused courtyard into an outdoor classroom. Student were asked to design "a secure and stimulating environment", which would "depict the biodiversity within the community" and actively encourage staff to use this area to deliver science /environmental studies". One class of 10year olds had been identified to represent "the client". Being located in an under-privileged area, the school had only limited funds available for the project, so consideration of cost was a premium requirement.

The training consisted of a two hours session every week apart from a distance task in week two, carried out by the author and analysed by a research student:

1. Introduction and relevance of non-technical skills: pre-test (written scenario), case study from [10], analysis of the ill-fated bag dispenser development [20], overview of behavioural markers
2. Distance learning text on project planning and questioning the client brief, written scenario as test
3. Input on chairing a discussion, idea generation in groups and facilitation techniques, observation and reflection of group discussion on problem definition, anticipation and option generation
4. Input on client interaction and presentation, written scenario on client meeting about project process, observation and reflection of client visit
5. Mock presentation with design feedback and observation of non-technical skills
6. Observation of final presentation to client and participant feedback

The students were briefed about the purpose of the course and the evaluation research.

4.2 Implementation of training

Overall the training was well received by students and supported by the staff involved. The students participated actively in the exercises and gave detailed responses to the written scenario. They were willing and able to reflect on their behaviour and extract lessons learned. Staff commented that being able to express a view and explain it is practiced from year one onwards, since this is an interdisciplinary course with lessons in contextual studies as well as input from engineering, design tools, manufacturing technology and marketing. However, the attendance rate in the beginning was low so the evaluation could only be based on a very small sample.

Distance learning

In an attempt to test different forms of teaching, we delivered the second session in a distance-learning format. We had assumed that the project planning and analytical task would be more suitable to teach through this format than social skills of communication and consideration, so we included both aspects but placed more emphasis on the former. Students were emailed the course content and asked to respond to a written scenario. However, the initial response was very low, and we had to allocate time in the next meeting to finish the answers. This should not be interpreted as a negative indication for distance learning, there are successful courses in operation; but rather that this part of the intervention failed due to a lack of infrastructure and an element of surprise for the students who had not yet committed themselves to the course in week two.

Problem definition

In week three, some of the students had been in contact with the school and questioned the children for their ideas, other had inquired at a local science museum and carried out research on other schools and the syllabus for primary schools in Scotland. However, the progress was still slow, so we used the exercise on facilitating team meetings to determine the future course of action. The class was divided into two halves, and students shared their research results somewhat reluctantly across the groups. The structure provided an overview of further research and option generation (see figure 1).

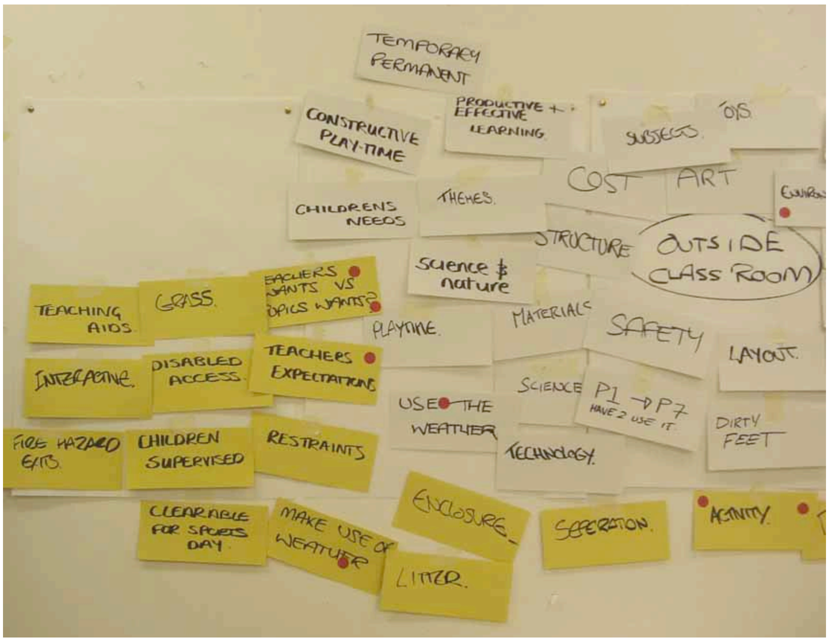

Figure 1. Aspects of the design problem captured by students

Meeting the client

The client is this project was multifaceted entity: the head teacher, other members of staff, potentially parents in the background, and the children as users. The basic problem that the person who commissions and pays for the design it not identical and may have inappropriate preconceptions of what the users wants and needs, is common to professional practice. We therefore encouraged the students to question the design brief and included other sources of information in the problem definition. In this case, the brief contained the additional challenge to deal with a young and less articulate user group. Apart from independent visits to the school, the course co-ordinator had arranged for the children to come to the design studio and view the first set of design concepts (see figure 2).

Figure 2. Students introduce their concepts to the users

On reflection of the visit, the students realised that their sketches did not easily appeal to the children and that they had not considered smaller kids in their concepts. The observation that “all they want is a McDonalds” elicited a discussion about the underlying reasons for this attraction. In terms of consideration, an important lesson learnt was careful expectation management with a client with limited resources and user representative who were not going to benefit from the new environment.

4.3 Learning progress according to behavioural marker system

An indicator for educationally successful training is that the performance at the end yields a higher mean and a lower variance, compared to the pre-test. This means that on average students are more competent and good and poor students reach the required standard alike. To test this hypothesis, we carried out pair-wise comparison for those behavioural markers that were used in the pre-test and the rating of the final presentation. This does not include all variables used, and only eight of the 23 students (half of the class was not present at the first meeting and one group did not present at the end). Table 1 shows the results of the comparison.

Table 1. Learning progress for five behavioural markers used at pre-test and final presentation

Behaviour marker	$mean_{t1}$	$mean_{t2}$	σ_{t1}	σ_{t2}
Co-ordinating	-.13	.38	.835	.518
Problem definition	.50	.88	.756	.354
Gathering information	.00	.50	.535	.535
Anticipation	-.63	.38*	.518	.744
Planning	-.38	.63*	.916	.518

The behaviour markers were rated on a scale of –1 for poor performance, 0 for acceptable, basic performance and 1 for good practice. The means at time 1, the pre-test, indicate that co-ordinating, anticipation and planning were not satisfactory. Only problem definition, which could be seen as a core design skill, was already at a positive level before the training started. For all behavioural markers indicate the means increased at time 2, the final presentation. The standard deviation σ, which can take values between 0 and 1, is relatively high at the beginning and decrease after the training apart from gathering information and anticipation. For anticipation and planning, this change is statistically significant despite the very small sample. This entails that the effect is definitely not due to chance even tough one might be careful about generalisations.

The staff involved commented positively on the learning progress for the students. The course helped to make both them and the students more aware of designer-client communication and project management in the teams. The fact that there was a real client raised the importance and accountability. However, staff were also conscious that the students spend too much time "getting into the mind of the kids" and too little on design principles. Adding two more people to the four already involved staff was also seen as a potentially distracting issue.

5 Conclusions

In both studies, students perceived non-technical skills as an important aspect of professional practice and are open to learn in a project-based environment. However, most courses only provide accidental learning opportunities without explicit instruction and professional feedback. Our training programme in study two was designed to remedy this. It generated a framework and assessment format for social competence training. The pilot evaluation indicates that overall the learning objectives were met and significant success was achieved. However, this result is based on a small sample size, which mainly poses question to the practicability in larger classes. So far the success seems to depend on face-to face interaction and personal feedback, the distance learning condition could not be implemented in the intended manner. This still implies high demands on teaching staff similar to study one. For a truly convincing approach to implement non-technical skills training as a standard module in design education, the existing work on the content and the assessment needs to be tested with larger classes.

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