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DESIGN-RESEARCH-IN-EDUCATION; COMBINING THE BEST OF BOTH WORLDS

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ABSTRACT
The pressure of publishing becomes more and more important, while on the other hand we have to deal with hard deadlines when it comes to education. In achieving the difficult balance between a good research track record and appropriate education we are condemned to see how we can implement design research in education. Performing such research can however have a benefit for both worlds. Students can learn from the developments in research and can also take part of it. On the other side we can use those students to test certain principles like a new developed design method, which can also improve the learning experience of the student. Best of both worlds you would think. Nevertheless, there are also some pitfalls that we came across. Especially with regard to evaluating different approaches, because normally it is deemed unethical to teach separate groups of students differently. This paper will share insights about performing design research in education. We will discuss a case where design research in education is used and we will evaluate the benefits, the pitfalls and the results for students as well as researchers.

Keywords: Design research in education, design education, comparing design methods, brand extensions.

1 INTRODUCTION

The very definition of a University is a place which combines education with research. Especially in the recent University practice the pressure is high to produce ample research output. On the other hand the budgets for education are shrinking or at its best frozen. In achieving the difficult balance between a good research track record and appropriate education we are therefore condemned to see how we can implement design research in education and vice-versa.
As discussed by Read [1] and later adapted by Frayling [2], we can divide design research into three areas: research into design, research through design, and research for design.
The first one, research into design is the most conventional one with a focus on researching the field of design (for instance historical research or researching the perception of consumers). The second one, research through design, is focusing more on the act of designing itself. The process of designing can be researched to achieve a better understanding of a research question. The latter one 'research for design' is according to Frayling the most doubtful one, where the "thinking is embodied in the artefact". In other words, it is the process of gaining knowledge which you need to make a proper design in the end.
From those three, the 'Research through design' approach is developing and gaining more and more importance since the 1990s. Ann Brown [3] was one of the first pioneers to execute 'design experiments' to know more about a certain phenomenon in the real world instead of executing experiments in a laboratory. Later the term design experiments was better labelled by 'research through design', where the actual designing itself is an important factor in the process which can learn us more about the research question.

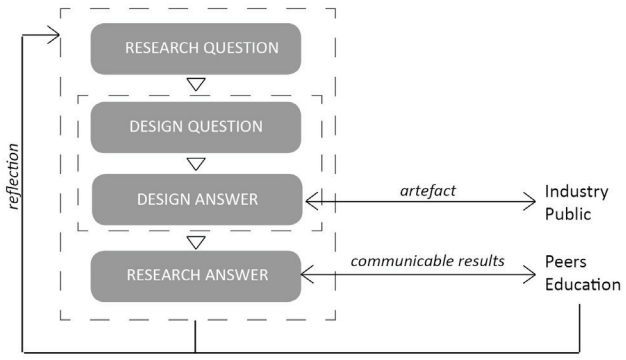

Figure 1. Scheme visualizing design research in education adapted from Findeli [4]

Findeli describes design research as "*a systematic search for and acquisition of knowledge related to general human ecology, considered from a 'designerly way of thinking (i.e. project-oriented) perspective*" [4] (see figure 1). So in other words: the central part of research through design is the design project which can be reframed into a broader research question. The design project can be performed by designers (in our case design students) and will result in artefacts. These artefacts can be used to communicate and evaluate with industry/public and finally will provide a better understanding of the research question.

Combining research through design *in* education seems to be promising for our situation, because in this case we are instantly balancing both worlds. Students can learn from the developments in research and can also take part of it. On the other side we can use those students to test certain principles like a new developed design methods, which can also improve the learning experience of the students. Best of both worlds you would think. Nevertheless, there are also some pitfalls that we came across in our 'research-educational' practice - especially with regard to evaluating different approaches. To evaluate different design methods we proposed to split a population of students in half. This led to problems with the board of examination, because normally it is deemed unethical to teach separate groups of students differently. This paper will report how we dealt with this issue in practice. We will discuss a case where design research in education is used and we will evaluate the benefits, pitfalls and results.

2 EVALUATING A DESIGN METHOD

A new design method for designing brand-extensions is validated in an existing second year Industrial Design Engineering course on advanced concept sketching. The learning target of this course focuses on enhancing drawing capabilities using a drawing tablet and the ability to use different tools/techniques in the design process (integrating sketches, photo's, CAD models and foam models). We decided to validate the design method in this specific course, because it has no relationship with the learning targets of the course, so the difference in teaching the method would not compromise the results of the students.

In order to validate a new developed design method, we decided to split the group in half. One half of the group received extra lectures where they learned the new design method, where the other half of the group was intended to follow only the normal lectures of the course. During the whole process the design students will be observed and also questioned about the actual effect of the different methods.

2.1 Split the group

The experiment was proposed to the board of examinations and this resulted in a negative advice to execute the experiment. The main raison of rejecting our proposal was that they could not be sure that the students received the same learning experience. Besides that, they had been hearing rumours about the two groups and the suggestion that the group using the specific method seemed more successful, compared to the other. In order to prevent this we carefully selected this specific sketching course, where the main learning target is focused on making correct drawings (instead of making successful designs). In fact the learning targets and the grading method were based on different aspects and had nothing to do with the design method under evaluation, which focuses on how to achieve a successful brand extension [5]. Thus, a successful result in the quality of drawing and a high grading result of the course, would not immediately imply a successful result of a brand extension and vice versa.

However, during the experiment the question arose whether those two aspects (quality of drawing and success of a brand extension) are correlated with each other. Our claim is that there is of course a relationship between the quality of drawing and the success of the design, but the difference in drawing quality between the two groups should not be noticeably discernible, due to our precautions. Both groups should be capable of designing a qualitative good drawing and a successful design.

2.2 Solution

In order to keep all parties satisfied, we had to come with a solution that works for all. We therefore changed the setup of the experiment and promised to prove that the difference in grading between both groups is minimal. The students had to design a snow scooter for the brand Lamborghini from scratch in four weeks and they all had to use a drawing tablet. The main structure of both groups is the same. In the beginning of the assignment all students receive an (artificial) design brief from Lamborghini. The aim of the experiment was to find out whether the group which uses the proposed new design method would come up with better brand extension designs, compared to the other. To prevent issues, we gave both groups extra 'knowledge' about designing successful products to fulfil their assignments. One group received specific knowledge on designing brand extensions and the other group received more general knowledge about designing products. The final design results of the students were later used as 'research data' to investigate the successfulness of brand extensions [6]. The flow diagram in figure 2 presents the approach that was taken to tackle both the main research question (light grey) and the extra research question to tackle the ethical one (dark grey).

For the main research question, we decided to evaluate the design results by 47 design experts, using ranking scales and semi structured interviews to test if there are differences between the designs of both groups. The respondents were asked to rank the designs on the quality of the drawing and subsequently on the expected market success and the level of brand fit. For the extra question the results of both groups are also examined by our colleagues of Industrial Design Engineering, responsible for design sketching courses in the bachelor. They examined the results based on the learning targets of the course.

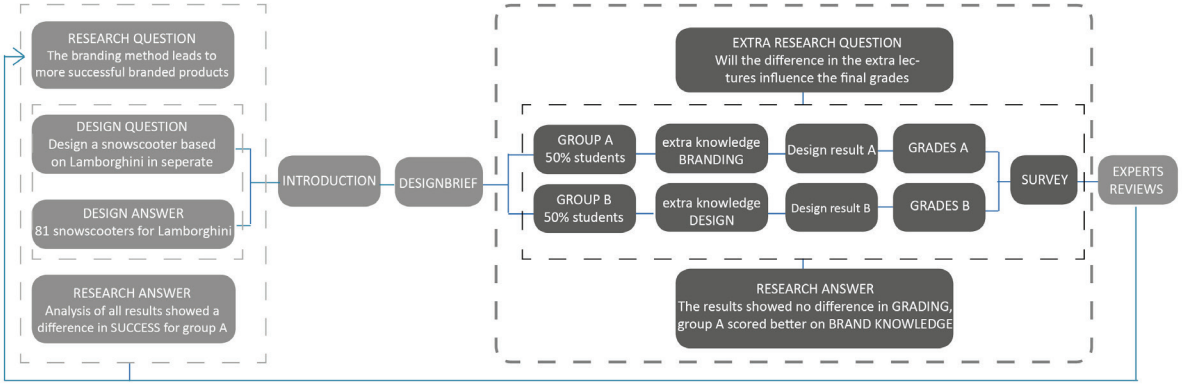

Figure 2. Flow diagram combining the main research question regarding Findeli's design research in education (light gray) and the approach to tackle the ethical question (dark gray)

3 OUTCOMES

In order to test our claim as discussed before we performed a regression analysis in SPSS, to test if the quality of drawing is related to the success of the design. The results of the expert analysis is used to perform this test. The analysis shows us a significant Pearson correlation of 0.74 between the level of quality of a drawing and the success of a brand extension. Thus a drawing with a high level of quality is highly correlated with the level of success. This result confirmed our own assumption, but we still cannot say anything about the differences per group. In table 1 we compared the mean averages of the two groups. Group 1 was the group with the design method on successful brand extensions, group 2 received extra knowledge about general ways to improve your design. The table shows that the average of the level of success in group 1 is higher (444,4) compared to group 2 (422,6), while the quality of drawing of group 1 was lower (453,1) compared to group 2 (493,2). The grading results of both of the groups are comparable. Group 1 has a slightly higher degree (7,0) compared to group 2 (6,8), this effect is so minimal that it can be regarded as no difference between both groups.

Table 1. Comparison between group 1 (with the method to design successful brand extensions) and group 2 (with a general design method)

	code	N	Mean	Std. Deviation	Std. Error Mean
Level of success	1,00	41	444,4390	189,25116	29,55607
	2,00	40	422,5750	207,71811	32,84312
Quality of drawing	1,00	41	453,0732	183,61936	28,67653
	2,00	40	493,1750	216,08390	34,16586
Gradings	1,00	41	7,0183	,93773	,14645
	2,00	40	6,8250	1,14522	,18108

When we perform an independent sample t-test between the two groups, to see whether the designs of group 1 are more successful compared to group 2, we see that both aspects do not reach significance ($p>0.01$).
When we compare only the most qualitative designs of the groups, the difference in success should increase even more, while the drawing quality remains comparable. In order to measure this, we divided all the designs in three levels of quality, namely (1) poor level of drawing quality (0-333), (2) average level of drawing quality (333-666) and (3) high level of drawing quality (666-1000) to investigate if the best students show a lot variation in the level of success. Subsequently we performed the same test with only the selection of designs with a high level of quality – level 3.

*Table 2. Comparison between results with a **high level of quality (3)** between group 1 & 2*

	code	N	Mean	Std. Deviation	Std. Error Mean
Level of success	1,00	8	646,2500	82,06400	29,01401
	2,00	12	572,0000	173,84214	50,18390
Quality of drawing	1,00	8	736,6250	58,14007	20,55562
	2,00	12	752,0833	64,21619	18,53762

Table 2 shows that the difference in level of success between these subsets of group 1 and 2 is even larger (646,3 compared to 572,0) than for the complete groups, with a lower standard deviation for group 1 (82,1 compared to 173,8). At the same time the quality of drawings of group 1 is even somewhat lower than group 2. This means that we can say that the level of drawing quality influences the success of the brand extension, but there is however no significant difference in the quality of drawings and the grading between the two groups.

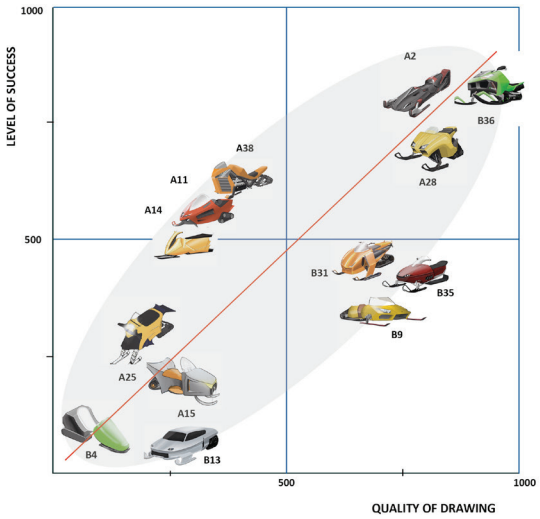

Figure 3. Visual representation of the correlation between the quality of drawing and the level of success for the 13 most extreme outcomes

So first of all we investigated that the difference in the grading (average) between A&B is marginal, subsequently we analysed the outliers of the experiment. This approach showed that indeed the

students from group A were able to design more successful designs and the students from group B were able to create more correct drawings. In figure 3 the extreme combinations of both aspects are visualized. On the horizontal axis the quality of drawing is displayed and on the vertical axis the level of success. The figure shows four quadrants with in the lower left corner low quality and low level of success. The straight line shows the correlation as analysed before, the grey ellipse shows the outliers of the experiment. Furthermore we can see that the designs of group 1 (A numbers in figure 2) tend to lie above the linear correlation line, which indicates that they were able to make more successful designs with relatively less drawing qualities. This could be due to the influence of the proposed method, but further analysis is needed here.

3.1 Differences between groups

To be sure that both groups have actually gained knowledge during the extra lectures, we performed an online survey where the respondents had to answer 10 questions; 5 questions (Questions A) were aimed to test knowledge about the method to design successful brand extensions, 5 questions (Questions B) were set up to test knowledge about the more general method. In total 70 students finished the survey (35 from group A and 35 from group B). The survey was also executed by a control group of first year students to test if the knowledge of both of the groups was actually higher compared to the control group. This test should prove that group 1 and 2 scored overall better compared to the control group. Of course the scores of group 1 for questions A need to be better than group 2 and the scores of group 2 on questions B need to be better compared to group 1. In table 3 the results are summarized and we can see that the overall score of group 1 was higher compared to group 2. Furthermore group 1 scored higher (3,2) on Questions A compared to group 2 (2,4).

Table 3. Average score of two groups based on Questions A and Questions B

	Groep	N	Mean	Std. Deviation	Std. Error Mean
Total score	1,00	35	6,2857	1,17752	,19904
	2,00	35	5,3714	1,30802	,22110
Total score_Questions_A	1,00	35	3,2286	,68966	,11657
	2,00	35	2,3714	,91026	,15386
Total score_Questions_B	1,00	35	3,0571	,93755	,15847
	2,00	35	3,0000	,90749	,15339

It is remarkable that group 1 and group 2 scored almost the same on Questions B. This can mean two things: the B questions were more general knowledge or group 2 is worse in gaining knowledge. The control group existed of 82 first year students with almost no knowledge about design. They scored an average of 5,23. This is just slightly lower than the score of group 2 of the second year students (5,37). In the survey we also asked some questions to evaluate the extra knowledge in the lectures. A short summary of the results of the survey can be found in table 4.

Table 4. Overview of the student evaluations for the extra lectures

		not at al agree (1), not agree (2), neutral (3)	agree (4) & totally agree (5)			not at al agree (1), not agree (2), neutral (3)	agree (4) & totally agree (5)
1. Designing an snowscooter for lamborghini was interesting							
	Group 1	33,3%	66,7%	6. The extra knowledge was easy to apply			
	Group 2	42,9%	57,1%		Group 1	38,9%	61,1%
2. The extra knowledge was interesting					Group 2	60,0%	40,0%
	Group 1	58,3%	41,7%	7. I am a good drawer			
	Group 2	37,1%	62,9%		Group 1	63,9%	36,1%
3. The extra knowlegde was helpful in the designproces					Group 2	80,0%	20,0%
	Group 1	50,0%	50,0%	8. I am a good designer			
	Group 2	42,9%	57,1%		Group 1	61,1%	38,9%
4. The assignments were helpful to practice the extra knowlegde					Group 2	57,1%	42,9%
	Group 1	58,3%	41,7%	9. I am satisfied with my final design of the snowscooter			
	Group 2	40,0%	60,0%		Group 1	61,1%	38,8%
5. The extra knowledge was easy to understand					Group 2	74,3%	25,7%
	Group 1	8,3%	91,7%				
	Group 2	14,3%	85,7%				

In the table you can see 9 questions, the respondents were able to answer the questions on a 5 points likert scale from 1 (not at all agree) to 5 (totally agree). The results are divided into two columns, the

first one combines the numbers 1, 2, 3 (not at all agree, agree and neutral), the second one combines 4 and 5 (agree and totally agree). The survey showed that the students from group 2 considered the extra knowledge interesting. It is also remarkable to see that the extra knowledge of both groups was really easy to understand, which could explain the fact that group 1 was also able to answer the questions B correctly.

4 DISCUSSION

Design-research-in-education helped us researchers to make progress in research outcomes and enhanced the experience in design education at the same time. It was especially interesting to learn from the students and see how they reacted on the methods and adapted the provided design tools.
Besides that, the students were really positive about testing and evaluating new design tools. The most important pitfall is clearly positioned in finding a balance between performing an experiment that will research the correct aspects, and creating an educational environment which ensures all students are able to gain knowledge on the same level. Performing a survey in the end to evaluate the results, really helped to understand the reactions of students and also provided important evidence for the examination board. From a research perspective, it was actually quite interesting to test our developed method based on grounded theories in a real world case as also discussed by other studies [7, 8]. In this way we were able to test the robustness of the method while in the end it also delivered 81 different designs which can be further analysed. An important aspect that has to be taken into account is that the experiment is executed by design students, who obviously react differently to methods and tools than are experienced designers [9]. On the other hand it leads to interesting first experiments which can be extended into real design practice. Perhaps the most interesting outcome is that design students like to be introduced to new knowledge. Unfortunately too much design education today relies on knowledge, tools, techniques and approaches that are "old". We argue that we need more expressions of creativity and innovation through design.

5 CONCLUSION

In this paper we explicitly tried to find a proper balance for doing research through education. In order to apply research through education in practice, it is important to carefully separate the learning targets of the course and the aims of the research. In order to decrease the yawning gap between research and education we hope this paper will provide insights to researchers who struggle with the same difficulties we encounter.

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